

VOLUME 3 | ISSUE 1 | ISSN ONLINE 3082-6373
JUNE 2023



Mabalacat City College
Institute of Business and Computing Education



MCC-IT Research Journal

A.Y 2022-2023

MABALACAT CITY COLLEGE

INSTITUTE OF COMPUTING STUDIES

MCC-IT Research Journal 2023

The MCC-IT Research Journal 2023 is a compilation of CAPSTONE PROJECTS from the academic year 2022-2023. The MCC-IT Research Journal will be published annually by the Mabalacat City College - Institute of Computing Studies (MCC-ICS). MCC-ICS as copyright owner reserves the right to publish, reproduce or copy.

EDITOR	:	Dennis L. Tacadena, PCpE, DIT
TECHNICAL ADVISER / EDITORS	:	Engr. Robbert M. Bamba, MEECE Marilou B. Cabuñag Dessalyn J. De Castro Ritchelle Z. Escoto, MIT Lorenzo C. Macam, MIT Jaypee B. Patdu, MIT Engr. Ernie Lee E. Pineda, MIT Frederic D. Santos Engr. Dennis L. Tacadena, DIT Lovely Ruth C. Valdez Agustin Edmin S. Yuzon
COVER DESIGN / LAYOUT	:	Dennis L. Tacadena, PCpE, DIT
POSTAL ADDRESS	:	Institute of Computing Studies, Mabalacat City College, Rizal St., Brgy. Dolores, Mabalacat City, Pampanga 2010 Philippines
Email Address	:	dennis.tacadena@mcc.edu.ph

MESSAGE FROM THE DEAN



TO OUR BSIT Student Researchers, Technical Advisers and BSIT Program Head,

As the Dean of the Institute of Business and Computing Education, I am delighted to extend my heartfelt congratulations to each and every one of you for a job well done. As we approach the end of the academic year, it is a perfect time to reflect on our accomplishments and look towards the future.

First and foremost, I want to express my pride in our BSIT student researchers, their technical advisers, and the BSIT Program Head who make up the Computing Education department. Your achievements serve as a testament to your unwavering determination, resilience, and adaptability. Despite the numerous challenges posed by the post-pandemic era, you have demonstrated remarkable perseverance and overcome them with flying colors.

As we move forward, my hope and challenge for all of you is to channel your personal curiosity, knowledge, and skills towards a noble purpose. I encourage you to take proactive steps in making a new and lasting difference in the lives of others in the upcoming year. Let your passion and dedication shine through as you continue to contribute to the field of computing education.

MYRNA E. CUENTO-CALMA, CPA, FRIAcc, Ph.D.

Dean, Institute of Business and Computing Education

Mabalacat City College

MESSAGE FROM THE BSIT PROGRAM HEAD



Dear Graduating BSIT Students,

Congratulations on successfully conducting and completing your capstone research projects!

Your achievements stand as a testament to your unwavering determination, resilience, and adaptability. Navigating through the post-pandemic era has posed numerous challenges, yet you have risen above them with commendable perseverance.

Despite the unprecedented obstacles, you have demonstrated exceptional dedication and innovation, which are the hallmarks of true professionals. Your hard work not only reflects your academic prowess but also your ability to thrive in the face of adversity.

We are immensely proud of your accomplishments and confident that the skills and knowledge you have gained will pave the way for a bright and successful future.

Once again, congratulations on this remarkable achievement!

Warm regards,

Engr. Ernie Lee E. Pineda, MIT

BSIT Program Head, Institute of Business and Computing Education

Mabalacat City College

BSIT FACULTY MEMBER & TECHNICAL ADVISER



Engr. Robbert M. Bamba, MEECE



Marilou B. Cabuñag



Dessalyn J. De Castro



Ritchelle Z. Escoto, MIT



Lorenzo C. Macam, MIT



Jaypee B. Patdu, MIT



Engr. Ernie Lee E. Pineda, MIT
BSIT Program Head



Frederic D. Santos



Engr. Dennis L. Tacadena, DIT



Lovely Ruth C. Valdez



Agustin Edmin S. Yuzon

Tables of Contents

Title	Page
AQUAOBRA: A Smart Hydroponics Farming System	1
Bsafe: An Android Mobile App for us in Case of Emergency [A]	14
BUBOY’S HAVEN: An Android Based 3D Endless Running Game [A]	23
BURAI DO: An IoT Based Multifunction Smart Blinds using Raspberry Pi [A]	34
CARTICON: A Microcontroller-Based Car Emoticon Display and Traffic Warning Messages with User Interface Application [A1] [A2]	43
CLEVERBIN: Smart Sortening Bin with IoT Notification	53
D.A.Ki.T.S.: Dau Apalit Kiosk Ticketing System	59
DANUM: “Web-Based Water Billing Management System with SMS Notification in Pueblo Real Water District”	65
E-PARK: An IoT and Web Based Premium Parking Reservation System	78
Ferjan PharmaSite: A Multi-Level Ecommerce Pharmacy for D.M. Ferjan Drug Store	91
Furbies: An IoT Based Smart Home Pet Monitoring System Using Android Mobile Application	102
FURNIFY: A Mobile-Based House Customization and Visualization using Augmented Reality Technology [A]	108
HUMANA CORPUZ: 3D Simulation of the Human Anatomy [A]	120
iLine: A Web-Based Queuing Tracking Management System for PELCO II Customers	128
iLTOGo: An Informative Land Transportation Guide Mobile App [A]	140
ImTheMap: An Android Mobile App that Locates Nearby Resorts [A]	153
ITOUR: 3D Web Campus Guide of Don Honorio Ventura State University and Mabalacat City College [S]	162
Library Management System with QR Code for Jose C. Feliciano College Foundation Library	172
MCC-HSU: Web-Based Mabalacat City College Health Services Appointment and Inventory with Report Generation System	181
OJT Record Monitoring System: A Web View Application for Logging In and Out using QR Code.	196
PADYHAC: Proprietary Application for Dietary, Your Health and Cycling	210
PetPal: A Web Application for Domestic Animal Adoption of Noah’s Ark Shelter for Dog and Cat	224
PlantoChick AquaTech: A System-based Farming of Plants, Fish, and Chicken with Mobile Cloud Application Interface	234
prodScout: A Multi-Platform Application for Parental Monitoring	256
Puzzyalan Jigsaw Battle: A 3D Android Based Jigsaw Puzzle with Trivia [A]	269
Smart Home: A Solar Powered Automated Door-lock, Lighting, and Plant Watering System using Arduino Mega	282

Tables of Contents

Title	Page
SPOTIHOUSE: A 3D Simulation Model of Online Fiesta Communities House Listing with Site Map	295
Talakutnangan: Sistemantikong Mipagsabi Queting MCC [S]	308
The Adventure of Techy Stud2: A 3D IT Essentials Game for Android [A1] [A2]	319
WeStack: A Web-based Ordering and Inventory Management System with Sales Forecasting using Moving Average and Exponential Smoothing Algorithm for Everlife General Marketing	327

NOTE: A – Application S – System

BSIT
FULL PAPER PRESENTATION
ABSTRACTS

AQUAOBRA: A Smart Hydroponics Farming System

Michelle J. Castro
Jennelyn Dela Cruz
Jicel C. Matic
Ezekiel Q. Mercado
Ron Kyle T. Pangilinan
Chester Ryan Sitchon
Dennis L. Tacadena, PCpE, DIT (Technical Adviser)

ABSTRACT

In traditional agriculture, soil is used to cultivate plants. However, plants require the minerals found in the soil for their growth. Hydroponic systems can be developed to provide continuous production all year round in addition to better yields and water efficiency when employed in a controlled environment. The study's main objective is to develop a system entitled "AQUAOBRA: A Smart Hydroponic Farming System". The researchers utilized and used the Prototyping Model methodology as a guide in the application and product development. The developed system has a capable to monitor the prototype ambiance temperature, water system pH level, and Total Dissolve Solids system using mobile application. The ATmega328P, TDS sensors, pH sensors, uPVC, a temperature sensor, a Bluetooth vibration sensor, and a material that is thermally stable, abrasion-resistant, chemically resistant, and UV-ray resistant were all used by the researchers. The Arduino Uno microcontroller board is built around the ATmega328P, and TDS sensors assess the amount of dissolved, mixed inorganic and organic compounds that are present in a liquid. The pH sensors gauge the water's acidity. The created mobile application has a home screen that allows users to check the pH status level, measure the total amount of dissolved solids in water, and view the temperature of the water in the IoT gadget. The developed system garnered a mean score of 81.11% on alpha test and 96.67% on beta test, both interpreted as "Excellent". With all of the evidence, the researchers concluded that the overall objective of the study was achieved.

INTRODUCTION

In traditional agriculture, soil is used to cultivate plants. However, plants require the minerals found in the soil for their growth, not just the soil itself. Numerous macronutrients and micronutrients found in soil are crucial for plant growth. When water is infused into the soil, it transports nutrients to the crops. Plants need to expend a lot of energy to grow their extensive root systems when using traditional soil-based farming and planting methods because the roots must dig deep inside the soil to find water and minerals. In essence, whether they grow in soil or not, plants require water and minerals for survival. These micronutrients are provided directly to the plants without any soil, which refers to hydroponics.

According to Shrestha, the Greek terms "hydro," which means "water," and "ponics," which means labor, are combined to form the English word "hydroponics". Different micro and macro nutrients that plants need is directly provided to them in hydroponic

farming. Moreover, the water already contains these nutrients [1].

As stated by Roser, considering that the world's population is expected to exceed 9 billion people by the year 2050, it is evident that food security is one of the defining issues of the twenty-first century and, thus, the most critical issue facing the agricultural sector [2].

However, according to Torrey, it should be considered that the progressive drop of fertile soil surface, due to environmental pollution and urbanization phenomena greatly complicates the context [3].

In the article of Nguyen, the population's poorest members work and reside in hazardous places. The Philippines had the highest rate of food insecurity in Southeast Asia from 2017 to 2019, with 59 million Filipinos experiencing a moderate to severe lack of reliable access to food. Food costs at local shops have soared today, and temporary farm jobs are in short supply [4].

According to household surveys by social weather stations, food inflation rates reached 6.2 percent in March, a record high that is quadruple per-pandemic levels, and more than one in five Filipinos would go hungry at some point in 2020 [5].

Conforming with Hursts, due to labor shortages or restrictions on transportation, many farmers forced to grow produce had to leave their crops unattended in the fields. The issues we will face in the near future cannot be met by the conventional farming system. To overcome these challenges and increase agricultural production, we must use more advanced farming equipment [6].

As explained by Garrity, through its Sustainable Food Systems section, the Philippines has been promoting food security. The majority of the programs within this unit focus on rural communities and advocate for all-natural agriculture as a strategy to combat poverty. Urban container gardening, though, is one of the unit's most important elements and one that might conceivably guarantee food security for everyone. Urban container gardening is the process of raising crops in movable and modular planters in locations with constrained agricultural land areas. Urban container gardening enables crops to be planted in constrained locations in vertical structures with the aid of trellises and efficient and compact irrigation [7].

As mentioned by Lagomarsino, given the need for more sustainable agriculture, there has been an increase in environmentally friendly start-up businesses using hydroponic technology to grow crops on a large scale using a method called "vertical farming." Vertical farms are structures filled with countless levels of hydroponic systems (or nutrient film style planters), growing various crops in an indoor, controlled temperature environment such as lettuce, basil, spinach, chili peppers, and more [8].

As indicated by Bernstein, smart agriculture, also referred to as smart farming, is the utilization of Internet of Things to the growing of plants with the aim to minimize work and consumption of resources, give greater accuracy over irrigation and fertilization, and collect more accurate information regarding the

environment throughout the planting process [9].

According to Boylan, there are several benefits of growing plants using hydroponics. Hydroponic systems can be developed to provide continuous production all year round in addition to better yields and water efficiency when employed in a controlled environment. Leafy plants like lettuce can also be grown hydroponically, and the nutrient film method produces the best results. Hydroponic systems can range from straightforward backyard setups to more complicated commercial operations [10].

The study is motivated by an eagerness to discover new information. In hydroponics, crops are grown without the need of soil and instead in nutrient-rich water that serves as the plant's root system. Although there are many ways to construct hydroponic systems, the fundamental components are essentially the same, making it a worthwhile subject for information technology learners to research.

The researcher's aim is to develop a smart hydroponic farming system that has a capable to produce a greater yield of vegetables. A system that has a capability to monitor the prototype ambiance temperature, humidity, water system pH level, water solution electrical conductivity, and controls water pump system using mobile application. Systems that will allow plants to get their nutrients from the moving water solution in the piping system.

General objective

The study's main objective is to develop a system entitled "AQUAOBRA: A Smart Hydroponic Farming System". A system that would capable to monitor the prototype ambiance temperature, humidity, water system pH level, water solution electrical conductivity, and controls water pump system using mobile application. In addition, the develop prototype would be an innovative, effective, and dependable monitoring and control solution that raises plant quality and crop yield. It seeks to create the right nutritional environment for optimum plant growth.

This study aims to achieve the following specific objectives:

1. To design an immerse device with the following:

- Ph level monitoring

- Tds level monitoring
 - Temperature monitoring
2. To design a Mobile Application with the following
 - Displaying all the level of PH,TDS AND TEMPERATURE
 3. To test the system using alpha testing case.
 4. To identify the required hardware and software.
- Hardware:
- Arduino Uno
 - TDS Sensor or Total Dissolved Solids
 - pH Sensor (Potential of Hydrogen ion Sensor)
 - 4 Channel Relay
 - The water pumps
 - Bluetooth Vibration Sensor
 - Temperature Sensor
 - Breadboard
 - PVDF (Polyvinylidene Fluoride) I
- Software:
- C++
 - MIT App Inventor
 - Google Chrome
5. To construct microcontroller-based prototype.
 6. To design the study using
 - Storyboard
 - Flowchart
 - Menu tree diagram tools for the design and analysis of the application.
 7. To assess the software using ISO 25010 in terms of the following.
 - Functional suitability
 - Usability
 - Reliability
 - Maintainability
 - Performance Efficiency
 - Compatibility
 - Security
 - Portability
 8. To deploy the system prototype.

Scope and limitation

The scope of this study is limited only to building a smart hydroponic system. Internet research and interviews were used on smart hydroponics farming to identify the hardware and software that they would use to construct

the prototype with mobile application that is capable to monitor the pH level, water temperature and nutrients solution count. This study also aims to test and evaluate the applicability of the system. At the end of this study is to deploy the system prototype.

Physically being present in survey made it possible to the capacity to lead conversations, guarantee that the respondent is the person who is being targeted, assist complex questions, and make use of examining techniques which is why the researchers chose this technique to collect their data. Consequently, the obtained data is usually more accurate.

The researchers would be using a laptop powered by Microsoft Windows 10 Pro with a hardware specification of a 1.60ghz processor, 8gb RAM and a 128ssd hard drive. The researchers would identify the needed software requirements to develop the Aquaobra mobile application by using the following software programs: C++, MIT app inventor, and Visual studio code. Moreover, the hardware programs that were used are: Arduino Uno, total dissolved solids, pH sensor, 4 channel relay, water pumps, uPVC pipe, bluetooth vibration sensor, temperature sensor, breadboard, and polyvinylidene fluoride.

High-performance applications can be made using the cross-platform language C++. Additionally, it allows programmers extensive control over memory and system resources. The researchers used C++ to develop the application. The researcher used the MIT App Inventor website to develop a mobile application using a web browser and either a connected phone or emulator. It is also utilized to bring the individual components of the app to life and assign them specific tasks, which together would form the overall functionality.

Using the Arduino IDE (Integrated Development Environment), the researchers were able to write and upload code to the Arduino board. The IDE includes a code editor, a compiler, and a bootloader that allows the researchers C++ programming language code to be uploaded to the board via a USB cable.

MIT App Inventor and Figma were both employed by the researchers to design the look of the mobile app. The Arduino IDE was employed to link the Arduino to the MIT App

Inventor. This is the APK file that was created once the researchers had done developing the mobile app in the mobile app creator. Then, it is prepared for phone installation.

In using the application, the first thing to have done is to create or log into your Aquaobra account. After you successfully log into your account, the next step is connecting your mobile application to your IoT device using Bluetooth. After connecting, then proceed to the application's home screen, where you can see the pH status level. The pH of a solution shows whether it is acidic or alkaline. Next is the TDS level, where you can see the measurement of the total amount of dissolved solids in water. Next is Temperature Status, to see the exact temperature of the water in the IoT device. There is also a button for the nutrients used in the water of the IoT, to see the iron chelate plus information and the nutrihydro lettuce information. In the last part of the home screen, you can disconnect your mobile device from the IoT device.

The mobile application will modify itself depending on the applications defined in each sensor. The user can also keep track of all sensor and pump activity using the mobile application. Only when it is Bluetooth-connected and receives information from an Arduino sensor to monitor pH levels and water temperatures. Moreover, mobile application can detect the pH level up to 5.5 to 6.5.

With the help of analysis and design tools, a smart hydroponics farming system created would allow users to regulate the pH level, fertilizer solutions, and water level using a mobile application.

In order to test the program, the researchers would select functional suitability, performance efficiency, compatibility, usability, and reliability using the ISO25010 Software Quality Standard Criteria. The following sub-characteristics are used to assess functional suitability: functional completeness, which is a group of functions that covers all of the tasks and user objectives listed. Functional suitability describes how successfully and precisely the application produces the desired results. The capacity of functions to complete specific activities and objectives is known as functional appropriateness. Usability is the capacity of a program to be successfully,

effectively, and efficiently used to achieve predetermined goals. When an application operates in the same hardware and software environment, compatibility refers to how well it can exchange data and carry out tasks.

In order to acquire data, the researchers would conduct an alpha test, in which they would test the program for further improvements and then complete a survey to assess its usability before putting it through and contrasting it with beta testing. Its findings would be compared to those of beta testing in order to evaluate alpha testing.

Using purposive sampling as its sampling technique, the study would collect data from six particular people in a community who at least had a background of farmers and IT experts. The researchers conducted alpha and beta testing during the data collection among the respondents by having them directly use the program and assess its effectiveness. Three of the ISO25010 criteria—functional suitability, performance efficiency, compatibility, usability, and reliability—would be used by the researchers. The researchers used a frequency distribution to obtain the percentage and mean score for the entire survey, which will then be classified to display various representations of results based on how the survey results would turn out.

Customers may download the software and test it out on their mobile devices after it was released in the Facebook page through the uploaded google drive link. The "AQUAOBRA: A Smart Hydroponic Farming System" mobile application requires Android 7 or higher specs.

SYSTEM DEVELOPMENT METHODOLOGY

This section gives an outline of research methods that were followed in the study. It provides information on the participants, that is, the criteria for inclusion in the study, who the participants were and how they were sampled.

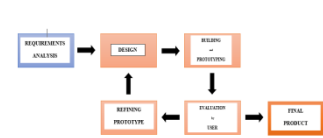


Figure 1. Prototype Model
(Source: <https://www.guru99.com/software-engineering-prototyping-model.html>)

This Prototype Model includes Requirements Analysis, Design, Building and Prototyping, Refining Prototype, Evaluation by User and Final Product. Figure 1 shows the steps of phase until the system is built in.

Human life has become more suitable as a result of technological advancements. Many things can be done today to solve human problems more efficiently and with less money, time, and energy. Agriculture is one of these technological developments. An automatic tool project based on the Arduino uno micro controller will monitor hydroponic plants, assisted by sensors to detect water level, the temperature around the plant will be detected by a sensor. A pH sensor to read the acidity level of a plant solution, and several motors to immediately provide nutrition and maintain water circulation an interface is also provided to see the condition of the plant as well as planting media and solutions. Based on the test results, the entire hydroponic system is capable of operating correctly, and all values that affect hydroponic plants are always in their proper condition.

Requirements

The first phase involves understanding what needs to design and what is its function, purpose, etc. With the assistance of the internet research and consulting from experts, the researchers modified their ideas in order to learn what specifications the system actually required. The application's concept, design, and functionality were identified by the researchers. Additionally, this is where the researchers provided assurances regarding the appropriate information and concepts that the system application would provide.

The researchers made the decision to make the following conclusions about the required hardware and software after gathering the essential materials, data, and information for the study:

Table 1: Software Requirements for Application Development

Software requirements	Description
Arduino Uno	A micro controller board acts as the brain of the system. It is the one that controls all the sensors and pumps and interacts with the web application to provide a visual representation of the data being gathered from the sensors.
MIT App Inventor	Website compiler for android application drag and drop coding, code blocks.
Arduino IDE	The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

Table 2: Hardware Requirements for Application Development

Hardware requirements	Specifications
TDS Sensor	Measure the amount of the dissolved combined content of all inorganic and organic substances present in a liquid. This measures the amount of nutrients present in the water.
pH Sensor	It is used to measure the acidity of water. In hydroponics acidity is the key to ensure the growth of the crops. This sensor helps to determine if we need to lessen or increase the acidity of the water.
4 Channel Relay	Is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. This is used to turn

Water pump	the pumps on and off. Serves various types of water into the system. This pumps the nutrient solutions to the crops.
uPVC Pipe	Will be used to hold the crops and allow the water to flow in the chamber where the crops will be placed.
Bluetooth Vibration Sensor	Accelerometer capable of recording vibration data and transfer it to a receiver using Bluetooth standard protocol.
Temperature Sensor	Measures the temperature of water or other medium. The probes are typically resistive thermal devices (RTD). RTD predict change in temperature as a function of electrical resistance.
Breadboard	A thin plastic board used to hold electronic components transistors, resistance, chips, etc. That are wired together. Used to develop prototyping of electronic circuits, breadboards can be reused for future jobs.
PVDF or UV light resistant plastic	UV Plastic that offers incredible thermal stability, abrasion shielding, and protection against chemicals and UV radiation. It is easy to weld thanks to its high heat resistance.

Design

In this phase, designing the project's system, the researchers created a storyboard to visually guides throughout the system process. The researchers investigated the application's entire potential structure after gathering information and materials, and they now describe the official tools that will be used to build the system. Of course, the researchers are confident that the aforementioned software will all be utilized to advance the program. Furthermore, the researchers created flow charts and diagrams to identify the problems and the requirements in order to successfully build the system. Given below is the storyboard plan for the user interface design plan.



Figure 2: Storyboard Plan

System Design

This evaluates the need specifications from the previous phase and creates the application design. Application architecture as a whole, as well as hardware and system requirements, are all influenced by application design. Additionally, the code for software is currently being developed.

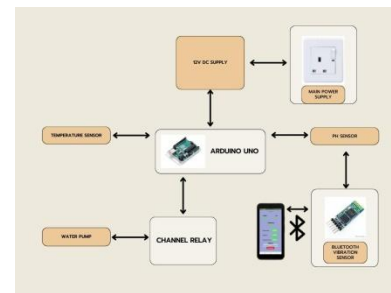


Figure 3. Developed System Architecture

Development

Developing an automated hydroponics system requires knowledge about electronics and agriculture which the researchers also studied. The researchers gathered enough information about how to grow specific plants in a hydroponic system.

The system solves the problem of lack of space and the time spent monitoring the crops. In the Nutrient Film Technique (NFT) setup, the system uses a pump to deliver fertilized water to the grow tray and a drainpipe to recycle the unused nutrient solution. The pump is turned on for 5 minutes with a 30-minute interval to ensure the plants are getting enough nutrients throughout the day. The pH sensor monitors

the pH level of the water solution, and the TDS sensor monitors the nutrient level in the water solution. When the level of nutrients and pH level is outside the recommended value, the pump for the pH solution and nutrient solution will turn on, making the water solution level within the recommended values.

Upon the development of the system, the researchers conducted trials and tests to ensure the accuracy of sensor readings. The system has been evaluated by the respondents to measure the effectiveness of the system.

Testing

The complete system is integrated once all units created during the implementation phase have been tested. To find bugs and flaws in a program, continuous software testing is required. To ensure that the client has no issues installing the software, it is tested.

The researchers would test the application while it was still in development by using alpha and beta testing. To test the application, the researchers utilize a purposive sampling of six participants, all of whom are farmers and IT professionals. Three days were required to complete the survey in order to enable individuals who wanted to test the application more time.

User Evaluation

After creating a successful prototype, the system is now being tested by alpha testers to look for any additional adjustments or expected input. The researchers used the software quality parameters of ISO 25010 to comprehensively assess the application's performance throughout this phase of alpha testing.

In order to evaluate the application during alpha testing, researchers purposefully approached three (3) IT experts. These individuals were selected based on their expertise in hardware engineering, programming, mobile application development, and design. Their comments and suggestions are crucial because they provide direction for improving the system.

Refining Prototype

At this stage, improvements to the system are made based on input from the alpha testers, recommendations, and requests for new functionality. In this step, the researchers go back to the quick design phase, where they

made improvements to the initial prototype while incorporating and taking into account all of the ideas acquired in the previous phase. They made improvements to the initial prototype while incorporating and taking into account all of the ideas acquired in the previous phase. When enhancing the system, needs are essential.

Engineering Product

Engineering the product involves the researchers developing the system's final output, which is tested and approved by the user after multiple iterations until a successful prototype is achieved and meets user criteria.

The researchers intend to apply the system created to the farm through implementation. Users will receive demonstrations from the researchers so they can become comfortable with the system.

Deployment

The application's overall functionality would be determined by its ratings. This would begin the maintenance phase, during which the researchers would pay attention to user feedback and bug reports for future application enhancement and development.

Customers can download and test the program on their own devices after the researchers post the google drive link through Facebook page. The consumer can submit feedback since it is important because it lays the groundwork for the development of the application.

RESULTS AND OUTCOMES

This section showed the results and outcomes based on the objectives of the study. These discussions and conclusions are based on the objectives of the study, completed analysis, and testing of the developed application prototype. It also presents the analysis and the interpretation of the alpha and beta testing made by the researchers.

Since the researchers wanted to offer assistance, reply to inquiries, and make sure respondents are attentive and engaged while completing the survey, the researchers personally conducted the survey. After giving the application a test run and getting some hands-on experience, the participants were handed survey questionnaires to complete in order to provide feedback on the mobile application.

The researchers gathered all the survey results for each category to calculate the percentage and mean scores for functional suitability, performance efficiency, compatibility, usability, and reliability using frequency distribution as the statistical tool. For each category, they added up all the results that were "yes". Then the researchers divided the number by six since the respondents needed for this survey consists of six individuals then multiplying the outcome by one hundred to get the percentage needed result.

Beta tester, the total beta testing performance of 89.33% still falls into the outstanding area, while 10.67% fell into the not-so-favorable category. However, the researchers used this knowledge to identify areas where the prototype needed development. The prototype was put through beta testing after undergoing improvements, and the findings show that it is functioning better overall, with a performance of 89.33%. The application can still be developed to work on different operating systems even if some of the ideas are taken into account.

The alpha tester's findings rated 85.33% of participants fell into the favorable category, while 14.67% fell into the not-so-favorable category. However, it demonstrates that the application provided the respondents with outstanding satisfaction. According to the criteria, the alpha testers gave the application good grades, which means that they experienced its best results. Out of the three criteria that the researchers devised, the usability criteria received the highest rating. An overall mean percentage of 93.33% and an interpretive rating of "excellent" were attained. This demonstrates that the application's alpha testers were able to swiftly comprehend it.

The researchers used the ATmega328P, which is the basis for the Arduino Uno microcontroller board. Then, TDS sensors are used to determine how much of all the dissolved, mixed inorganic and organic chemicals, whether they are in molecule, ionized, or micro-granular (colloidal sol) suspended form, are present in a liquid. Also, the pH sensor is used to gauge how acidic the water is. A relatively little electric current powers a 4 Channel Relay, which has the ability to turn on or off a considerably larger

electric current. Moreover, a pure water pump, a solution A pump, a solution B pump, an acid pump, and a nutrients water pump make up the group of five water pumps. Various pumps will operate open and close in response to the relay's command. Continually, uPVC is used to make many different gardening systems, including tomato cages, hydroponic gardens, irrigation systems, and vertical gardens. Additionally, a Bluetooth vibration sensor is an accelerometer with the capacity to store vibration data and broadcast it to a receiver using the Bluetooth standard protocol. Water or other medium's temperature can be measured via a temperature sensor. Also, using the breadboard, create a circuit to show how it works before reusing the parts in another circuit. Lastly, a material that is remarkably thermally stable, abrasion-resistant, chemically and UV-ray resistant.

Furthermore, C++ assisted the researchers to develop apparent understandable code for both minor and huge applications. The MIT App Inventor is used for visual programming, it is an educational tool that uses the creation of mobile apps to teach computational thinking and computational action principles. Additionally, using Figma to develop the prototype, it allows to quickly bring ideas to life in animated prototypes that feel authentic.

The researchers' used storyboard that enables them to create low-level data structure implementations from high-level graphical insights in a natural and accessible way. It demonstrates the screens that make up an Aquaobra's user interface as well as how to navigate between them. The flowchart also provides a visual depiction of how to utilize the application and can be used to outline an algorithm's logic before beginning to develop an automated procedure. The menu tree diagram is a tool that shows the hierarchy of Aquaobra operations and subtasks required to accomplish an objective. It is used for problem-solving, including troubleshooting and root cause analysis.

The prototype would be filled with water while waiting for the lettuces that have been planted in the styro cups to grow then when the day comes when they can be transferred put the lettuces in the prototype then also put the water pumps and the sensors so that the flow

of water is even and the plants are also monitored when the mobile app is opened after that the two chemicals have been put are iron chelate plus, it is a rapid intervention nutrient designed to quickly resolve iron and trace element deficiencies in vegetation, and nutriHydro lettuce, it is formulated with nutrients that target the growth of roots and stems. After that, if everything is balance, it will be evident that the plants have grown properly; all that is left to do is wait until they are ready for harvest.



Figure 4. Developed prototype

The mobile application's home screen, where you can check the pH status level, would appear after pairing with Bluetooth. A solution's pH value reveals whether it is acidic or alkaline. The measurement of the total amount of dissolved solids in water is shown next by the TDS level. The precise temperature of the water in the IoT gadget may be seen next under Temperature Status. Additionally, there is a button for the nutrients used in the water of the IoT, where you can view details on iron chelate plus and nutrihydro lettuce. You can sever the connection between your mobile device and the IoT device in the home screen's last section.

Fill the lot with water, then place the sensors on the bottom and the TDS sensor in the container that is on the bottom of the lot with water. Then, simply plug the prototype into an outlet, open the mobile app, and connect to bluetooth to enable monitoring.



Figure 25. Operating Mobile Application and System Response

The result of the computation of the alpha test was 81.11%, which fell into the positive category, suggesting that the application had offered excellent satisfaction to the responders. This suggests that the alpha tester was satisfied with the application's performance, which convinced them to give it a high rating based on the criteria.

The functional suitability criteria scored highest out of the three criteria that the researchers established. It obtained an overall mean percentage of 83.33 percent and an interpretive evaluation of "excellent". This shows that the alpha testers learned how easy and reliable the interface navigation was. The usability and compatibility criterion, which obtained the lowest rating, nonetheless falls under the excellent category. It received a score of 80%. Even though the app had already proven to be successful, several respondents who had tested it had recommendations for how it could be made even better.



Figure 26. Alpha tester physically testing the mobile app and prototype

Table 3. Result of alpha tester

Criteria	Percentage Rank	Interpretation
Functional Suitability	86.67%	Excellent
Performance Efficiency	83.33%	Excellent
Compatibility	80.00%	Good
Usability	93.33%	Excellent
Reliability	83.33%	Excellent
Alpha Tester	85.33%	Excellent

The alpha result is 85.33% landed into the favorable category, while 14.67% landed into not so favorable category. However, it shows that the application had offered excellent satisfaction to the respondents. The fact that the alpha testers gave the application high marks based on the criteria suggests that they got the best outcomes from it. The usability

criteria scored highest out of the three criteria that the researchers established. It achieved an overall mean percentage of 93.33% and an interpretive evaluation of "excellent". This shows that the alpha testers were able to quickly understand and grasp the application. The compatibility criterion, which obtained the lowest rating, is nonetheless classified as good. It received a percentage of 80%. Two or three of the respondents who had tested the app had suggested that it be made available for iOS despite the fact that it had already proven to be successful.

Table 4. Result of beta tester

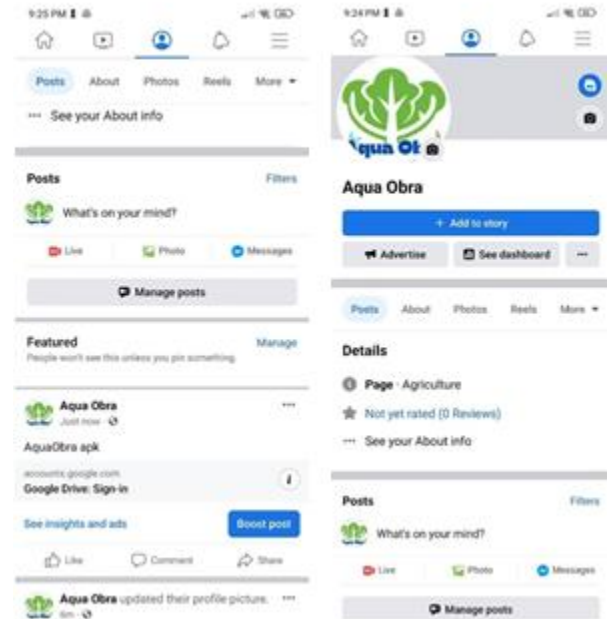
Criteria	Percentage Rank	Interpretation
Functional Suitability	86.67%	Excellent
Performance Efficiency	96.67%	Excellent
Compatibility	83.33%	Excellent
Usability	90.00%	Excellent
Reliability	90.00%	Excellent
Alpha Tester	89.33%	Excellent

Even if the overall performance for the beta testing is 89.33%, it still falls into the excellent category, while 10.67% landed into not so favorable category. However, the researchers used this information to determine where to make improvements to the prototype. The beta testing was conducted after the prototype had undergone enhancements, and the results indicate that the prototype is performing better in all areas, with an overall performance of 89.33%. Even though some of the suggestions were taken into consideration, it is still possible to develop the application so that it can run on multiple operating systems.

In the screenshots, Aquaobra is put on a google drive and uploaded at Facebook page, allowing users to download it on their smartphones and then evaluate and leave a comment according on how satisfied they are with its features.

DISCUSSIONS

These discussion and conclusions are based on the objectives of the study, completed analysis, and testing and evaluation of the developed application. It also covers the recommendations of the developers to further improve the application for future researchers.



Summary findings

The researchers conducted a survey to offer assistance, reply to inquiries, and ensure respondents were attentive and engaged. After a test run, participants were given questionnaires to complete to provide feedback on the mobile application.

The ATmega328P, TDS sensors, pH sensors, a 4-channel relay, five water pumps, uPVC, a temperature sensor, a Bluetooth vibration sensor, and a material that is thermally stable, abrasion-resistant, chemically resistant, and UV-ray resistant were all used by the researchers. The Arduino Uno microcontroller board is built around the ATmega328P, and TDS sensors assess the amount of dissolved, mixed inorganic and organic compounds that are present in a liquid. The pH sensors gauge the water's acidity. The five water pumps respond to commands from the 4 Channel Relay, which has the power to turn on or off a bigger electric current. A Bluetooth vibration sensor is an accelerometer with the ability to record vibration data and broadcast it to a receiver using the Bluetooth standard protocol. uPVC is also used to construct gardening systems. The material also exhibits remarkable thermal stability, abrasion resistance, chemical resistance, and UV ray resistance. Furthermore, in order to generate understandable code for applications, the

researchers utilized C++. While, the MIT App Inventor is a tool that emphasizes computational thinking and action principles through mobile apps. Figma was used to develop the prototype, which enables ideas to be swiftly transformed into accurate-feeling prototypes.

To convey high-level graphical concepts to low-level data structure implementations, the researchers used a storyboard and flowchart. The flowchart offers a visual representation of how to use the program and can be used to show the reasoning behind an algorithm. For problem-solving techniques like troubleshooting and root cause analysis, the researchers use the menu tree diagram.

For the successful constructed prototype, the lettuces were placed into Styrofoam cups and the prototype was submerged in water. When the time came, the lettuces were moved to the prototype and two chemicals—nutriHydro lettuce and iron chelate plus—were used. The plants would have grown appropriately and be ready for harvest if everything was in balance.

The successful created mobile application it has a home screen that allows users to check the pH status level, measure the total amount of dissolved solids in water, and view the temperature of the water in the IoT gadget. Additionally, there is a button for the nutrients used in the water, where users can view details on iron chelate plus and nutrihydro lettuce. Finally, users can sever the connection between their mobile device and the IoT device in the home screen's last section.

For the developed smart farming system, it shows that it can fill the lot with water, place sensors and TDS sensor in container, plug prototype into outlet, open mobile app, and connect to Bluetooth for monitoring.

The alpha testing of the prototype was 81.11 percent and fell into the excellent category. The beta testing was conducted after enhancements and the results showed that the prototype was performing better in all areas, with an overall performance of 96.67 percent. Even though some suggestions were taken into consideration, it is still possible to develop the application so it can run on multiple operating systems.

Furthermore, for the deployment the Aquaobra is available on the facebook page through the

uploaded google drive link, allowing users to download it and evaluate its features. They can leave comments on how satisfied they are with its features.

Conclusions

Smart farming can increase the farmer's profitability in the agricultural sector. Farmers can save money and effort by using fewer resources, and risks will be decreased by using more reliable spatially explicit data. With the use of this technology, all agricultural equipment and instruments can be connected together to help with irrigation and fertilizer supply. The accuracy and effectiveness of equipment that monitor plant development and even the care of livestock are improved by the smart systems.

Understanding how pH level impacts the quantity of nutrients and compounds that are soluble in soil water—and subsequently, the quantity of nutrients available to plants—helps the farmers to make better decisions. While some nutrients are more readily available in acidic environments, others are more readily available in alkaline environments. TDS also has an impact on water clarity. It aids in keeping an eye on heavier solids and lessens light's ability to flow through water, reducing the photosynthesis of aquatic plants. Aquatic species that has adapted to a lower temperature regime may suffer as a result of the water's increased ability to absorb and conduct heat. Furthermore, the temperature-based sensors' feature is useful for producing crops that require dry or wet conditions. They detect the amount of thermal energy in the soil, which enables them to pinpoint the ideal locations for plant growth. This is essential to guarantee the product's quality.

The future of smart farming is not simply an abstract idea; it is a path for learning, technological advancement, and, most importantly, innovation. Agri-food companies, technology providers, and subsequently all of us as consumers stand to benefit greatly from new Internet of Things (IoT)-based solutions that make the best use of digital devices and the virtual world in difficult as well as hazardous circumstances. The Aquaobra will pave the way and contribute to the global availability of food. At the same time, consumers may learn more about the entire

agri-food chain, which will enable them to choose specific product with awareness. This may provide the chance to show consumers the full value of premium, organic, and emerging sustainable production techniques. It may also provide opportunities for better managing fair trade for farmers, facilitating their ability to make well-informed decisions.

Recommendations

Future researchers may use this study as a guide for their own research if they want to take part with the development of a mobile applications or even smart farming.

The researchers recommend the following:

1. Water flow rate, flow start and stop times/flow rate variance alert
2. Seasonal total volume of ground water extraction
3. Soil moisture level threshold automatic shutdowns
4. Filter and fluids scheduler based on run-time tracking
5. Organizer for equipment maintenance items by engine type and filter part numbers

REFERENCES

- [1] ARJINA SHRESTHA. 2017. Hydroponics. <https://extension.okstate.edu/fact-sheets/hydroponics.html>
- [2] MAX ROSER. 2019. Future Population Growth. <https://ourworldindata.org/future-population-growth>
- [3] BARBARA TORREY. 2014. Urbanization: An Environmental Force to Be Reckoned With. <https://www.prb.org/resources/urbanization-an-environmental-force-to-be-reckoned-with/>
- [4] KHIEM NGUYEN. 2014. 2020 State of Food Security and Nutrition in the World report: Rising hunger and COVID-19 present formidable challenges. [https://www.ifpri.org/blog/2020-state-food-security-and-nutrition-world-report-rising-hunger-and-covid-19-present#:~:text=Almost%20690%20million%20people%20went,\)%20report%2C%20released%20July%2013.](https://www.ifpri.org/blog/2020-state-food-security-and-nutrition-world-report-rising-hunger-and-covid-19-present#:~:text=Almost%20690%20million%20people%20went,)%20report%2C%20released%20July%2013.)
- [5] SOCIAL WEATHER STATIONS. 2021. Food Inflation and Food and Nutrition Security Situation in Developing Asia During the COVID-19 Pandemic. <https://www.adb.org/news/features/food-inflation-food-nutrition-security-situation-developing-asia-covid-19-pandemic>
- [6] PETER HURST. (2021). Agricultural Workers and Their Contribution to Sustainable Agriculture and Rural Development. https://www.ilo.org/wcmsp5/groups/public/@ed_dialogue/@actrav/documents/publication/wcms_113732.pdf
- [7] DENNIS GARRITY. 2020. Sustainable Agriculture and the Environment in the Humid Tropics. <https://doi.org/10.17226/1985>.
- [8] VALENTINA LAGOMARSINO. 2019. Hydroponics: The power of water to grow food. <https://sitn.hms.harvard.edu/flash/2019/hydroponics-the-power-of-water-to-grow-food/>
- [9] CORINNE BERSTEIN. 2020. Smart Farming. <https://www.techtarget.com/iotagenda/definition/smart-farming>
- [10] CAMILLE BOYLAN. 2020. The Future of Farming: Hydroponics. <https://psci.princeton.edu/tips/2020/11/9/the-future-of-farming-hydroponics>
- [11] ANDRE FUSSY. 2022. An Overview of Soil and Soilless Cultivation Techniques—Chances, Challenges and the Neglected Question of Sustainability. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9102199/>
- [12] USDA. 2020. Hydroponics. <https://www.nal.usda.gov/farms-and-agricultural-production-systems/hydroponics#:~:text=Hydroponics%20is%20the%20technique%20of,%2C%20hobbyists%2C%20and%20commercial%20enterprises.>
- [13] SAGAR DHOLWANI. Introduction of Hydroponic system and it's Methods. <https://www.ijrti.org/papers/IJRTI1803011.pdf>
- [14] SABEENA NABI. 2019. Hydroponics: Environmentally sustainable practice in the agricultural system. <https://www.thepharmajournal.com/archives/2022/vol11issue7S/PartC/S-11-5-19-926.pdf>
- [15] JAMES SUMBERG. 2021. What is 'conventional' agriculture?. <https://www.sciencedirect.com/science/article/pii/S2211912422000086>
- [16] ALFREDO AIRES. 2017. Hydroponic Production Systems: Impact on Nutritional Status and Bioactive Compounds of Fresh Vegetables. <https://www.intechopen.com/chapters/58552>
- [17] SEERAT JAN. 2018. Hydroponics – A Review. <https://www.ijcmas.com/9-8-2020/Seerat%20Jan,%20et%20al.pdf>
- [18] ESTEBAN DUANLARA. 2020. Natural Organic Compounds for Application in Organic Farming. <https://www.mdpi.com/2077-0472/10/2/41>
- [19] RHOUKAYA GHORBEL. 2022. Hydroponic Fodder Production: An Alternative Solution for Feed Scarcity. https://www.researchgate.net/publication/363515955_Hydroponic_Fodder_Production_An_Alternative_Solution_for_Feed_Scarcity
- [20] BENJAVAN RERKASEM. 2020. The Growth and Sustainability of Agriculture in Asia. <https://www.adb.org/sites/default/files/publication/n/28031/growth-and-sustainability-agriculture-asia.pdf>
- [21] ERIK FRAMSTAD. 2016. Biodiversity, Carbon Storage and Dynamics of Old Northern Forests. <http://norden.diva-portal.org/smash/get/diva2:702580/FULLTEXT01.pdf>

- [22] HENRIK ECKERSTEN. 2018. Climate Change and Agricultural Land Use in Sweden. <https://www.slu.se/globalassets/ew/org/inst/vpe/vpe-report/vpe-report-no-7.pdf>
- [23] CARLOS AGIUS. 2015. The Yield and Quality of Lettuce Crop, Grown in Different Growing Media. https://www.researchgate.net/publication/314121919_The_yield_and_quality_of_lettuce_crop_grown_in_different_growing_media
- [24] TEWELDE GEBRE. 2019. The Mutual Benefits of Promoting Rural-Urban Interdependence Through Linked Ecosystem Services. <https://www.sciencedirect.com/science/article/pii/S235198941930143X>
- [25] ASSEM HATAB. 2019. Urban Sprawl, Food Security and Agricultural Systems in Developing Countries: A Systematic Review of the Literature. <https://www.sciencedirect.com/science/article/pii/S0264275118310485>
- [26] GRACE YUAN. 2022. A Review on Urban Agriculture: Technology, Socio-economy, and Policy. <https://www.sciencedirect.com/science/article/pii/S2405844022028717>
- [27] GIDEON AZUNRE. 2019. A Review of the Role of Urban Agriculture in the Sustainable City Discourse. <https://www.sciencedirect.com/science/article/abs/pii/S0264275118303044>
- [28] DEEPAK KUMAR. 2017. Reducing Postharvest Losses during Storage of Grain Crops to Strengthen Food Security in Developing Countries. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5296677/>
- [29] ALFONSO ALIPIO. 2020. Cost-Benefit Analysis of Soilless Cultivation System in Tagaytay City, Philippines. <https://ijosmas.org/index.php/ijosmas/article/download/137/108>
- [30] NISHA SHARMA. 2019. Hydroponics as an Advanced Technique for Vegetable Production: An Overview. https://www.researchgate.net/publication/330080392_Hydroponics_as_an_advanced_technique_for_vegetable_production_An_overview

Bsafe: An Android Mobile App for us in Case of Emergency

Bryan F. Custodio
Nikko Bryan M. Esguerra
Ryan F. Feliciano
Alf Vincent G. Lazaro
Paul Joshua A. Manaloto
Jherald C. Rosales
Lorenzo C. Macam, MIT (Technical Adviser)

ABSTRACT

bSafe is a mobile application designed to help users manage and respond to emergency situations. The app allows users to send SOS alerts to emergency contacts, display their location on a map, access emergency resources, and store personal and medical information. The app includes both online and offline features, such as an emergency contact list, emergency alerts, GPS location tracking, and real-time updates on natural disasters and other emergencies. However, the app requires an internet or cellular connection to access some features. The research for the app is limited to the use of ISO 25010 standards for testing, and it is not intended for use by professional emergency responders. It is a personal emergency management and response app aimed at providing easy access to emergency resources and contacts for individuals. bSafe is a mobile application designed to provide safety and security to its users in case of emergencies. The app features several functionalities, including an SOS alarm that sends the user's location to a predefined list of contacts, an automatic alarm that triggers if the user doesn't check in after a certain time, and a Sos feature that helps the user get out of an uncomfortable situation. The app was evaluated by 30 beta testers from Mabalacat City, who assessed its functionality, performance efficiency, usability, reliability, security, maintainability, and portability. The beta testers' evaluation revealed that the app exceeded their expectations in all aspects. The app received a weighted mean of 4.4 for functionality, indicating that users found the app's features to be comprehensive and useful. The app's performance efficiency received a weighted mean of 4.49, indicating that the app operated smoothly and without delays. Additionally, the app's usability received a weighted mean of 4.49, indicating that the app was easy to use and navigate. The app's reliability, security, and maintainability also received high scores, with a weighted mean of 4.41, 4.43, and 4.43, respectively. These scores indicate that the app was reliable and protected against threats, and that it was easy to maintain and update. Furthermore, the app's portability received an average weighted mean of 4.29, indicating that the app was easily portable across different devices and platforms. Overall, the beta testers' evaluation showed that bSafe is an effective and reliable tool for providing safety and security to its users in case of emergencies.

INTRODUCTION

An emergency is defined as an urgent, unexpected, and dangerous incident or a change in circumstances that requires immediate action to remedy injury or prevent imminent danger to life, health, or property. It is an unforeseen situation that puts one or more people in danger. Since emergencies are unpredictable, it is essential for health and safety practitioners to identify potential dangers, limit risks, and have emergency preparedness in place to enable for a quick and effective response in case of an emergency. Emergencies can occur anywhere, from severe weather storms and natural disasters to

chemical spills, explosions, and health emergencies. Therefore, it is important to understand what to do in the event of an emergency [1].

While everyone faces somewhat varying risks depending on their lifestyle and location, many of the most frequent emergency cases can happen to anyone. Sudden heart attacks or strokes, for example, can afflict a startlingly large proportion of the population. Car accidents are becoming an increasingly prevalent cause of injury. Many emergency situations entail potentially dangerous interactions with other individuals. It's important to know what to do in cases of

muggings, house burglaries, and other situations where your personal safety is threatened. When an emergency occurs, there is no time to begin planning how to respond. From natural disasters to traffic accidents, people never know when a situation would require quick thinking, calm nerves, and enough information [2].

Emergency situations highlight the importance of an emergency mobile application in providing assistance to individuals, including those that may be related to crime and violence. It also emphasizes the need for effective measures to ensure the safety of police officers and other first responders as they carry out their duties.

There are several appropriate solutions on the issue of emergency service access, and selecting the good option from the optimal set is a complex and difficult procedure that depends on several parameters. According to the European Emergency Number Association (EENA), there are three major ways to access emergency services: voice calls, emergency SMS (eSMS), and mobile emergency applications [3]. With the telecom market rapidly growing, mobile devices have the potential to improve citizens' safety and can be considered an important instrument for communicating with emergency services, as well as provide several opportunities for more efficient help in emergencies by delivering more than just voice in these situations: accurate location, relevant information about the user, prediction of dangers and disasters, and so on [4].

The proposed mobile application, bSafe, aims to help individuals in case of emergency situations such as Health, Accidents, Crimes, Fire and Disaster. The researchers at Mabalacat City College recognized the need for a tool that can assist people in difficult situations and speed up the rescue process. The application will have features that help users to provide information to emergency responders, despite the technology that already exists. To develop the application, the researchers brainstormed potential solutions to address the problem of emergency response in their community. The application is designed specifically to address the common emergency situations encountered in Mabalacat City.

The bSafe application is an emergency and safety app that can be used to alert emergency contacts and let responders know where the user is located. It can also be used to send important information about the user and their location to the emergency personnel. The application is designed to be simple and easy to use, with a user-friendly interface. Additionally, it's designed to be accessed quickly in case of an emergency and allows users to customize the SOS message. It's important as it can help to save lives by providing immediate assistance to someone in an emergency situation, and can also help to prevent further injury and promote healing. The bSafe app is an essential tool for anyone looking to stay safe and prepared in case of an emergency.

General Objective of the Study

The general objective of this study is to develop a mobile application entitled "bSafe: A Hybrid Mobile App for Use in Case of Emergency". Furthermore, it aimed to achieve the following:

1. To gather information about the study:
 - 1.1 Survey
 - 1.2 News
 - 1.3 Articles
 - 1.4 Related Research
2. To identify common emergency problem of the public in terms of:
 - 2.1 Health
 - 2.2 Accident
 - 2.3 Crime
 - 2.4 Fires
 - 2.5 Disasters
3. To identify the hardware and software tools to be used:
 - 3.1 Hardware Requirements:
 - 3.1.1 Personal Computer (PC)
 - 3.1.2 Laptop
 - 3.1.3 Mobile Phone
 - 3.2 Software Requirements:
 - 3.2.1 Android Studio
 - 3.2.2 MySQL
 - 3.2.3 Google API
 - 3.2.4 SMS API
 - 3.2.5 MIT App Inventor
 - 3.2.6 Open Route Service
4. To design the mobile application using the following:
 - 4.1 Flow Chart
 - 4.2 Story Board

5. To create the emergency mobile application with the following features:

- 5.1 SOS Alert
- 5.2 911 Direct Dial
- 5.3 SOS Message
- 5.4 Siren Alarm
- 5.5 Emergency Hotlines Web
- 5.6 Responders Map
- 5.7 My Location
- 5.8 Emergency Guide
- 5.9 Alert Contact Department
- 5.10 National Search
- 5.11 User Profile

6. To test the system within the locality of "Mabalacat."

- 6.1 ISO25010
- 6.2 Alpha and Beta Test

7. To deploy the mobile application in the Play Store.

Scope and Limitation

The researchers also gathered information from the internet by reading various articles related to the research. In addition, collecting information from various departments, such as the Medical Department, has further helped in the development of the application and possibility of this study.

The study aims to develop a mobile application called "bSafe: A Hybrid Mobile App For Use in Case of Emergency" to help people at risk, particularly in Mabalacat City. The scope of the study covers various emergency situations such as Health, Accidents, Crime, Fire, and Disasters. The application will be useful for responders from different departments such as Hospital, Police Department, Fire Department, and Disaster Department to quickly respond to emergencies.

The researchers used the Android Studio software for Android app development, which was used to design the interface and program the modules of the system. In addition to Android Studio, the researchers also used the MySQL database and Google API for data storage and integration. They also used the SMS API for messaging functionality and the Open Route Service for navigation and mapping. Additionally, the researchers had certain equipment and software requirements that needed to be met. These requirements included compatibility with both Android and iOS operating systems, a minimum of 2GB of

RAM for smooth performance, and a minimum of 20MB of internal storage space above the app's size. The use of the SMS API and OpenRouteService helped enhance the app's functionality and user experience.

In addition, to design the system, the researchers also utilized flowchart and storyboard in visualizing and illustrating the flow of the emergency mobile application. The researchers also decided to incorporate common and additional features that would help all the users of the developed application: SOS Alert, 911 Direct Dial, SOS Message, Siren Alarm, Emergency Hotlines Web, Responders Map (Online), My Location, Emergency Guide, Alert Contact Department, National Search, and User Profile. The bSafe mobile application is designed to help users manage and respond to emergency situations.

In the SOS Alert feature, the application allows users to send an SOS message without the need for a data connection. This is achieved by checking the phone's GPS coordinates and sending the user's location through a messaging app. The sharing component enables users to share files and messages between the bSafe app and other apps installed on the device. The app also has a texting component that allows users to send text messages directly to their designated responder. The application has also a 911 Direct Dial feature where users can immediately call the responders if there is an emergency. The SOS Message feature allows the users to send emergency message. The researchers also included a Siren Alarm function where users can just press a button and the phone would sound an alarm. The mobile application also features Emergency Hotlines that allows the users to be informed about the contact details of different Hospitals, Police Departments, Fire Departments, and Disaster Departments. The feature, Responders Map, displays the map and/or the location of different departments.

Additionally, the OpenRouteService API is utilized in this app for the My Location feature to track the user's location using GPS. With this OpenRouteService, the location of the users can be tracked even when offline, which is one of the best features of map navigation. The researchers of the bSafe app have utilized

the static MIT map for tracking the user's location, which includes information such as latitude, longitude, address, IP, and zip code. Markers are also used to identify the responder's location on the map, along with their department name, contact information, and address. A dialog box is available for users to view the details of the departments, which will be updated by the user every month. Moreover, the mobile application would also include an Emergency Guide feature where users were given an additional information on what to do when there is an emergency. There will be video guides in this feature that will surely help the users. The users can also set and update an alert contact of different emergency departments in the Alert Contact Department feature. The bSafe app also incorporates a National Search function through Google Maps Web View. This feature allows the app to efficiently and accurately locate emergency departments such as hospitals, police stations, fire stations, and disaster response units by connecting to Google Maps. When the user clicks on a department icon, they will be taken to the Google Maps web view, where they can see the exact location of the department. The web view is fully functional for the user, and not just an embedded code. The users can also edit and update their information in the Profile feature of the application.

The bSafe mobile application would be evaluated using ISO 25010 standards. The researchers would tabulate, analyze, and interpret the result of the evaluation to determine if the application is functional and has met the objectives of the study. The result of the evaluation would determine if the bSafe is acceptable and ready to deploy or subjected for improvement. Furthermore, the researchers would deploy the bSafe: A Hybrid Mobile App for Use in Case of Emergency in the Play Store in order for the users to have a fully functional emergency mobile application.

However, there are several limitations to its use. Firstly, the app requires a functional device with an internet or sim to operate properly, and some features may not work without a connection. Additionally, the research is limited to the development of the mobile application and does not include any

physical emergency response training. The app is intended for personal emergency management and response, and is not meant for use by professional emergency responders. The research is also limited to the use of ISO 25010 standards for testing the app.

It is important to keep in mind that the app may not be usable in certain situations such as when the device has a dead battery or low battery, if the user is trapped in a landslide and unable to use their phone, if the user is unconscious, or if the user has suffered a severe accident that disabled the use of both hands. In such cases, the application may not work or be used as intended.

SYSTEM DEVELOPMENT METHODOLOGY

This section contains the methodology and design to explain the process of the development of the study. This section discusses the data collection methods, mobile application development life cycle, and diagrams used by the researchers in the development of bSafe: A Hybrid Mobile Application for Use in Case of Emergency.

A purposive sampling method was used to gather respondents' data or information. The researchers used Mobile Application Development Life Cycle in the study.



Figure 1. System Development Methodology

Figure 1 shows the Mobile Application Development Life Cycle was the basis of the bSafe mobile application development. It consisted of five phases: discovery, design, development, testing, and deployment. The mobile app development life cycle process necessitated the development of applications that can be loaded into the device, the activation of backend services for data access via APIs, and application testing on target devices. While developing scalable mobile apps, we considered screen sizes, hardware

requirements, and a range of other aspects of the mobile application development life cycle process.

The researchers chose this methodology since this lifecycle addressed some of the distinctive features of mobile apps, such as life span, complex functionalities, fewer physical interfaces, a greater number of displays for interaction, battery and memory utilization, and cross platform development and maintenance. According to preliminary indications, this would have helped mobile developers follow the development process inside MADLC to construct robust and efficient applications.

Build Prototype

Discovery

The researchers discovered the need for the bSafe app through researching various articles and studies on different emergencies and the lack of support for individuals who experience them in everyday life. They found that there are many types of emergencies, including both human-made and natural disasters. The researchers limited their study to the most common emergency problems and aimed to develop solutions for them through the creation of the bSafe app. The app is designed to help individuals in emergency situations by providing quick and easy access to emergency services and contacts. The researchers believed that the bSafe app would be an important tool for individuals to have in order to be prepared for emergencies and to receive the necessary support during such situations. The researchers identified the problems of emergency management and the need for a mobile application to address them. They gathered information through articles and studies on different emergencies, and narrowed the scope of the study to common emergency problems that could be addressed through the app.

Design

The researchers used flowchart and storyboard during the design phase of the bSafe app development. Flowchart is a diagrammatic representation of an algorithm, process or system that shows the steps and the sequence in which they are executed. This tool helped the researchers to visualize the entire process and identify any potential issues or problems

before the development phase (see Figure 8). Storyboard, on the other hand, is a visual representation of the user interface and the flow of the application. It helped the researchers to plan the layout and the navigation of the app, and to see how the different screens and features would interact with each other (see Figure 9). Using both flowchart and storyboard helped the researchers to create a clear and organized plan for the development of the bSafe app.

Development

To develop the bSafe app, the researchers used the Android Studio software for Android app development. This software was used to design the interface of the system and program the module of the system. In addition to this, the researchers also had certain hardware and software requirements that need to be met. These requirements included:

- Operating System: The app needs to be able to run on both Android and IOS devices.
- RAM: The device should have a minimum of 2GB of RAM to ensure smooth performance of the app.
- Internal storage: The device should have a minimum of 20MB of storage space above the app's size to ensure proper function.

Testing

ISO 25010 is a standard that provides a set of quality requirements and evaluation criteria for software products. It provides a set of evaluation criteria that can be used to assess the quality of the app. These criteria can be grouped into five main categories: functionality, performance, compatibility, security, and usability. By using these criteria, researchers can ensure that bSafe app meets or exceeds the quality standards established by the standard. In testing the bSafe app using ISO 25010, the researchers would begin by selecting a sample of 2 alpha testers and 30 beta testers to evaluate the app. The alpha testers would be the first group to test the app, and would provide feedback on any major issues or bugs that need to be addressed before the app is released to the beta testers. The beta testers would then test the mobile application and

provide feedback on any remaining issues or bugs that need to be addressed, as well as any suggestions for improvements or additional features.

Sample Method

The researchers used purposive sampling to choose the beta testers of the study. This method of choosing beta testers was selective wherein the researchers relied on their own judgement to choose who will participate in the study. The researchers used purposive sampling since beta testers came from the selected field area of study which could have the knowledge pertaining to ideas and

Scale	Weighted Mean	Interpretation
5	4.21-5.00	Strongly Agree
4	3.41-4.20	Agree
3	2.61-3.40	Neutral
2	1.80-2.60	Disagree
1	0-1.80	Strongly Disagree

experiences with emergencies in their everyday lives. This method was chosen by the researchers since they had a clear idea about the purpose of the study and which respondents were both eligible and required to answer the evaluation form. By using purposive sampling, the researchers selected individuals or a subset of the population to make statistical inferences. It was one of the most important criteria for determining the reliability of the research findings. The evaluation results would indicate if the developed system was acceptable or has to be reassessed for improvement.

Statistical Treatment of Data

Weighted Mean. The researchers used the mean to calculate the beta testers' ratings of the developed bSafe hybrid mobile application's performance and effectiveness.

Weighted Mean (WM) = $(\sum f(x_1 + x_2 + \dots + x_n)) / N$

Where:

$(\sum f(x_1 + x_2 + \dots + x_n)) / N$ = Represents the summation of all means of each criterion.

N = number of criteria

Percentage. This was used to determine the qualitative ratio of the data gathered.

This is a number or ratio expressed as a fraction of 100.

Percentage(P) = $F/N \times 100$

Where:

F = frequency of a numeric rating for some given criteria

N = represents the total number of the respondents

Likert Scale. It works by having a person complete a survey in which they indicate how much they agree or disagree with a series of statements.

The Likert Scale is an immensely important type of rating scale. Researchers can gather insights on perceptions, behaviors, feelings, and more by asking beta testers in surveys, user satisfaction questionnaires, and other forms to self-report their responses based on how they feel using the Likert scale. The bSafe hybrid mobile application's functionality, performance efficiency, usability, reliability, security, maintainability, and portability will be evaluated.

Table 1: Likert Scale

RESULTS AND OUTCOMES

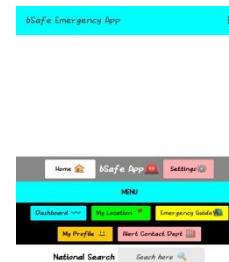


Figure 2. Home page

Figure 2 shows the Home Page of the developed bSafe application. Dashboard, My Location, Emergency Guide, My Profile, Alert Contact Department, and National Search were all displayed on this page.

Figure 3 shows the Dashboard of bSafe app displays the SOS Alert feature where users can send an SOS message without the need for a data connection. This was achieved by checking the phone's GPS coordinates and sending the user's location through a messaging app. The application has also a 911

Direct Dial feature where users can immediately call the responders if there was an emergency. The SOS Message feature allowed the users to send emergency messages. The researchers also included a Siren Alarm function, where users can just press a button and the phone would sound an alarm. The mobile applications would also have an Emergency Hotlines feature that allows the users to be informed about the contact details of different Hospitals, Police Departments, Fire Departments, and Disaster Departments.



Figure 3. Dashboard of bSafe

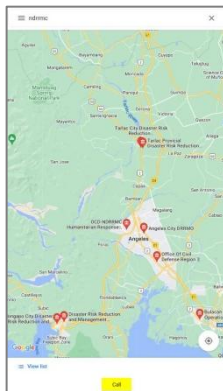


Figure 4: Responders Map

The feature, Responders Map, displays the map and/or the location of different departments (Hospitals, Police Departments, Fire Departments, and Disaster Departments).



Figure 5: Emergency Guide
The app includes an Emergency Guide feature (shown in Figure 5), which provides users with further information on what to do in an emergency. This feature also included a video guide that will surely help the users.

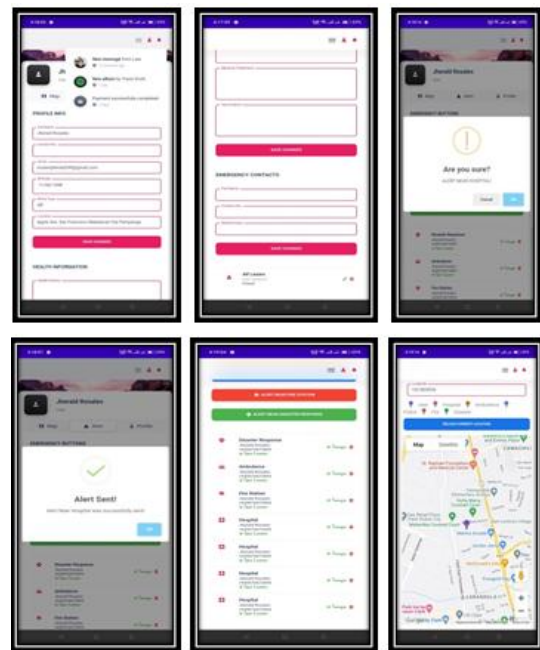


Figure 6. bSafe Web Application

The bSafe Web Application is shown in figures 6. The website for the bSafe app was created to provide users with additional information about the app, such as features, instructions for use,

and contact information for support. This website was linked with the app and can direct users to the app store to download the app. It was included to give users more information and to advertise the app to a wider audience.

Alpha Testing Results

The bSafe: A Hybrid Mobile App for Use in Case of Emergency was evaluated by two (2) IT experts. The alpha testers evaluated the developed hybrid mobile application in terms of functionality, performance efficiency, usability, reliability, security, maintainability, and portability. The alpha testers were given an evaluation form to help the researchers evaluate the application. The evaluation results indicated if the developed hybrid mobile application was acceptable or needs to be subjected for improvement.

Table 2. Summary of the Alpha Testers' Evaluation of the bSafe Hybrid Mobile Application

Criteria	Weighted Mean	Interpretation
1. Functionality	4.97	Strongly Agree
2. Performance	4.6	Strongly Agree
3. Usability	4.3	Strongly Agree
4. Reliability	4.7	Strongly Agree
5. Security	5	Strongly Agree
6. Maintainability	4.75	Strongly Agree
7. Portability	4.58	Strongly Agree
Average Weighted Mean:	4.7	Strongly Agree

Overall, the alpha tester's software evaluation of the developed bSafe Hybrid Mobile Application obtained a general weighted mean of 4.7 which fell to a "Strongly Agree" verbal interpretation. This indicated that overall, the alpha testers were satisfied with each specific criteria of the developed bSafe.

Beta Testing Results

The bSafe: A Hybrid Mobile App for Use in Case of Emergency was evaluated by thirty (30) beta

testers who were residents of Mabalacat City. The beta testers evaluated the developed hybrid mobile application in terms of functionality, performance efficiency, usability, reliability, security, maintainability, and portability through user acceptance survey. The thirty (30) beta testers were given an evaluation form to help the researchers evaluate the application. The evaluation results indicated if the developed hybrid mobile application was acceptable or needs to be subjected for improvement.

Table 3. Summary of the Beta Testers' Evaluation of the bSafe Hybrid Mobile Application

Criteria	Weighted Mean	Interpretation
1. Functionality	4.4	Strongly Agree
2. Performance	4.49	Strongly Agree
3. Usability	4.49	Strongly Agree
4. Reliability	4.41	Strongly Agree
5. Security	4.43	Strongly Agree
6. Maintainability	4.43	Strongly Agree
7. Portability	4.29	Strongly Agree
Average Weighted Mean:	4.42	Strongly Agree

Overall, the beta tester's software evaluation of the developed bSafe Hybrid Mobile Application obtained a general weighted mean of 4.42 which fell to the "Strongly Agree" verbal interpretation. This indicated the overall satisfaction of the end users on the specific criteria of the developed bSafe.

DISCUSSIONS

Based on the data gathered throughout the study, the researchers concluded that the "bSafe: A Hybrid Mobile App for Use in Case of Emergency" was beneficial for individuals in case of emergency situations. It is a tool that can help people in difficult situations and

speed up the rescue process. The application was designed specifically to address the common emergency situations encountered in Mabalacat City. In line with the study, the researchers gathered information through survey, news, articles and related research to identify common emergency problems of the public in terms of Health, Accident, Crime, Fires, and Disasters. The researchers also identified the hardware and software requirements needed in the development of the hybrid mobile application. In designing the mobile application, the researchers used flowchart and storyboard to create as well as visualize the flow of the application's features. In addition, the researchers incorporated features in the application such as SOS Alert, 911 Direct Dial, SOS Message, Siren Alarm, Emergency Hotlines Web, Responders Map, My Location, Emergency Guide, Alert Contact Department, National Search, and User Profile. The bSafe Hybrid Mobile App was developed and evaluated in compliance with ISO 25010 to ensure functional suitability, performance efficiency, usability, reliability, security, and portability.

Overall, the researchers completed the study following a thorough process of development and evaluation. Based on the results of the evaluation, the developed bSafe hybrid mobile application had been proven acceptable since the app was able to perform the features specified in the scope and objectives. All of its features and functionalities were able to meet the expected outcome. Furthermore, the researchers deployed the mobile application in the Play Store.

REFERENCES

- [1] Safeopedia. (2019). Emergency. [safeopedia.com. https://www.safeopedia.com/definition/1645/emergency-hse](https://www.safeopedia.com/definition/1645/emergency-hse)
- [2] Ikwuagwu, L., & Liu, A. R. L. N. (2020). First Aid for Emergency Situations. <https://www.acls.net/first-aid-situations>
- [3] Vivier B. (2019). Emergency Communications and the Eu Legislative Framework EENA Operations. <https://eena.org/knowledge-hub/documents/emergency-communications-and-the-eu-legislative-framework/>
- [4] Repanovici, R., & Nedelcu, A. (2021). Mobile emergency notification apps: current state, barriers and future potential. IOP Conference Series: Materials Science and Engineering, 1009(1), 012049. <https://doi.org/10.1088/1757-899x/1009/1/012049>
- [5] Mathur, N. (2018). What is Android Studio and how does it differ from other IDEs? Packt Hub. <https://hub.packtpub.com/android-studio-how-does-it-differ-from-other-ides/>
- [6] Heller, M. (2022). What is Kotlin? The Java alternative explained. InfoWorld. <https://www.infoworld.com/article/3224868/what-is-kotlin-the-java-alternative-explained.html>
- [7] Drake, M. (2020). What is MySQL? <https://www.digitalocean.com/community/tutorials/what-is-mysql>
- [8] Tudip. (2019). What are Google APIs & its Importance for Business. Tudip. <https://tudip.com/blog-post/apis-in-google/>
- [9] Tomikas, U., Pintsaar, J., Sulamägi, M., & Rebane, T. (2023). What Is an SMS API and How Does It Work? <https://www.cm.com/en-us/blog/what-is-an-sms-api/>
- [10] Edwards, L. (2022). What Is MIT App Inventor and How Does It Work? Tips & Tricks. TechLearningMagazine. <https://www.techlearning.com/how-to/what-is-mit-app-inventor-and-how-does-it-work-tips-and-tricks>
- [11] Lithmee. (2016). What is the Difference Between System Flowchart and Program Flowchart. <https://pediaa.com/what-is-the-difference-between-system-flowchart-and-program-flowchart/>
- [12] Little, A. (2017). Storyboarding in the Software Design Process. <https://uxmag.com/articles/storyboarding-in-the-software-design-process>
- [13] Swaen, B. & George, T. (2022). What Is a Conceptual Framework? | Tips & Examples. Scribbr. <https://www.scribbr.com/methodology/conceptual-framework/>
- [14] Subin. (2022). Mobile Application Development Life Cycle- Detailed Guide. CronJ. <https://www.cronj.com/blog/application-development-lifecycle/>
- [15] Estdale, John & Georgiadou, Elli. (2018). Applying the ISO/IEC 25010 Quality Models to Software Product: 25th European Conference, EuroSPI 2018, Bilbao, Spain, September 5-7, 2018, Proceedings. 10.1007/978-3-319-97925-0_42.

BUBOY'S HAVEN: An Android Based 3D Endless Running Game

Janet Mae A. Alvendia
Uni Cyril A. Bagsic
Dustin Niel D. Camaya
Relldhen G. Ferraz
Adrian Paul R. Mercado
Karlo D. Pangilinan
Ritchelle Z. Escoto, MIT (Technical Adviser)

ABSTRACT

Nowadays, the world uses technological advancement for different purposes, specifically entertainment. Mobile games quickly grew to become one of the most flexible and accessible sources of entertainment for individuals stuck at home. With this reason, the researchers decided to create the Endless Runner game, a game based on the true stories of dogs and their owners who reach across the globe with their story. Learning about these stories and different facts about dogs is one of the reasons why the researchers decided to create this study. With this goal in mind, the researchers conducted research and developed the game "Buboy's haven: An android based 3D endless running game." The researchers applied the Scrum method to improve the project's outcome. As a result, the researcher used Blender 3D for the 3D objects in this study, which helped to make the game's UI more visually appealing. The researcher created the UI design to be aesthetically pleasing. The researchers used MEEGA+ as a test case to validate both the project's functionalities and game design. The researchers used MEEGA+ questionnaires to collect data from respondents. Based on the MEEGA+ results, the studies showed that the project met all of the study's objectives and requirements. Based on the test-case results, the researchers have proven that the project met all the objectives of the study as well as the requirements needed. The researchers drew some recommendations for future upgrades of the study that they would like to include.

INTRODUCTION

Presently, everyone in the world seems deeply involved in technology. The present society relies heavily on technology, which has indeed contributed to increased effectiveness and efficiency. Innovation is good for the world, it has a positive impact on communication, education, economics and so on. Every day, people use technology that makes everyone lives easier would not be possible similar as mobile phone for communication and browsing using the internet. Still in moment's the ways in which people communicate, learn, and suppose are told by technology. It contributes to society and determines diurnal relations between people. In moment's society, technology plays an important part. It has an impact on everyday life and has both positive and negative goods on the world. The world moment is characterized by frequent technological advancements. (Mickeel Allen, Alvernia University 2019). [1]
Android is the world's most considerably used mobile operating system. It has the largest and

nippy - growing installed base of any mobile platform. The field of Android development is growing in. Programmers and inventors continually discover new styles of games which utmost people are looking forward to. This is the reason why the experimenters are encouraged to develop a game that will not only give fun but also helps the player enhance his skills. Android is developed by an institute of formulators known as the Open Handset Alliance. (September 2008). [2]

Nowadays, there are lots of android games with different genres available on Google Play Store. Most individuals can access these games online for a better and enjoyable experience. People appreciate online games for a variety of reasons. They can be a pleasant way for companions and family to spend time together and competing or collaborating with others for fun. Mobile games are one of the most popular mobile application categories, with consumers typically prepared to pay for goods and services. (Esko Penttinen, Matti Rossi, Virpi Kristina Tuunainen 2010). [3]

Endless Running Game is characterized as an action game, which a constantly moving character that players must navigate around and dodge obstacles as they automatically and continuously scroll onto the screen, with the simple objective of not crashing into anything to finish the level. These games may include circumstances with a start and end, but the key aspect is a character who never stops moving, as well as time and dexterity. The main goal of Endless Running Game maturity is to complete the level. Endless Running Game is popular because it is easily accessible to players of all ages. They are simple to learn but difficult to master. (Mudit Misra, Elena arquez Segura, Ahmed Sabbir Arif. October 2019).[4]

Also, to be one of the first and the most popular video game category, it is also one of the categories that blends in elements from another category similar as leveling and character capacities that can be set up in a role - playing games. (Isabela Granic, Adam Lobel, and Rutger. 2014).[5]

Since the whole world is affected by the pandemic, many people are compelled to remain at home. Students and school now spend the majority of their time using their mobile phones. In this case, many people are now downloading mobile apps for entertainment, such as Super Mario and Cookie run: Oven Break. The researchers wanted to create a smartphone application that is suitable for people of all ages and has well-known gameplay.[3]

Dogs really are man's best friend. There was a known Filipino Hachiko in Mabalacat City College went viral on internet and social media. In Japanese, Hachiko is known as Chken Hachik, which means "loyal dog Hachiko," with hachi meaning "eight" and the suffix -k formerly used for ancient Chinese dukes. This is the story of Buboy and Sir Carmelito Marcelo. Mr. Carmelito Marcelo used to be a professor at Mabalacat City College, and Buboy is known as a campus canine who roams the campus freely. Demafelix's Facebook post got over 138,000 likes and 75,000 shares as of the advertisement for this composition. Many netizens thought the prints were bittersweet and compared them to the Japanese Akita canine Hachiko, who was noted for his loyalty to his owner. (May 2019).[6]

The development of this study entitled "BUBOY'S HAVEN: AN ANDROID BASED 3D ENDLESS RUNNING GAME" is to serve as a memory tribute for the dog Buboy and the teacher Sir Marcelo at Mabalacat City College. The late Mr. Carmelito Marcelo was a lecturer at Mabalacat City College, and Buboy is a famous academy stray canine who roams freely inside the institution's premises. The researchers developed this game to remind the next generation students of MCC that the school have a dog that is similar to Hachiko of Japan.

General objective

The aim of this research is to develop an endless running game, entitled: "Buboy's Heaven: An Android Based 3D Endless Running Game".

In fulfillment of this, the research aims to achieve the following specific objectives:

- 1 To gather information through internet and related article.
- 2 To identify software required for the creation of the application.
 - 2.1 Blender 3D
 - 2.2 Adobe Photoshop and Canva
 - 2.3 Audacity
 - 2.4 Unreal Engine 5.01
 - 2.4.1 Visual Scripting
 - 2.4.2 Emulator
- 3 To design the application using design and analysis tools.
 - 3.1 Storyboard
 - 3.2 Game Mechanics
 - 3.3 Character model
 - 3.4 Flow chart
- 4 To create a game with the concept of Buboy's and Mr. Marcelo and other true story of dogs and owners.
- 5 To develop a 3D runner dog game.
 - 5.1 Single Player
 - 5.1.1 Three (3) Stage
 - 5.1.1.1 Each stage has five (5) levels
 - 5.1.2 Story of each stage
 - 5.1.3 Trivia about dog
 - 5.2 Multiplayer
 - 5.2.1 Host game
 - 5.2.1.1 Enter name
 - 5.2.2 Find Session
 - 5.2.2.1 Join game
 - 5.3 Option
 - 5.3.1 Character Profile

6 To test the application using the adopted MEEGA+ as an evaluation tool to validate the results of the project in terms of player experience and suitability.

7 To deploy the game in Google Play store.

Scope and limitation of the study

Endless runner or an unending runner game, is a platform game sub-genre that involves the player character being required to run for an infinite amount of time and path. The researchers came up with the true story of dogs and owners especially Buboy, Hachiko and Shurastey. The game that the researchers develop was titled “Buboy’s Haven: An Android Based 3D Endless Running Game”. The researchers gathered ideas on the main concept of the game and decided to make a runner game with the concept of the dog and owners that went viral on social media because of their story. After finalizing the game concept, the researchers identified what software and hardware needed to develop a 3D endless running game, after several meetings, the researchers used Blender 3D and Photoshop to create game assets and UI of the game and since the game is 3D the researchers used high specification of computer to modify and develop the game smoothly. Before developing the game, the researchers used story board by drawing in a piece of paper to plan what the game looks like just like a prototype plan. After the concept and story board is done, the researchers started to create the intro of the game, using Photoshop the researchers successfully created main menu and lobby for introduction of the game. After the introduction, UI the researchers develop and transformed the diagrams and storyboard into game application using Unreal Engine 5.

In this game, there are 2 different modes: the first is single player and the second is multiplayer. For the single player, the user will play alone and start with specific dog, each stage there will be a different character and environment.

Single player is like adventure endless runner mode and has a story at the end of the stage. Player needs to collect 300 dog biscuits to convert into the key that unlocks the next game character and stage. Every player has one life each and the goal for this game is to

avoid the coming obstacles and enemy by jumping and moving left and right. Every stage there is dog biscuit they can get from each path lanes.

There is also power they can get which is the boots and magnet power up. If the character of the player collides with the boots power up, the player can gain the high jump for 10 seconds only. If the character of the player collides with the magnet power up, the player can gain the magnet and get the dog biscuit nearby even if the character does not collide and the duration for this power up is also 10 seconds only. Every second of the game it automatically gets faster compared from the starting speed of the game to make it harder when the player is still surviving. In this game there are 3 stages and each stage there is 5 levels. Every stage, there are different environment theme which is Street, Jungle and Train rails. Every stage, there are also different enemy for different environment theme depends on the stage that the player currently playing. Each player has the ability to attack the enemy by clicking the button at the lower right corner to destroy it but the player needs to attack or bark 10 times before the enemy disappears. Each stage there are only 2 enemies that are indicates in the button in the lower right side of the screen for the player to know what button they need to press to attack.

Since this is an educational trivia game, the researchers shared some trivia before the stage ended to give information about dogs. The same mechanics from single player to multiplayer and the only difference is having a team work to get all the dog biscuit along the infinite path. The game is limited to Android version 7.0 (Nougat) and above to play comfortably with the game’s graphics and animation.

The game consists of only the story of Buboy, Hachiko and Shurastey to limit the study within this topic. The game can only accommodate 3 players to play for multiplayer because of the 3 dogs in the story and the game only has 3 paths each stage. When playing multiplayer, players shall be connected via Wi-Fi with the same network connection only.

The researchers used MEEGA+ as the evaluation tool for this study because it is an

educational endless runner game which is highly applicable to this evaluation tool as test case. The researchers themselves stand as the alpha testers of this game with a total of six (6). And gathered 30 respondents that aged 20-25 years old as the beta testers. After so many tests to the game using prototyping method, the researchers succeed reaching the high score in MEEGA+ statistical treatment by using mean formula, this means that the game is ready to be package using Android SDK and upload into Google Play Store as repository site.

SYSTEM DEVELOPMENT METHODOLOGY

This section describes the technique and design used to illustrate the parameters and procedure for developing the study. This section would display the Software Development Life Cycle technique, analysis diagrams, and the research instrument used by the researcher to collect data during the development of the game application.

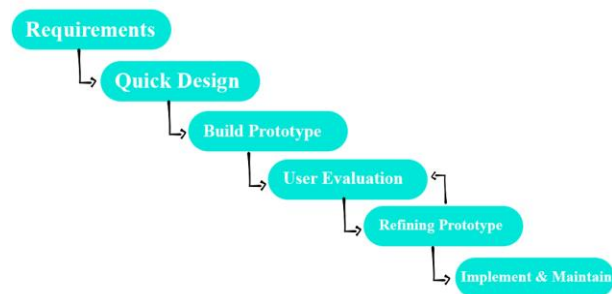


Figure 1: Prototyping Model

(Source:<https://medium.com/@chathmini96/waterfall-vs-agile-methodology-28001a9ca487>)

Figure 1 shows the Prototype Model that was used in the development of software applications. A Prototyping Model is an experimental process where the researchers can implement each idea they think of. After the ideas were combined, the researchers then created a prototype that allows the idea and concepts of the researchers that need to be tested and look for the missing functionality needs to be developed. This study is to create an educational endless running game and this model is very useful for the researchers to make the game better for the user.

The study used an Evolutionary Prototyping Model. For this type of prototyping model, the researchers conduct beta testing for the initial

prototype. This helped the researchers to re-create and develop the game better than the initial prototype from the feedback. This process produced subsequent prototypes wherein each prototype with additional functionality and improvements will be merged until the user is satisfied with the final product.

The researchers chose Evolutionary Prototyping Model, to explain why researchers conducted this kind of model, researchers had few reasons: The prototype.....

1. Serves as a basis for finding out missing functionalities
2. Receives feedback for improvement of the system
3. Shows improvements every prototype
4. Provides customer feedback to achieve the goal of the system

Requirements

A prototyping model starts with requirement analysis. In this phase, the researchers gathered data from the Internet and related games and literature from the alumni and college student of Mabalacat City College (MCC) and also brainstormed to gain ideas to achieve the goal for the game design before creating the prototype. This process allowed the researchers to brainstorm and merge the ideas to come up with a better concept. At the end of the data gathering and brainstorming, the researchers decided to create endless running game with a true story of dogs and owners' concept.

After finishing the concept and storyboard, the researchers got to work on the game's introduction. Using Photoshop, they were successful in creating the main menu and lobby. Following the introduction of the user interface, the researchers used Unreal Engine 5 to create a gaming application from the storyboard and diagrams. The researchers' hardware and software requirements for testing the game application are listed below.

Table 1 Hardware specification

Component	Specification
Processor	AMD Ryzen 5 4600G
Memory	16GB
Video RAM	16 GB
Hard Disk	500GB
SSD	125GB

Following the completion of the game concept, the researchers determined the software and hardware required to develop a 3D endless running game. Following several meetings, the researchers used Blender 3D and Photoshop to create the game's assets and user interface, and because the game is 3D, the researchers used high-end computers to modify and develop it smoothly.

Table 2 Software specification

Software	Description
Unreal Engine 5.1	Game Engine software
Blender 3D	3D Creation tool
Adobe Photoshop 2023	Image Editing
Audacity	Digital Audio Editor

Quick design

This phase is an initial design or a quick design that allows the researchers to create a simple design like story board and 3D modeling by drawing on a paper for storyboard to have an idea and to visualize the user interface of the game while brainstorming to create a diagram on how will the app will look like before proceeding to the 3D modeling software using Blender 3D and Photoshop CS6. The researchers chose to create a runner game with the notion of the dog and owners after gathering ideas for the game's core concept. Because of their tale, the game's concept of the dog and owners quickly gained popularity on social media. The researchers utilized Blender 3D and Photoshop to create the game's components and user interface after settling on an idea for the game. Because the game is 3D, the researchers also required high-end computers to change and develop it smoothly. With this, the researchers create character model by utilizing the Blender 3D software to maximize the game graphics. (See Appendix G)

Build a Prototype

In this phase, the researchers built a prototype after the brainstorming and creating story board. The researchers already have the idea on how an what to create into the game. The researchers export all the game character model first after they finished the quick design phase on the Unreal Engine 5 for animation and gameplay mechanics. The researchers

embed blue print code into the game character which is the dog to run because the game is an endless runner dog and to manipulate the behavior of the game character on how to make it go right, left or jump to avoid enemies and obstacles. This blue print is also used in the additional educational features which are the trivia after each stage completed by the players.

User evaluation

For alpha testers, this study had six (6) alpha testers and twenty-four (24) beta testers. The researchers are the alpha testers who initially tried to play the game to have an idea what the researchers need to debug and add into the game in graphics and gameplay. The researchers used MEEGA+, with this method, the researchers received feedback from the alpha and beta testers according to the user's experience and this helped the researchers know the missing functionalities and to have more ideas that can add up to the next prototype to make it better. The researchers or the main developers stand as the alpha testers who played the initial prototype, and they are between 20 and 25 years old. The researchers gathered them and made them the beta testers to test the functionality of the game. To get the average score of the game through MEEGA+ as test case the researchers used Likert Scale with an average of Excellent and arithmetic mean for statistic result to validate the average of the evaluation result each tester. Since this is the game, researchers tried to play the game with different specification of android phone such as Android Nougat (7.0) to Tiramisu (OS 13) to see how the phone handle the high and 3D graphics of the game. (See Appendix G)

Table 3 Likert Scale

Value	Likert Scale Description	Likert Scale Interval	Verbal Interpretation
4	Strongly Agree	3.51-4.00	Excellent
3	Agree	2.51-3.50	Good
2	Disagree	1.51-2.50	Satisfactory
1	Strongly Disagree	1.00-1.50	Poor

The researchers used the statistical tool to scale respondent responses. The scaling system is based on the Likert scale; in this way, the researcher can interpret facts from respondent responses. Table 3 above shows the results from the Likert Scale used to find out the overall assessment of the respondents.

Mean Formula:

$$A = \text{Arithmetic Mean} \quad A = \frac{1}{n} \sum_{i=1}^n a_i$$

N = Number of set values Ai = Data set value

The researcher's results about the application testing with the developer are listed above. Techno Pop 5 LTE (Android 11) the game reality is ok but it has a slight lag when navigating the jump and swipe gesture. Realme 8 5g 9Android 11 also played with no lags. The obstacle is easy to avoid, and the enemies can quickly kill using the finger's movements. In Techno Spark6 Go (Android 10), the game is realistic when it comes to 3d models and is easy to navigate. In Techno Camon16 (Android 10), the game can jump, turn left and right quickly, the game can be played without any lags. In Oppo a79 (Android 7.1) the game was smooth and the player doesn't encounter any lags during the gameplay.

Refining prototype

In this stage, the researchers gathered beta testers between the ages of 20 and 25 and used MEEGA+ as an evaluation tool to determine whether the developers were successful in achieving the desired satisfaction rate for this test case evaluation tool. This won't be over until all of the user's requests and recommendations have been fulfilled. During this stage, the researchers improved the prototype in response to user comments and suggestions. The prototype was continuously modified and improved by the researchers until the final system was constructed and the user was happy with the accepted final prototype. During this stage, the researchers kept making adjustments and putting the user feedback into practice. The researchers in this study received comments to improve the game user interface and game settings so the researchers refined and implemented the ideas from the user 5 times and proceeded to implement and maintain phases. One of these problems that

the researchers encountered is the multiplayer that keeps on disconnecting and sometime the players are not seeing each other though both players are in the same server. Also, the researchers tried to create an online multiplayer game but this feature seems difficult because this needs an online server which the researchers can't afford to make it happen. After debugging, for improvement for the next prototype the researchers wanted to have an open world feature of the game not just limited in single player and multiplayer. (See Appendix H)

Implement and Maintain

This step is the final phase of the prototyping model. This phase is the time when the final prototype is approved and tested. After the prototype is approved by the clients, the researchers packaged the systems using Android SDK to play on Android devices. The researchers uploaded that packaged on Google Play Store as a repository site to store the game and for future updates on the game.

RESULTS AND OUTCOMES

In this section, the results and the discussions were laid out to determine if the researchers met the objectives of the project.

As a result, the researchers conducted a related literature review to gain concepts and ideas from previous researchers before brainstorming and proceeding to the planning stage. From the planning and requirements analysis, the researchers were able to identify easily the following requirements shown in the table. In this chapter, the researchers also used the MEEGA+ as a test case to choose the thirty (30) respondents college student at Mabalacat City College (MCC).

The researchers tested the mobile game application in five (5) different android phones with different operating systems to check compatibility

The researchers used the Internet to access online research papers and some documents from the students of Mabalacat City College (MCC) and also brainstormed to gather enough ideas to establish the project and meet the researchers' main goal, which is to develop an instructive endless runner game based on genuine stories of dogs and owners.

The researchers included the software and hardware requirements needed to be used for this game project, the table number one (1) below shows the requirements needed.

The phone must be android phone to install the game with mobile operating system (Nougat 7.0) with at least 8GB memory and internal storage to download and to play the game smoothly on mobile. The researchers tested the game with different android phone with different specification to come up with this recommended hardware and software and to validate this result the researchers include the MEEGA+ as test case.

The researchers used Blender 3D for developing game assets such as character, enemy, tiles, obstacles, and background assets (tree, wall, environment).

The researchers created the game user interface and buttons for the game banner (high score, dog biscuits, victory, and game over) from Adobe Photoshop CC and Canva.

The researchers used the Unreal Game Engine to create code and to run the program using blueprint visual scripting and emulator of UE5. Lastly, the researchers used Android SDK to build the game application.

The researchers also used the MEEGA+ as a test case to choose the thirty (30) college student respondents at Mabalacat City College (MCC) for refining the prototype and to re-create what the users' suggestions to make the game better.

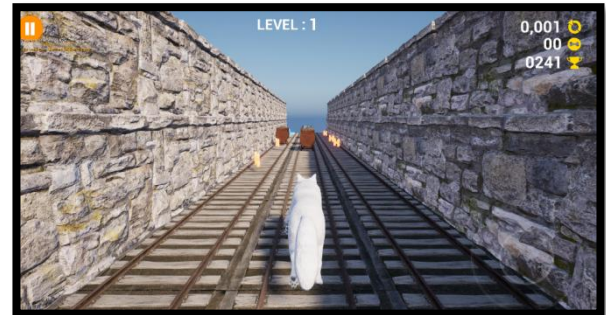
The research development had a few problems such as connectivity for multiplayer, replication of game assets for multiplayer, development of the mobile application user interface, and replicating and importing game assets into the software.

The researchers managed to create three (3) dog characters, four (4) boss enemies with animation and few obstacles for the game. However, importing these game assets into Unreal Engine 5 is the main problem. The animation that the researchers create is not working when it imported at the Unreal Engine 5. The solution the researchers made was to import the characters and enemies and creating the animation inside the Unreal Engine.

To fix the connectivity of the devices of the user to be able to play multiplayer, the researchers

used a LAN Internet connection. The requirement to play multiplayer in this game is to have the same IP address by using the same router or Internet connection.

Figure 2: Game Screen



Game screen when the user start playing, there is also level, high score, collected dog biscuits and paused icon in the screen.



Figure 3: In game enemies

These are sample screen shots of the enemies in the game, the game has a human enemy and four (4) legged animals.

Alpa Tester Evaluation Result

The highest scores for the sub-criteria of Usability were Aesthetics, Aesthetic typeface and color, Learnability, and Operability, with an average score of 4 for verbal "excellent" interpretation. This means that the game design is great and helps you learn. The lowest score for the sub-criterion is readability, with an average score of 3.67 for verbal interpretation of "good". This means players are happy with the little things in the game.

The highest score for the sub-criteria is learning ability, with a median interpretation of 'excellent' of 4. This means that the player has gained a lot of knowledge in the game. The

lowest sub-criteria scores were satisfaction, attention focus, encouragement, charm, motivation, and sense of accomplishment, with a median score of 3.33 for good verbal interpretation. This means that players are happy with how the game is designed, the excitement they get from the game, the way they can focus on the gameplay, and the feeling of success.

Table 4: Summary result of Alpha test

Criteria	Average mean	Interpretation
Usability	3.78	Excellent
Player Experience	3.55	Excellent
Total	3.66	Excellent

The table shows that the game passed the evaluation with the "Excellent" interpretation with an average mean of 3.66. The table reveals that the game is good when it comes to usability and player experience. The Alpha testing process has been completed and is now ready for deployment.

Beta Tester Evaluation Result

The researchers employed stratified purposive sampling to select suitable participants for an assessment instrument. As soon as the researchers used this tool, the researchers divided the population and chose 30 college students of Mabalacat City College (MCC) aged 20-25 years old to be the respondent on the testing tool that the researchers provided.

The highest scores for the sub-criteria of Usability are Aesthetic, with an average score of 3.6 for verbal "excellent" interpretation. This also means that the game Aesthetic design is great. The lowest score for the sub-criterion is readability, with an average score of 3.37 for verbal interpretation of "good". This means players are happy with the tiny details in the game.

The highest score for the sub-criteria is Attractiveness, with a median interpretation of 'excellent' of 3.87. This means that the game has an interesting design and engaging story. The player was satisfied on how the game turned out. The lowest sub-criteria scores is Completeness, with a median score of 3.03 for good verbal interpretation. This means that

players neither satisfied nor dissatisfied in playing the game

Table 5: Summary of Beta Test Results

Criteria	Average mean	Interpretation
Usability	3.52	Excellent
Player Experience	3.54	Excellent
Total	3.53	Excellent

The table shows that the game passed the evaluation with the "Excellent" interpretation with an average mean of 3.53. The table reveals that the game is good when it comes to usability and player experience. The beta testing process has been completed and is now ready for deployment.

DISCUSSIONS

This section highlights the results, conclusions, and suggestions based on the results of the study entitled "Buboy's Haven: An Android Based 3D Endless Running Game."

The researchers used the Evolutionary prototype model as a methodology while creating and developing the project. The main reason why the researchers used this method is to receive feedback for the researcher to make the game more exciting and reach the satisfaction of every user. This method includes quick design and building prototypes to test the functionality of the initial program in the game. In this phase, the researchers create an initial game design and program to have a prototype that can be used as a basis for the user to evaluate the missing functionalities and if the user has some ideas to make the system better for the next prototype of the game.

The next step is refining the prototype, after the researchers received the feedback and recommendations from the users, the researchers then worked for the next prototype and implemented the recommendations of the users.

The last phase after achieving the recommendations and successfully fixing all the missing functionalities is to deploy and develop the game application to test the minimum requirement for hardware to play the game.

Before deploying the mobile application, the researchers utilized testing cases to assess its functionality, usability, portability, and reliability.

Usability

The mobile game application passed all the test cases under usability that the researchers used. The following are the questions and results in the test case for usability.

The results for game design, blending colors, and text font size and color revealed that all the thirty (30) respondents agreed that the game passed these criteria. Having these results and feedback helped the researchers to know which game designs need to improve and to make sure that the researchers achieved one of the objectives of the study which is to maximize the 3D graphics of the game.

The mobile game application also passed the usability testing cases about learning to play the game easily. The purpose of this test case is if the user would manage to play the game easily.

Player Experience

The mobile game application passed all the test cases under player experience that the researchers used. The following are the questions and results in the test case for player experience.

The game conceptualized the true story of dogs and owners that the researchers mentioned in the objective of the study. With this concept, the researchers passed the content and structure of the game that are visible for users to become confident that the player is to learn while playing this game.

The researchers also wanted to produce a game that is educational for the players, gain knowledge while playing mobile games and to have communication with the other users. This also promotes cooperation among players.

As the researchers mentioned that this game is educational, the researchers have included a trivia about dogs to have something that is considered to be a very unique gameplay and this also passed the test cases for having something new to happen during the game to make players smile and be confident for what the player can learn about the game.

And lastly, the study shows that when it comes to player experience, this research passed all the requirements to satisfy the players in terms of satisfying accomplishment and cooperation among players, content relevant to the player's interest, and efficient alternative learning method.

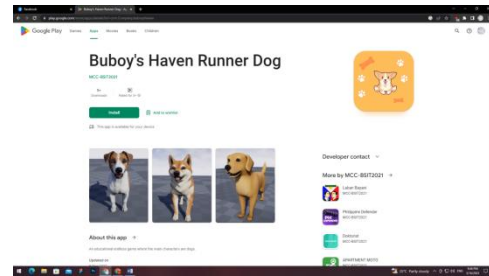


Figure 4. Game repository site

Summary result of Objective

Based on the previous related literature that the researchers considered, they easily determined all the specific requirements needed to complete the study. [6] [27] [28]

The use of diagrams such as Storyboard, Game Mechanics, Character model and Flowchart in developing the prototype model. The mobile application was essential to better understand the flow and the outcome in developing the game application.

The researchers planned this game as a 3D runner game. The character is based on a true story about a dog and its master, a schoolteacher. They created this as a tribute to the named character because their story touched the hearts of not only developers and researchers, but also others. It is also a reminder to generations of students that the school has a history similar to the story of Hachiko, Japan's loyal dog.

The game was a 3D runner game that told a story about the adventures the protagonist had before meeting his master. Researchers placed trivia at the end of the level as a gentle reminder of dog awareness. Researchers created storyboards to guide how to play the game.

The researchers also used it to visualize the appearance of menus, options, and other features. The researchers set rules, guidelines, and limits to make the game more challenging

for players. The researchers first designed the character in a rough draft as a guide for what the character should look like. Then they used 3D Blender to create, manipulate and animate the character's movements. Researchers used flowcharts to step through the game, including game features and features. It also acted as a direction for the plot to flow.

The developer used Blender 3D, Photoshop CS6 and Unreal Engine software to develop the game. They used Blender 3D and Photoshop CS6 to prototype and design characters and obstacles. For game design and development, they used Unreal Engine. They chose Google Play to publish the game because Google Play is the most widely used platform and widely known for Android games.

The development of the game started with basic movements, mechanics and game rules. They tested the space the characters would run in and placed obstacles for the characters to avoid. The next step was to design the levels and implement the graphics. The developers used some assets from the Unreal Engine Market to improve the graphics. After testing gameplay, they created the user interface, including screen sizes, menus, options, multiplayer lobbies, and more.

The researchers used MEEGA+ evaluation tool to validate the results. The researchers achieved the objectives of the study which is to maximize the 3D graphics and game user interface using Blender 3D and Photoshop CC shown in the test case result.

The researchers passed the test cases for player experience by having knowledge about dogs which is the main concept of the project. The group used Unreal Engine 5 to construct blueprint codes for this project. The result of Alpha test Usability is 3.78 and Player Experience 3.55 with Total of 3.66 the Verbal Interpretation Equivalent is Excellent. In Beta test result Usability is 3.52 and Player Experience 3.54 with a Total of 3.53 the Verbal Interpretation Equivalent is Excellent.

The group managed to conceptualize the game using the true story of dogs and owners specifically Buboy, Hachiko and Shurastey as a theme of the game to limit the study of the researchers.

Conclusion

The development of this game followed its stated objectives wherein the researchers developed an educational 3D endless runner game with the concept of the true story of dogs and owners.

The mobile game conformed to the stated objectives of the study. The researchers created the game interesting and attractive by maximizing the graphics using Blender 3D creating animation and making the game challenging using Unreal Game Engine 5. The result about graphics in the testing tool showed that the researchers achieved this objective.

The researchers also managed to create sound effects to make the game more realistic and exciting through Audacity, Internet access, and book-based information for educational trivia about dogs. This was added into the game successfully as unique mechanic for the game. To validate this result, the test case showed that the researchers passed the criterion for sound effects.

The researchers aimed to develop an educational endless runner game that conceptualize dogs to provide knowledge. For this to succeed, the researchers created an endless runner game with the concept of true story of dogs and owners. The researchers validated this result under player experience in testing tool which has shown that the game is challenging and it makes the player confident that they can learn from this game.

The researchers also wanted to maximize the 3D game graphics design of the game and for this to be successful, the researchers managed to implement game settings to manipulate game graphics such as lightning, shadows, and background music.

The researchers created a multiplayer game for the players to interact and communicate with each other to have fun and also to learn about dogs while playing mobile games.

Recommendation

In addition to the results and conclusions of the study, the researchers mentioned some future improvements to the system, thus the following recommendations. To play this game not only for Android devices but also for IOS devices. To add another animal (cat, bird or fish) which does not only cover the dogs. To create additional types of enemies and character with other skill types to attack. To

implement to other target platforms aside from mobile devices such as PC and Laptop. To make the game playable over the Internet and make it not limited to local area network connectivity.

REFERENCES

- [1] Technological Influence on Society by Mickeel Allen, Alvernia University Nov 07, 2019. <https://www.bctv.org/2019/11/07/technological-influence-on-society/>
- [2] Sylvander, Samu and Penttinen, Esko and Rossi, Matti and Tuunainen, Virpi Kristiina, Mobile Games: Analysing the Needs and Values of the Consumers, The Global Mobility Roundtable Conference, Journal of Information Technology Theory and Application, A Publication of the Association for Information Systems, Volume 11, Issue 1, pp. 5-22, 2010.
- [3] Mudit Misra, Elena arquez Segura, Ahmed Sabbir Arif. Exploring the Pace of an Endless Runner Game in Stationary and Mobile Settings. October 17, 2019 <https://dl.acm.org/doi/10.1145/3341215.3356256>
- [4] Granic, Isabela and Lobel, Adam and Engels, Rutger, The Benets of Playing Video Games, doi 10.1037/a0034857, pp. 66-78, 2014. <https://www.apa.org/pubs/journals/releases/amp-a0034857.pdf>

BURAIIDO: An IoT Based Multifunction Smart Blinds using Raspberry Pi

Lyjay Dred G. Cayanong
Jayvie F. De Leon
Shawn Nicole D. Farrow
Eunixin C. Lansang
Arlie T. Torres
Justin D. Yalung
Frederic D. Santos (Technical Adviser)

ABSTRACT

The Internet of Things (IoT) is a key differentiation in many ways, such as how it improves convenience and efficiency; therefore, the researchers decided to develop an IoT device designed specifically for households. The researchers chose blinds because they have easy and quick method to get started with smart-home technology and are a perfect entry point for a home-related IoT device. The raspberry pi 4b micro-controller was used by the researchers in this study, with the installed smart blinds with various capabilities and features. The primary objective of this study is to create a prototype termed "Buraindo: An IOT Based Multi-function Smart Blinds Using Raspberry Pi." The prototype model is the general methodology used in this study. The researchers used this method to develop a prototype, test it, and then improve it as needed until an acceptable prototype was established. The researchers discovered that it is critical to appropriately display the data and to include the decimal digits. Additionally, they discovered that utilizing a powerful motor is necessary for the blinds to operate effectively. Since installing a speech recognition module would be too expensive, the researchers opted to use Google Speech Recognition. Derived from the findings, the prototype was built by the researchers that incorporated multifunctional smart blinds. Finally, successful alpha and beta testing results demonstrated that the application and prototype met the specifications, using the collected evidence. The research concluded that the product prototype "Buraindo: An IOT Based Multi-function Smart Blinds Using Raspberry Pi" was a success.

INTRODUCTION

Modern technology, particularly the Internet of Things, is radically altering our world. In the current environment, businesses and people communicate at previously unheard-of speeds, spreading information more rapidly than before. Decision-making is sped up by the IoT, or Internet of Things, which is the seamless networking of diverse mechanical components and includes sensors [1]. The Internet of Things (IoT) is a game-changer in many aspects, including how it increases comfort, convenience, safety, and efficiency, and improves health.

Smart blinds are a simple way to get started with smart home technology and are suitable entry points for any home because they do not have to be installed during construction and can be installed anywhere [2]. Although it ceases to appear that opening or closing a blind is a difficult task that should be automated, there are benefits to motorizing and programming the blinds.

Blinds can be closed completely, eliminating view, daylight, and sunshine. They can be slanted, eliminating glare, and controlling daylight but allowing some view. They can be opened up completely, allowing full access to sunshine, daylight, and view. Additionally, these can block glare from the sunlight and guide solar radiation toward the ceiling while still allowing illuminance to into the space.

A multi-function device provides several benefits. Humidifiers are excellent for relieving allergy symptoms or combating dryness induced by air conditioners. If the users accidentally neglect to pay attention to humidity levels; although, operating it too much can cause mold or mildew to build in the home [3].

Blinds can be raised and lowered as usual while the users at home, or completely closed, blocking out all light and sunshine.

Raspberry Pi 4 Model B expands on the already incredible Pi concept. The Pi 4b is one of the most powerful versions of the greatest tinkering

PC on the market because of its tiny size, and flexible form factor [4]. The raspberry pi 4b has many features that can be used to develop, it has an integrated Wi-Fi module, and can also be used to install speech recognition stronger than its forerunners. A quicker processor makes the Pi 4 easier to operate and enables to creation of more challenging projects.

The researchers thought of the name “Buraindo” through their brainstorming and one of the members translated the word “blinds” into Japanese word which is “Buraindo” and that was how the researchers came up with the name of their study.

The researchers developed a smart blind that has different features entitled “Buraindo: An IOT Based Multi-function Smart Blinds using Raspberry Pi. The micro-controller that the researchers used in this study is the raspberry pi 4b. This aimed to have a comfortable room with the installed smart blinds that have different features. Buraindo has speech commands to control the blinds, temperature monitoring that can be seen on the blinds and their humidity level, and a digital clock. The blinds also have humidifiers that moisturizes the air which can relieve the user. A led light can change to many different colors of lights that the user may want. The mobile application that is connected to the Buraindo is the controller of the prototype which has many interfaces.

General objective

The main objective of this study is to develop a prototype entitled “Buraindo: An IOT Based Multifunction Smart Blinds Using Raspberry Pi.” In line with this, the study aims to achieve the following specific objectives:

- To gather information through the use of physical interviews, brainstorming, and the use of online platforms and identify the software and hardware requirements.
- To design a mobile application and prototype using the design and analytical tools.
- To construct a multifunction smart blind using raspberry pi with the essential IoT devices.
- To develop a mobile application and interconnect the app to the prototype.
- To test the mobile application and the prototype, the researchers would use test cases and a questionnaire of ISO 25010.

Scope and Limitation of the Study

The scope of the study focuses on developing Buraindo. The prototype has multifunction smart blinds with additional features that can be controlled by speech commands using the mobile application.

The researchers gathered information through physical interview, brainstorming, and the use of online platforms.

The researchers identified the hardware and software requirements that are needed in developing the prototype, Buraindo. The software requirements that were used for the study are Figma, Firebase, Python, Raspberry Pi OS, Thonny IDE, 3D Blender and Mit App Inventor V2. The hardware requirements that would also be used for the study are Air Humidifier, DHT22, L298N Motor Driver, Max7219 Dot Matrix 8x32 Module, Nema 17 Stepper Motor, Raspberry Pi 4B, Relay 5v 1 Channel Module, and WS2812B Led Strip Lights. The researchers utilized the design and analytical tools in modeling the prototype and the mobile application. The researchers also designed a block diagram to understand the flow of the system. Furthermore, they used a flowchart to understand the concept or flow of the mobile application. Hardware design circuit diagram were also used as a guide for the researchers in connecting wires for the prototype. They even created a storyboard to visualize how the mobile user interface would be developed. Also, a 3D blender was used to create a structural design for the researchers to see how the prototype design would turn out.

A multifunction smart blind was constructed using the raspberry pi 4B as the microcontroller. The researchers used air humidifier to connect to the relay 5v 1 channel then connected it to the raspberry pi which allowed the raspberry pi to have access to control the air humidifier. They also used dht22 temperature and humidity monitoring sensor to monitor the room. To display the output of dht22, the max7219 dot matrix 8x32 module was used which was connected to the raspberry pi then obtains the data that the dht22 is sensing. Right then, it displays the output of dht22 to the max7219 dot matrix 8x32 module. The researcher used nema 17 stepper motor to control the blinds, in order for the stepper motor to function. The stepper

motor needs to be connected to the L298N motor driver which is also connected to the Raspberry Pi to control the voltage of the NEMA 17 stepper motor and sends signals on how the motor would work. Moreover, they utilized WS2812B LED strip lights. Since the WS2812B LED strip lights are programmable, these were also used to connect it to the Raspberry Pi to be programmed and allows the user to control the LED lights.

The study also aimed to integrate the IOT devices into the smart blinds that has features for temperature and humidity display, which would help the user to monitor the room temperature and humidity. A humidifier that would blow a scent and produce moisturized air to avoid having dry skin. The LED strips lights, on the other hand, are used to enhance the user's mood.

This study also aims to create a mobile application user interface that would monitor the four parameters through a mobile application that monitors and controls the following: temperature panel, humidity panel, LED lights panel, and blinds control panel.

The researchers also developed a mobile application with the following features. The temperature panel would display the current room temperature in degree Celsius. The main function of this panel is to provide a convenient and easy-to-read display of the current room temperature, allowing users to monitor.

The humidity panel, also known as humidity monitor, is a device that measures and displays the relative humidity of a specific environment. The panel consists of sensor, such as a hygrometer, that detects the humidity and would display unit that shows the humidity reading. The panel can do several things such as: display the current room humidity level, allow the user to monitor the humidity level, provide the user with the ability to set the humidifier to "Auto-mode" or "Always-on" and automatically turns on the humidifier when the humidity level reaches 30% below and turns off when it reaches 45% above.

The LED lights panel provides a convenient and user-friendly interface for controlling and managing LED lights. The application allows the user to easily turn the lights on and off, adjusts their brightness, and selects the color of the lights. The user can perform a variety of

tasks such as: turning the LED lights on or off, selecting the color of the lights, adjusting the brightness of the lights and choosing different LED effects. The LED lights panel mobile application provides a simple and intuitive way for users to control and manage their LED lights, allowing them to easily customize the lighting to suit their preferences and needs.

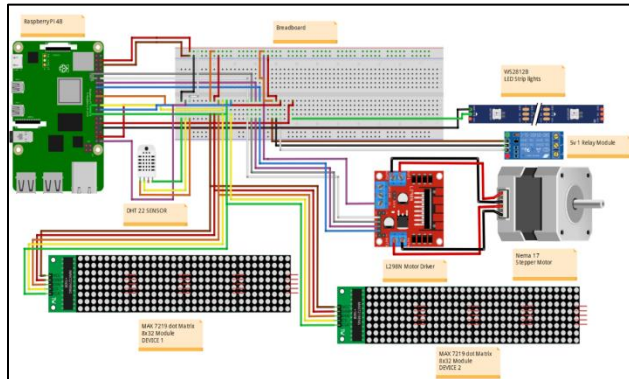
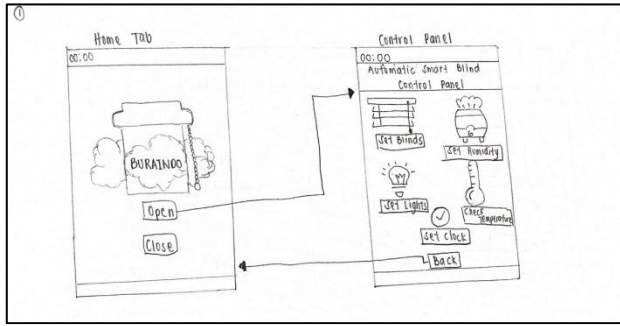
The blind control panel displays various information and options related to the blind control panel, such as the current status of the blinds (open or closed) and the current position of the blinds (up or down), a button to open or close the blinds a button to access the schedule settings for the blinds, where the user can set a schedule for the blinds to open or close automatically, an arrow icon to manually control the position of the blind, allowing the user to move the blinds up or down in increments, and a button to activate speech recognition, allowing the user to give command to the system through speech.

Speech recognition is only available through the use of a mobile phone by tapping the speech icon. Making use of speech recognition, the user should give commands to the systems, and the system would receive the specific commands and process the command given.

The researchers interconnected the mobile application to the prototype with the use of Internet and Firebase. The mobile application gets the data and also sends data to the Firebase which the Raspberry Pi would receive the data from the Firebase to process the task given which would be transmitted to the IOT devices that are connected to the Raspberry Pi.

In order to test if the mobile application and the prototype are all functional, the researchers tested the prototype and the mobile user interface through test cases and the use of questionnaire ISO 25010, which was verified by IT experts.

However, the developed mobile application is only applicable to Android phones. The developed system incapable to install a voice recognition module due to finances was replaced with a mobile speech recognition that can still use speech commands. The mobile user interface is incapable of monitoring the air humidifier liquid level. The proposed system was also incapable to function if the users is disconnected to the Internet. Most of the data



Quick Design

The second phase is the quick design, in which the researchers are able to design a quick design. Once the requirements are known, it helps the researchers to visualize how the product should be developed. MIT APP Inventor V2 was discovered by the researcher which is a good tool to develop a mobile application with the help of MIT APP Inventor V2, the researchers drew a storyboard to be used for developing a mobile application. In addition, the researchers also created their prototype design with the use of Blender software which is useful for creating 3D objects. Figma also used for designing the mobile user interface. The block diagram helps the researcher to understand how the system would work in development. The hardware design circuit diagram is used to guide the researchers in connecting the wires from the IoT devices to the raspberry pi. The flowchart is also used to guide the researchers on how the mobile application should work.

Build Prototype

Building a prototype will utilize the data acquired in quick design which was used to develop the prototype. The researchers

followed the Gantt chart in developing the prototype (see appendix P). The researchers identified that DHT22 is a humidity temperature sensor that monitors the room temperature and humidity. Furthermore, the researchers also investigated Nema 17 Stepper Motor rotates 1.8° which helps them to operate the close and open of Smart Blinds. They also found out that WS2812B is a programmable led light which allows the research to control the led lights through the use of a mobile application. A humidifier is added to produce moist air which controls the humidity level of a room. In addition, voice recognition was programmed to allow voice control of the system. The researchers have identified all the functions of the components. They started connecting the components to the raspberry pi, building the prototype, and developing the mobile application. After fulfilling the requirements, the researchers interconnected prototype and mobile application with the use of internet and firebase which were connected to each other.

User Evaluation

At this stage, the researchers conducted test cases, an alpha test and beta test to test the functionalities of the prototype and the mobile application. The alpha test helped the researchers to identify if there are possible bugs in the mobile application and if the prototype needs adjustment and if there are recommendations and suggestions for the prototype and mobile application (see figure 35). The beta test also helped the researchers to identify the bugs and possible error that possibly occur and the researchers also checked if there are adjustments needed for the prototype and if the mobile application needs further enhancements (see figure 36). The respondents for the beta tester are the household members and the number of respondents for the beta testing is thirty participants (30). The participants that were chosen for the beta testing was chosen through the use of random sampling method. The test started in the month of October after the prototype and mobile application was developed until early of November. The questionnaires that were used for the testing is ISO25010 that was validated by Engr. Oliver R. Santos who is an Electronic Engineer Expert

(see appendix V). The system and mobile application were evaluated in terms of functional suitability, usability and portability. The data that was collected are compiled and analyzed so conclusions can be derived. Frequency Distribution is utilized to determine the number of responses. The results from the Likert Scale were used to find out the overall assessment of the respondents and is used to interpret the test results (see appendix O for the Likert Scale).

In order to interpret the results from the Likert Scale, the data that were gathered are compiled and analyzed. The formula that was used to get the mean score of the results is $x = \sum fx / n$.

Refining Prototype

Once the user evaluation was conducted, the researchers gathered the results of the test cases, alpha and beta test and if there are suggestions and feedback to the developed prototype and mobile application. The researchers made adjustments to the prototype and mobile application until the recommendations and feedbacks are met.

Implement and Maintain

After it has been developed to its final stage, The prototype is tested and put into service. The prototype would be implemented to household who are in range of upper-class family. To avoid malfunctions, routine maintenance is performed to avoid malfunctions. The prototype is limited to the final defense and maintenance is not included in the scope of the study. However, it is part of the stage, that the researchers discussed thoroughly.

RESULTS AND OUTCOMES

The researchers developed a multifunction smart blind that was in accordance to the study's objective. As the developer finished developing the system's main functionalities, the researchers conducted series of tests to ensure that the prototype was functioning properly and effectively. Please refer to the figures below for more information on the system prototype and testing process.



Testing the functionalities of the prototype will be represented by the test cases shown in the table above. Each of the prototype functions was tested more than ten times to ensure that each prototype performs in accordance with its intended function. After conducting preliminary tests there is some slight delay for the system to response on its functionality, it was discovered that the speed of Wi-fi connectivity affects the whole system.

When the humidity level reaches 30% and the auto of humidifier is turned then the humidifier will start to function, but it does not monitor the liquid inside the humidifier which the users need to monitor.

The researcher found out that nema 17 stepper motor works properly in opening or closing the blinds. It can be manually controlled through the use of mobile application.

After completing the prototype testing and ensuring that all wires are properly connected and all devices are working, the researchers confirmed that the prototypes are all functional based on test cases trials.

The test cases for the features of the mobile application user interface were shown in the table above. For each test case, more than 10 trials we carried out to ensure that the mobile application user interface are in sync with the prototype.

The researchers were able to create a user interface for a mobile application that displays the room temperature and humidity. The DHT22 records the humidity and temperature of a room and the data gathered by the sensor will be sent to the database. As a result, the mobile user interface was able to display the current room humidity and temperature.

Finally, the mobile user interface test case was run ten times to ensure that the mobile applications are all functional and in sync.

Table 1. Summary of Alpha Tester in terms of ISO25010 criteria

Criteria	%	Interpret %
Functional Suitability	100%	Very Agree
Usability	80%	Very Agree
Portability	100%	Very Agree
Total	93.33%	Very Agree

The tables above show the summary of Alpha Tester in terms of ISO25010 criteria which would be interpreted through the use of Likert scales. The prototype and mobile application overall Functional Suitability test has garnered a mean percentage of 100 with a verbal interpretation of “Very Agree”. This means that the majority of alpha tester are very satisfied and agreed that the application user-interface was completely functional. The application correctly displays the expected result from the prototype sensors. The system is pleasingly appropriate to accomplish the desired result. The overall Usability test has garnered 80 with a verbal interpretation of “Very Agree”. This means that most of the alpha tester were easily able to operate and control both the application and prototype. The application has a user-friendly interface design that user have navigate and learned it easily with minimal guidance of the researchers. The overall Portability test has garnered a mean percentage of 100 with a verbal interpretation of “Very Agree”. This means that majority of the alpha tester were able to adapt the system to the blinds and install the mobile application easily on to their mobile phone. The overall total of 93.33 mean percentage with a verbal interpretation “Very Agree”. This means that the overall result is satisfied with the outcome.

Table 2. Summary of Alpha Tester in terms of ISO25010 sub criteria

Criteria	Yes	%	No	%
Functional Suitability				
Functional Completeness	6	100%	0	0%
Functional Correctness	6	100%	0	0%
Functional Appropriateness	6	100%	0	0%
Usability				
Appropriateness	3	100%	0	0%
Recognizability				
Learnability	6	100%	0	0%
Operability	24	100%	0	0%
User Interface	2	33.33%	4	66.67%
Aesthetics				
Accessibility	4	66.67%	2	33.33%
Portability				
Adaptability	3	100%	0	0%
Installability	6	100%	0	0%
Total	66	91.7%	6	8.3%

The table shows the summary of Alpha Tester in terms of ISO25010 sub criteria shows the score under Functional Suitability. The Functional Completeness that answered “yes” was 6 which $6/6 * 100 = 100\%$ percentage score which means that the majority of alpha testers agree that the application user-interface was completely functional. The Functional Correctness that answered “yes” was 6 which $6/6 * 100 = 100\%$ percentage score which means the alpha testers agree with the application correctly display the expected result from the prototype sensors. The Functional Appropriateness that answered “yes” was 3 which $3/3 * 100 = 100\%$ percentage score which means that majority of the alpha tester agrees that the system is pleasingly appropriate to accomplish the desired result. Under the sub criteria of usability shows the Appropriate Recognizability that answered “yes” was 3 which $3/3 * 100 = 100\%$ percentage score which means that the alpha testers agree that the mobile interface icons are recognizable. The Learnability that answered “yes” was 6 which $6/6 * 100 = 100\%$ percentage score which means that the majority of alpha testers agrees that the mobile interfaces are user-friendly and easy to understand. The Operability that answered “yes” was 24 which $24/24 * 100 = 100\%$ percentage score which means that the majority of alpha testers agree that the mobile application and prototype are operatable. The User Interface Aesthetics that answered “yes” was 2 which $2/6 * 100 = 33.33\%$ percentage score and 4 “no” which $4/6 * 100 = 66.67\%$ percentage score which means that the majority of alpha testers agree that the mobile interface graphical user interface and

icon are recognizable. The Accessibility that answered “yes” was 4 which $4/6 * 100 = 66.67\%$ percentage score and 2 “no” which $2/6 * 100 = 33.33\%$ percentage score which means that most of the alpha testers agree. Under the portability, the adaptability answered “yes” was 3 which $3/3 * 100 = 100\%$ percentage score which means that the alpha testers agree that the system can be installed on different blinds and the Installability that answered “yes” was 6 which $6/6 * 100\% = 100\%$ percentage score which means the alpha testers agree that mobile application can be installed easily. The total that answered “yes” was 66 which is equivalent to $66/72 * 100 = 91.7\%$ percentage score and 6 “no” which $6/72 * 100 = 8.3\%$ percentage score.

Table 3 Summary of Beta Tester in terms of ISO25010 sub criteria

Criteria	Yes	%	No	%
Functional Suitability				
Functional Completeness	60	100%	0	0%
Functional Correctness	60	100%	0	0%
Functional Appropriateness	59	98.33%	1	1.67%
Usability				
Appropriateness	28	93.33%	2	6.67%
Recognizability				
Learnability	57	95%	3	5%
Operability	239	99.58%	1	0.42%
User Interface	55	91.67%	5	8.33%
Aesthetics				
Accessibility	41	68.33%	19	31.67%
Portability				
Adaptability	24	80%	6	20%
Installability	30	100%	0	0%
Total	653	94.64%	37	5.36%

The table shows the summary of Beta Tester in terms of ISO25010 sub criteria shows the score under Functional Suitability. The Functional Completeness that answered “yes” was 60 which $60/60 * 100 = 100\%$ percentage score which means that the majority of beta testers agree that the application user-interface was completely functional. The Functional Appropriateness that answered “yes” was 59 which $59/60 * 100 = 98.33\%$ and 1 “no” which $1/60 * 100 = 1.67\%$ percentage score which means that majority of the beta tester agrees that the system is pleasingly appropriate to accomplish the desired result. Under the sub criteria of Usability shows the Appropriate Recognizability that answered “yes” was 28

which $28/30 * 100 = 93.33\%$ percentage score and 2 “no” which $2/30 * 100 = 6.67\%$ percentage score which means that the beta testers agree that the mobile interface icons are recognizable. The Learnability that answered “yes” was 57 which $57/60 * 100 = 95\%$ percentage score and 3 “no” which $3/60 * 100 = 5\%$ percentage score which means that the majority of beta testers agrees that the mobile interfaces are user-friendly and easy to understand. The Operability that answered was 239 which $239/240 = 99.58\%$ percentage score and 1 “no” which $1/240 = 0.42\%$ percentage score which means that the majority of beta testers agree that the mobile application and prototype are operatable. The User Interface Aesthetics that answered “yes” was 55 which $55/60 * 100 = 91.67\%$ and 5 “no” which $5/60 * 100 = 8.33\%$ percentage score which means that the majority of beta testers agree that the mobile interface graphical user interface and icon are recognizable. The Accessibility that answered “yes” was 41 which $41/60 = 68.33\%$ percentage score and 19 “no” which $19/60 = 31.67\%$ percentage score which means that most of the beta testers agree. Under the Portability, the adaptability answered “yes” was 24 which $24/30 * 100 = 80\%$ percentage score and 6 “no” which $6/30 * 100 = 20\%$ percentage score which means that the beta testers agree that the system can be installed on different blinds. The Installability that answered “yes” was 30 which $30/30 * 100 = 100\%$ percentage score which means the beta testers agree that mobile application can be installed easily. The total of who answered “yes” was 653 which $653/690 * 100 = 94.64\%$ percentage score and 37 “no” which $37/690 * 100 = 5.36\%$ percentage scores.

Table 4. Summary of Beta Tester in terms of ISO25010 criteria

Criteria	%	Interpret %
Functional Suitability	99.44%	Very Agree
Usability	89.58%	Very Agree
Portability	90%	Very Agree
Total	93.01%	Very Agree

Table 5. Comparison of Alpha and Beta Tester

Alpha			Beta		
Criteria	%	Interpret %	Criteria	%	Interpret %
Functional Suitability	100%	Very Agree	Functional Suitability	99.44%	Very Agree
Usability	80%	Very Agree	Usability	89.58%	Very Agree
Portability	100%	Very Agree	Portability	90%	Very Agree
Total	94.56%	Very Agree	Total	93.01%	Very Agree

The table above shows the comparison of the results of alpha and beta testers. The prototype and mobile application overall Functional Suitability test of alpha has garnered 100 mean percentage with a verbal interpretation of “Very Agree” and the beta has also garnered 99.44 mean percentage with a verbal interpretation of “Very Agree” which means that the alpha and beta were satisfied with the functionalities of the mobile application and the prototype. The overall Usability test of alpha has garnered 80 mean percentage with a verbal interpretation of “Very Agree” and the beta has also garnered 89.58 with a verbal interpretation of “Very Agree” which means that the alpha and beta were easily able to operate and control both the application and prototype. The user was able to navigate the interface and learned it easily with minimal guidance of the researchers. The overall Portability test of alpha has garnered 100 with a verbal interpretation of “Very Agree” and the beta has also garnered 90 with a verbal interpretation of “Very Agree” which means that the alpha and beta were able to install the mobile application with ease. The overall total of alpha is 94.56 with a verbal interpretation of “Very Agree” and beta has 93.01 with a verbal interpretation of “Very Agree” which means that the alpha and beta tester were satisfied with the functionalities of mobile application and the prototype.

DISCUSSIONS

The summary of findings that the researchers were able to identify based on the trials, errors and results of the study, are specified below: The researchers included the temperature monitoring, during the development phase. They used dht11 but the researcher's encountered problem which the dht11 only records whole number reading. Hence, the researchers looked for another solution to solve this problem, which leads them to the use of dht22. The dht22 is able to read decimal digits without rounding off the number. In order to display the data digitally, the researchers used seven segments led to display the data. Unfortunately, the researchers found out it was out of stock, which the researcher learned the

use of dot matrix that could be also used to display the data digitally. For the blinds to be controlled through the use of a motor, the researchers thought servo motor would work but due to its functions which leads to incompatibility, it was replaced by the nema 17 stepper which was the best solution for this and which would be able to hold the blinds as it also has the capability to open or close through the rotation of motor. The researchers also included speech recognition module but due to the module being expensive, the researchers used Google speech recognition. Additionally, led lights were added to the prototype. For the led lights to be programmed, the researchers used ws2812b for the led strip lights since it is a programmable led light which can be programmed according to the user's preference. The researchers also used analytical and design tools such as flowcharts, hardware design circuit diagram, storyboard and structural design. MIT app inventor v2 was used by the researcher to develop the mobile application and for the mobile user interface design figma was used. To program the prototype the researcher used raspberry pi 4b as the microcontroller and the programming language that was used is python. In order to connect the prototype and the mobile application, firebase was used wherein the mobile application sends the commands into the firebase which the raspberry pi receives the data and process it to control the prototype. The researchers successfully developed the mobile application and the prototype.

REFERENCE

- [1] Kingston Technology. (2021, Apr). Beyond Smart Cities: How IoT is Changing the World [Online]. Available: <https://www.kingston.com/en/blog/servers-and-data-centers/how-iot-is-changing-the-world>
- [2] SmarterHome. (2019, Oct. 14). How to Get Started with Smart Blind [Online]. Available: <https://www.smarterhome.com/blogs/tilt/how-to-get-started-with-smart-blinds>
- [3] S. Finley. (2021, Nov. 20). Do humidifiers help with allergies? [Online]. Available: <https://www.livescience.com/do-humidifiers-help-with-allergies>
- [4] P. Mezger, V. Weaver (2018, Oct 01). A raspberry pi operating system for exploring advanced memory system concepts [Online]. Availability:

CARTICON: A Microcontroller-Based Car Emoticon Display and Traffic Warning Messages with User Interface Application

Catherine V. Castro
Luis Vincent V. Garcia
Sarah May P. Gonzaga
Tristan Renz Angelo V. Manusig
Donnabel D. Petilla
Joshua C. Ramilo
Engr. Ernie Lee E. Pineda, MIT (Technical Adviser)

ABSTRACT

As stated by the research “Top 10 Importance of Technology in Our Life”, Technology is an essential part of our daily lives. Most of the time, communication with each other is made thru gestures and signals like horning which may lead to miscommunication and may cause an accident or a fight since neither all people know the meaning of the gesture or signals. The general objective of the study is entitled CARTICON: A Microcontroller-Based Car Emoticon Display and Traffic Warnings Messages with User Interface Application. The researchers used the prototyping model as a guide to complete Carticon and its mobile interface application. It also had beta testers who are professional drivers. The device's components were the P10 LED display, Arduino Uno, Bluetooth receiver, and battery. It could display emoticons, traffic signs, traffic warning messages, and short messages. The developed user interface has a Bluetooth connection, fixed emoticons, fixed traffic signs, fixed traffic warning messages, and fixed short messages. The mobile application also features customized messages, and authorized drivers can use it in two ways: through manual typing and voice commands. The researchers released the software to a small group of external thirty beta users for testing after the mobile application and prototype passed the developers' test. The application was evaluated using the ISO 25010 Software Quality Standard criteria. The researchers believed that the overall percentage mean score of 86.84% of beta test ended to the conclusion that the CARTICON prototype and mobile application has interpreted as “Excellent” and achieved the set criteria for the evaluation.

INTRODUCTION

As stated by the research “Top 10 Importance of Technology in Our Life”, Technology is an essential part of our daily lives. Every other task they do today relies heavily on technology. People depend so much on it that they can't even imagine their lives without technology; they use hundreds of gadgets in their homes, schools, and offices. They understand that technology connects the world. For example, they may communicate with others through cellphones, internet access, GPS, and a variety of other technology. [1] According to Google, emojis are a big part of modern communication. People use pictures to convey a message — in a lot fewer characters! In the late 1990s, a Japanese artist named Shigetaka Kurita created the first emoji. He was working for a mobile communications company called NTT Docomo. They were developing a new internet platform. Since it allowed for a limited number of characters, Kurita came up with the

idea to replace words with pictures. This would allow people to communicate longer messages while using less data. Over a decade later, Unicode created a universal standard set of emojis; this meant that people all over the world were using the same emoji dictionary. Emojis now are part of our everyday lives. When text messaging via mobile phones and the internet began to be widely available in the latter part of 1990, emoticons gained popularity and were frequently employed in text messaging, internet forums, and emails. For example, a filter that transforms emoticon (smiley) characters into pictures can display emoticons as images. Emojis can be added to the picture by clicking on the icon. Type in the emoticon's characters in the text editor or add an emoticon to their text editor. Emoticons play a crucial part in electronic communications, and a variety of gadgets and apps have produced stylized graphics which do not utilize punctuation marks in text. Emoticons are the

precursors to modern emojis that are in constant development to suit a variety of platforms. Over 90 percent of the world's online users use emojis and emoticons. If they are in a nation that allows such displays, people can let their emotions flow by displaying an emoji-themed car. They offer a more comprehensive range of "tone" and feeling through texting that expresses emotions unique to the individual by using facial expressions in online conversations that are text-based. The ads range from happy faces to warnings and writing to read the whole text. Emoticons are graphic symbols that express emotion or mood by employing punctuation marks, words, and numbers. In fact, that's where the word "emoticon" comes from: emoticons are emotional signs. Also, most emoticons are read upside down because of keyboard limitations.[2]

Every enthusiast or motorhead, which means car lover, connects to the field of driving. [3] Drivers need good communication with other drivers as well as with the people walking and crossing the road since these are some of the problems they are experiencing. The use of traffic warning signs which are readable is a great help to drivers. It is important to inform the drivers and people using pedestrians about the situation of the coming and going cars. With that, confusion may be avoided at best, and a collision, at worst. Most of the time, communication with each other is made thru gestures and signals like honking which may lead to miscommunication and may cause an accident or a fight since neither all people know the meaning of the gesture or signals. LED displays are nowadays introduced to the drivers to get something written on it. Traffic displays on LEDs began to be famous so many enthusiasts tried them. The moment they bought it, they installed it then the display illuminated. The screen is more of an LED display that can be tucked into the rear of the vehicle.

Vehicular-related accidents could be avoided if motorists have proper communication and etiquette. In the Philippines, there is a law about anti-distracting driving. Therefore, the study is limited to exempted vehicle only which is health care provider, fire department, or other emergency services. This vehicle is

necessary to have a lot of attention as they respond to the people who needed help.

The researchers aimed to develop a Carticon that would include features like text messages, emoji displays, and traffic warning signs. It is possible to change the display of text or emojis in their car and remove them when required. There would be neither impact from the weather on this screen as it is placed in the vehicle. The screen would display images and text in the exact format—emoji screens, which can be customized. This would allow them to choose the option of personalizing. Additionally, they can alter the display when driving. The researchers aimed to develop a product prototype with mobile application titled CARTICON: A Microcontroller-Based Car Emoticon Display and Traffic Warnings with User-Interface Application. The project would display different types of warnings to anticipate possible dangers in the roadway or issue caution for other motorists. The project would display warning signs on the road, motions, and simple acknowledgment words.

General Objective

The study's overarching goal is to create a Carticon: a Microcontroller-Based Car Emoticon Display and Traffic Warnings Messages with User Interface Application. Specifically, the study aims to:

Specific Objectives:

To gather information about the study

- Data from the library
- Review Related Literature
- Observed cars

To identify all the hardware and software requirements

Hardware Requirements;

- Arduino UNO
- P10 led matrix
- Bluetooth Receiver
- Asus Laptop
- Dell Laptop

Software Requirements;

- Arduino IDE
- MIT App Inventor

To design the CARTICON product and mobile application using diagrams and analysis tools:

- Storyboard
- Block diagram
- Schematic diagram

To create an IOT device and system that has the following features:

- Bluetooth Connection
- Emoticon Display
- Customized Text Messages
- Common Traffic Warnings
- Google Voice Recognition
- Indicator

To test the systems using:

- Test Case; and
- ISO25010

To deploy the mobile application that drivers can access the respective repository link of the APK on the website created by the researchers together with the prototype:

- Ambulance
- Firetruck
- Police
- Any Emergency Assistance

Scope and Limitation

The researchers gathered information from the MCC library and collected additional information on the internet, gathered articles and studies to conclude what was the researcher's capability and the possibility to make the study happen. By observing cars, they notice and get necessary data on how the vehicles work on the road. The researchers did this in the morning, afternoon, and evening to see through the differences.

The hardware requirements used for the study are Arduino Uno as the core functions for all, P10 Led Matrix used for the display panel where one can see the output, and Bluetooth receiver that has pairing for security purposes. For the device, the researchers used DELL for coding and creating the user interface. As for the software requirements, the researchers used Arduino IDE as the primary control of the device. This is where the codes for the emoticon are put and hard coded. MIT App Inventor to create the user interface application that would connect to the panel for the output.

Researchers designed the system's potential back end and front end using analysis tools such as block diagrams, schematic diagrams, and storyboards. The goal of the block diagram is to know how the study would work. A schematic diagram is designed for the IOT device's electrical components and how the device would be needed to create. And

storyboard on how the study would run, how to set up the device, how to join the device, and how to display an output to the panel, everything about the Carticon.

Carticon would have the following features: display emojis, text that the user can customize to their preference, and limited fixed messages to communicate with other drivers. The displays would have indicators that would help the drivers know what is being displayed. It would also have voice recognition that would automatically display in the panel, this is a special feature provided by the researchers because according to the gathered data, drivers' hands are always on the steering wheels, it would help them to display what they want and start Bluetooth pairings for security purposes. For the IoT device, users need to get the prototype from the researchers. Second, install it at the rear of their four wheels car. Inside the prototype, a battery can last up to 12 hours of continuous use. To make it run, switch the on and off buttons at the side of the panel. It is automatically detecting the Bluetooth receiver that the user interface needs. Then put in the pairing password and start utilizing the system and device. If he/she wants to turn it off, tap the off button. The study's limitation is that it only applies to 4 wheels cars. The IoT device is designed to be non-invasive, which means that it is designed to function alone and would never be tapping into any electrical and electronic functions of a car for obvious safety reasons. The researchers suggested that avoid tapping anything related to the vehicle. The device would continue even if the mobile application is off. The last they entered would stay displayed in the panel. The Carticon would have the number of fixed text message warnings that would be used in the application precisely. The researchers would consider only the 10 common warning signs, emojis with a database maximum of 10 characters of emoticon, and a limited number of common ethical traffic messages. The most common and prone to accidents would be displayed. The LED would display fixed words that can show up to 4 letters without running, emoticons, emojis, and symbols, and is editable with a maximum of 30 letters thru the user interface to avoid any unethical or not related traffic rules. The device might have bugs if the

letters exceed the given amount. Hence, users cannot modify the colors that the Programmers would be using. The problem of this study is that the drivers can use the device without knowing how the battery would last long and hopefully adding the One of the battery's energy sources is a solar panel that the researchers would like to recommend to future researchers. The user interface can download to the repository where they can see all the little information about the Carticon via APK provided by the researchers. Testing would be from the selected beta tester who are professional drivers with four-wheeled cars. The sampling method was Simple Random Sampling distributed to the potential respondents. The statistical treatment is followed because the survey tool used is ISO10150 and deploys the IOT device to the drivers who have an exemption from law Republic Act 10913 sec 6. Anti-Distracted Driving.

The mobile application would be uploaded, deployed, and is currently accessible at the (<https://carticon1.webnode.page/>) repository site after passing the acceptance testing of the beta users and expert panels.

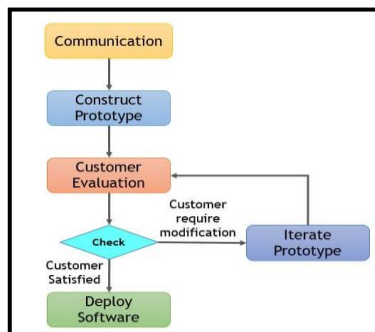


Figure 1. Prototyping Model

(Source: <http://What is a Prototyping Model? Phases, Types, Advantages & Disadvantages - Binary Terms>)

SYSTEM DEVELOPMENT METHODOLOGY

This section examined the process employed by the developers of the application to design and construct it and the diagrams that are used to clarify the study's process and design. This chapter also discussed an outline in the case of a block diagram,, a Storyboard, and a schematic diagram which give additional

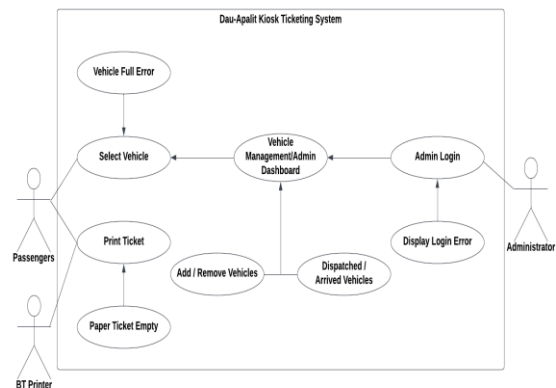
details about the methods and their application.

Prototyping Model

The researchers used the research design method of the prototyping model. This model is the instructions on how to accomplish the study from the very start of the project. The following are the primary phases involved in the development cycle of any prototyping model:

Communication

The researchers made a smart option to



acquire information from the MCC library and obtain additional information online. They collected articles and studies to determine their capabilities and chances of carrying out the study. They examined and gathered essential information about how the vehicles operate on the highway by observing cars. At this point, researchers engaged with the drivers to understand the needs of the client. For the researcher's study, the purpose of the mobile app and the part where the definitions need to be clarified are described. The requirements that are clear and easily understood are defined. The study's hardware specifications include an Arduino Uno as the central processor, a P10 LED matrix as the display panel where the output may be seen, and a Bluetooth receiver with pairing capabilities for further security. The researchers used laptops and computers (see Table 1) to code and build the user interface for the gadget they were using for this study. The principal program utilized by the researcher to control the device was Arduino IDE. The emoticon codes are stored and hardcoded at this location. The user interface application that would link to the

panel for the output was made using MIT App Inventor (see Table 2).

Researchers seek guidance from an expert in technical matters, Engr. Oliver Santos from the electronics retailer and from the technical advisor who has a lot of knowledge and could provide guidance on how to build the model's technical features. The researchers designed the potential back end and front end of the system using an analysis tool, such as a block diagram, schematic diagram, or storyboard, to construct the application and prototype. The block diagram's goal is to show how the project would operate. A schematic diagram is created to show the electrical components of an IOT device and what the device would be required to produce. And a storyboard outlining how the study would run, how to connect the device, how to set it up, how to display output on the panel, and how to use the Carticon in general.

Table 1. Hardware Requirements During System Development

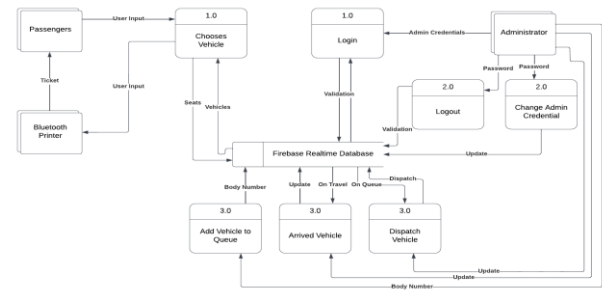
Components	Specification
Processor	I3 intel
RAM	8GB
Build	19044.2251
Hard Disk	1TB

Table 2. Software Requirements During System Development

Software	Description
Arduino IDE	The Arduino Integrated Development Environment (IDE) connects to the Arduino boards and allows them to upload programs and interface with them. Arduino sketches are programs developed with the Arduino software (IDE). These graphics are made in a text editor and saved with the .ino file extension.
MIT App Inventor	App Inventor lets them design Android applications using a web browser, a connected phone, or an emulator. The App Inventor servers preserve their work and help them maintain track of their applications.

Construct Prototype

When creating a prototype, the researchers set their goals. These were the purpose of the design, and the characteristics of the final Prototype. The idea was that the price of the Prototype created must be minimal, and the pace of development must be swift. The prototypes were generally built based on the



demands of the client's requirements, such as the user interface, unclear functions, etc. The user would then go through a basic electronic course in conjunction with the technical advisor. The software used as the main program for the study was the Arduino IDE, and researchers used MIT App Inventor for the user interface that the drivers would be using. Constructing this prototype was hard, researchers do trial and error. Tried a dot matrix as a main panel but it did not work. Researchers consulted the problem to our consultant engineer Mr. Santos, but he said, "This is due to the error of codes and technical components are assembled incorrectly". Researchers tried and fixed it again but still did not work so researchers look for a different panel and which is the P10 LED matrix which was working smoothly and perfectly fine. Having a lot of different features in the study makes this hard. Achieving them one by one, the features were the progress of the study until it became complete. Drivers using this unnecessarily need to know about basic electrical knowledge because they may get this prototype complete and polished.

Evaluation

After the prototype of the pre-final user interface has been developed, researchers tried it first to see some bugs, and then it was shown to the drivers and passengers that they could use the user interface and see face to face the IOT device for deployment and evaluation.

Researchers then tried to test the prototype together with the user interface. They approached 30 drivers who would be the beta tester, teaching them how to set up the device in their car, giving them the APK for the user interface, and showing how it functions—and getting feedback to see if it's successful and running smoothly. The driver or the passenger tests the prototype against the specifications specified in the communication stage. If the users are happy then the researchers can begin creating the final version of the program. If the driver is not happy with the initial version the researcher is expected to suggest improvements.

Statistical Treatment

ISO 25010, which stands for "Systems and software engineering - Systems and software Quality Requirements and Evaluation (SQuaRE) - System and software quality models," is a software quality standard. It discussed the models for both software product quality and software quality in use, which were composed of characteristics and sub-characteristics, as well as practical tips on how to use the quality models. The characteristics and sub-characteristics provided a standard vocabulary for describing, measuring, and evaluating the quality of system and software products. They also provided a set of quality attributes that may be compared for completeness to the given quality requirements. The researchers gathered the beta tester from a simple random purposive sampling method. While testing the device, they answered the test case. Researchers made sure to present the IoT prototype to the beta tester for the more apparent survey. The thirty-beta testers that were collected by the researchers were all professional drivers on the road. It is simple random sampling within the community of the researchers. The prototype and user interface were presented while they were being interviewed while simultaneously answering the test case needed in the study. The survey started right after the final defense of the researchers. The ISO25010 was used as the questionnaire reference given to the beta tester who were professional drivers. It took two consecutive days to finish the survey on December 01, 2022. The collected results were explained using frequency distribution, mean

score with percentage, and Likert for verbal interpretation. The results in chapter 4 were the computation using the formula. The mean, which measures the central tendency of the data, was the average or computed central value of a set of numbers. The mean formula in statistics for a collection was defined as the sum of the observations divided by the total number of observations. The mean formula for a set of given observations could be expressed as, $\text{Mean} = (\text{Sum of Observations}) \div (\text{Total Numbers of Observations})$. $\bar{x} = \Sigma fx / \Sigma f$.

Frequency Distribution was used to identify who answered Yes or No to the ISO25010 questionnaire (see the table in chapter 4). Frequency distributions were visual representations of frequency counts that organize and transmit information to make them simpler to understand—computing the mean score to get the percentage needed in the Likert scale for verbal interpretation.

Iterate Prototype

Based on the changes suggested by the beta tester, developers begun to alter the prototype. After constructing the prototype and testing it with the beta tester, researchers gathered all the feedback to see what was needed to add to their project. Driver evaluations would be the basis of the study's findings before it was indicated that this was successful. Researchers made the casing and put all the wires inside. This way, the prototype was modified until the car drivers could use the devices properly. Then, the latest version was presented to the customer to be evaluated. After taking the recommendation with the prototype, the researchers started developing the full version of the user interface and device.

Table 3. Likert Scale

Percentage (%)	Score Scale	Interpretation
0-20	1	Extremely Poor
21-40	2	Very Poor
41-60	3	Moderate
61-80	4	Good
81-100	5	Excellent

(Source: Interpretation of Likert scale assessment product | Download Scientific Diagram (researchgate.net))

Deploy the prototype

Once the goal of the prototype and user interface has been finished, the deployment would proceed as the application would deploy via APK with the package of the marketable device given to the driver. Also, the link for the user interface was uploaded to the repository website which is this <https://carticon1.webnode.page/>, created by the researchers.

RESULTS AND OUTCOMES

In this section, the researchers achieved the system and prototype requirements and objectives of the study. A user interface with the researchers' specific goals and a prototype that functions along with the mobile application.

The hardware that the researcher used during the development is ASUS. It has the specifications: processor, RAM, Build, And hard disk. The processor is i3 intel, the RAM has 8 Gigabytes, for the build, it is 19044.2251, and the hard disk has 1 terabyte. The software that was used during the development was Arduino IDE and MIT App Inventor. It was downloaded to the desktop that was used in making the process. Arduino was the main program that would input inside the microcontroller device, and The user interface is designed by the MIT app inventor that the user would employ.

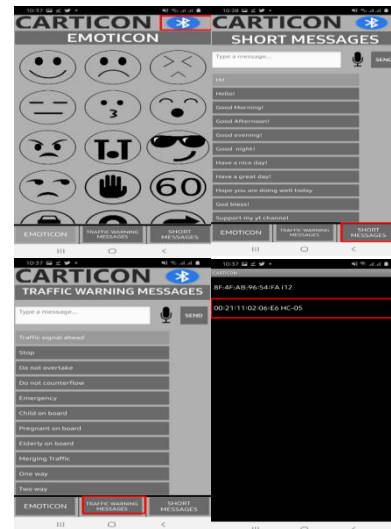
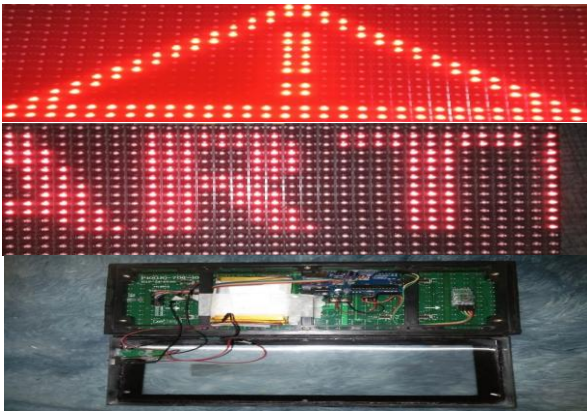


Figure 2. Back-end programming and online platform for application development tool.

The final output of the prototype was the picture below that the researchers created. It already has the casing and handles for setting up in a car. There were also on and off buttons on the visible display coming from the panel.

The mobile application provided by the researchers was completed during the prototype development for trial and error. All the features according to the specific objectives set by the researchers have been achieved. Users could download it via APK.

The result for suitability has three sectors, and the sector 'Completeness' has the highest. It garnered 96.3% which has an 'Excellent' interpretation. Correctness has the lowest, still, it received 82.57% with an 'Excellent' remark. The overall mean score was 90.61% with verbal interpretation Excellent. For illustration, one among the most popular Yes answers were "Is the system's application good for android?" The result above shows how effective and smooth the system was. Having the beta tester try and assess the prototype and the methods were helpful to fulfill on how to accomplish all the features wanted the researchers to put in. The tester was satisfied with the outcome of the device.

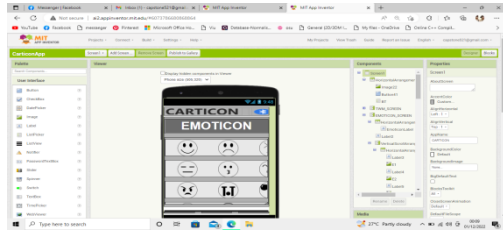


Figure 3. Mobile App Interface Design

The result for Usability has two sectors; the accessibility ranked highest, which garnered a 90% mean score with a verbal interpretation 'Excellent'. User interface that collected 75.5% means score with a 'Good' remark. The overall mean score for Usability is 82.75% with an 'Excellent' remark. The testing and evaluation of the user interface, as well as device was done by the researchers and some of the selected beta tester. It showed that the application was working smoothly and not giving a sign of delay. For the display panel, the speed of the running letters was hard coded by the researchers, so it is normal if the words or phrases were slow to illuminate. It was designed to be readable. Voice recognition was good, and it needed a clear voice to give command and displays a correct output.

Portability has one set sub-criteria; 'Installability' has garnered an 87.62% mean score with an 'Excellent' remark. Most respondents answered Yes to the question, "Can the system and prototype be easily installed and removed to connect to another vehicle?" Based on the results, the device could be used when travelling anytime and anywhere. It was light and not too big because the priority was to make this device excellent and convenient. The on-and-off was working correctly in the outskirts of the panel. It has a capacity to save battery life.

The Suitability Completeness showed that the survey result was more on yes. It simply explained how beta testers see the outcome finished. In the frequency distribution, 28.89 out of 30 respondents answered Yes. Converted into 100 percentage, it is 96.3%. In completeness there were also who answered No (3.7%).

The Suitability correctness was also more on 'Yes'. A 24.77 total of frequency distribution converted into 100 percent was 82.57%. The

questions here were connected to the main features and function of the study. So, this section was where the researchers may see the problem of their research because, as stated in the survey form of the beta tester of the study, it was the sample test case that asks if the connection was working correctly. If the panel could display the output, and if there was an accurate outcome. 17.43% answered 'No'; it is because the panel displayed a little bit slow.

The computation for the Suitability Functionality for frequency distribution survey accumulated 27.5 out of 30 respondents converted in 91.6%. It has only two test cases that would ask directly if the system's function were working and can aid in achieving the role that the researchers set. An 8.4% of the respondents answered 'No' but it was not enough to prove that it has a problem on the user interface.

For the usability test cases, researchers gave a question for the user interface about the application if it has a bug. The graphical user interface the programmers provided was created in MIT App Inventor. Frequency distribution totals 22.67 out of 30, it is converted in percentage to 75.5. 25.5 which means they answered 'No' as they have encountered some delay because it used Bluetooth, not Wi-Fi.

Based on the result, the accessibility of the system is straightforward; hence, 27 (97%) out of 30 beta testers say it was excellent. Therefore, it was proven that if the system was utilized to authorize vehicular drivers, they could use the application immediately.

The last part of the test case was about portability. In interviewing the selected drivers, researchers taught them how to set up the prototype at the rear back of the car. After they tried, the drivers answered the survey and gave their feedback. Surprisingly, 30 beta testers answered 'Yes', which meant that it has no problem setting up the panel inside the car.

The researchers gathered 90.16% under functional suitability with a remark 'Excellent'. The Likert scale result showed that most of the beta testers were satisfied with all the suitability test cases. The user interface was good in android, and the intended drivers have access and have the user manual which could be their guide. The Bluetooth connection was

also good. The output in the panel was accurate, and more importantly, the letters were readable.

The result of 82.75%, on the Likert scale, indicated that most of the beta testers were satisfied with all the usability test cases. The table score 4 and 5 were both excellent evaluations; hence, it was also a success for having good and honest feedback. The system had no problem connecting to any android phone that downloaded the APK. The voice recognition was working correctly, and the accessibility was convenient to access anytime. As the data result was 87.62%, Installability scores 5, which meant that it was excellent during the survey and testing for the prototype. The researchers who conducted the study brought the prototype to test the portability. The outcome was higher, which was suitable for the panel because the beta tester was marked 'satisfied'.

DISCUSSION

This section discussed the summary of findings anchored on the objectives, conclusion, and recommendations based on the results of the study.

The hardware requirements for the study consisted of an Arduino Uno serving as the main CPU, a P10 LED matrix as the output display, and a Bluetooth receiver with pairing capabilities for added security. The backend user interface for the device was programmed and created by the researchers using a laptop. The emoticon codes were kept and hardcoded at this area, and Arduino IDE was the main tool used by the researcher to control the device. MIT App Inventor was used to create the front-end user interface application that would link to the output panel (see Figure 15). Using an analysis tool, such as a block diagram (see Appendix F), schematic diagram (see Appendix G), or storyboard (see Appendix E), researchers built the application and prototype and designed the probable back end and front end of the system. The block diagram's [F] objective was to depict how the project would function. To depict the electrical parts of an IOT device and the output the device would need to produce, a schematic design [G] is made. Additionally, there was a storyboard [E] describing how the study would progress as

well as how to join the device, set it up, display an output on the panel, and utilize the Carticon in general.

The researcher translated the design and analysis tools into a working IoT device interconnected with the mobile app for the purpose of monitoring and controlling. The IoT device's components were the P10 LED display, Arduino Uno, Bluetooth receiver, and battery. It could display emoticons, traffic signs, traffic warning messages, and short messages. The developed mobile application has a features of Bluetooth connection, fixed emoticons, fixed traffic signs, fixed traffic warning messages, and fixed short messages. Also, it has a customized message feature; authorized drivers could use it in two ways, through manual typing or voice command.

The researchers released the software to a small group of external beta users for testing after the mobile application and prototype passed the developers' test. The study applied homogeneous purposive sampling [Figure 7] because it required the researcher to quickly reach a certain sample. The researchers approached thirty (30) licensed drivers to test and evaluate the application and prototype during beta testing. The application has been assessed using the ISO 25010 [Appendices A] survey questionnaire's Software Quality Standard criteria. The researcher concluded using the statistical mean formula, frequency distribution, percentage, mean score, and Likert scale. This provided reliable information to support the interpretations of the sub-criteria and criteria outcomes. The Portability criteria was the highest among the other criteria. The Functionality garnered a total mean score of 91.6% with a verbal interpretation of "Excellent". This meant that the functionality was approved to the potential user of this study. The Usability was the lowest among criteria's which garnered a total mean score of 82.75% with a verbal interpretation of "Excellent". This meant that even the Usability ranked low in the survey was still Excellent which was a good outcome. An overall mean score of 86.84% with a remark of "Excellent" which meant that all the section of the survey tool which was the ISO10150 has been approved to the beta tester who were the users. The link for the mobile application was

uploaded to the repository (Link: <https://carticon1.webnode.page/>) and some introduction about the study Carticon.

Conclusion

Taking everything into account, the researchers aimed for systems that have Bluetooth connections and have pairings for security purposes, emoticon display for entertainment, customized text messages for the text, and common traffic warnings that would give caution to the drivers if something came up. Moreover, this study achieved Google voice recognition for the convenience of the interface that would be used give the driver easy access to write what they want to display in the panel. Lastly, for portability, the Carticon achieved easy to set up remark at the back of the car.

Further, the user interface would be provided via APK. The prototype systems, which were built by the researchers, are complete and ready to use. The user interface has been deployed by the repository website created by the researchers via APK for easy access to all. and to get some feedback researcher chose this. (Link: <https://carticon1.webnode.page/>) Hence, all the specific objectives were achieved through the creation of the prototype. Yet, it should be noted that only authorized vehicular drivers can use this prototype.

Recommendation

The Americans built and created a similar study to Carticon since they were the first inventor. The researchers developed this study; however, the study has a lot to upgrade. Therefore, the following are recommended to future researchers:

1. Make the default lights changeable on the panel.
2. Add and delete features for the mobile application.
3. Make the battery percentage visible to the user interface.
4. On and off buttons that can control be through the application.
5. Solar sensor to lessen the use of battery usage.

REFERENCES

- [1] "Top 10 Importance Of Technology In Our Life," Java Assignment Help, Jun. 20, 2022. [Online]. Available: <https://www.javaassignmenthelp.com/blog/importance-of-technology/>. [Accessed: Dec. 04, 2022]

- [2] "Who invented emojis." [Online]. Available: https://kids.tpl.ca/wonders/573?fbclid=IwAR3bG147gN_v8EcemGg-hpWsAWCAPLkRdhYPZq_1UGEYDINbVeH8R7JzX9Y. [Accessed: Dec. 04, 2022]
- [3] Qiyu Bai, "A Systematic Review of Emoji: Current Research and Future Perspectives(PDF) A Systematic Review of Emoji: Current Research and Future Perspectives (researchgate.net), October 2019
- [4] "Republic Act No. 10913," Republic Act No. 10913. [Online]. Available: https://lawphil.net/statutes/repacts/ra2016/ra_10913_2016.html?fbclid=IwAR2hwiRI6uHKVPVST9OZlKxqxuxMiBy6wxkfkfrfU1TXwWR2zopxYJ0OBf7w. [Accessed: Dec. 04, 2022]
- [5] Maria Savelidi, "Microcontroller Systems in Education for Sustainable Development Service. A Qualitative Thematic Meta-AnalysisEuropean", (PDF) Microcontroller Systems in Education for Sustainable Development Service. A Qualitative Thematic Meta-AnalysisEuropean (researchgate.net), February 2022
- [6] Daniel Chebat, "Traffic warning message", View article (google.com), 2021/11/1
- [7] Admin, "10 most common warning signs on the road" 10 Most Common Warning Signs Worksafe Traffic Control (worksafetci.com)" February 12, 2020

CLEVERBIN: Smart Sortening Bin with IoT Notification

Ralph Vincent M. Daquis

Patrick G. Manarang

Christian Louise P. Sicat

Don G. Vidal

Engr. Ernie Lee E. Pineda, MIT (Technical Adviser)

ABSTRACT

This research provides a low-cost design for an intelligent waste container for small-scale applications. The solution uses an Arduino UNO board and an ultrasonic sensor to monitor the container's fullness level and send notification alerts via the Blynk application. In order to become a smart city, the government provides different trash cans so that people can dispose of trash according to the type of garbage, and waste can be readily recycled. However, some people do not understand which bins they must use to dispose of their waste, so they simply toss it in any bin without considering the type of waste. The goal of this research is to develop a trash can that can detect the type of waste dumped and autonomously dispose of it in the appropriate bin. The study employs device design, device fabrication, data retrieval, and data analysis as research methods. As a result of the study's findings, a smart garbage can prototype that can be applied in a smart city can be created based on Arduino and Android. This prototype can eventually be used to educate youngsters about the different types of waste from an early age.

INTRODUCTION

People today employ modern technology to do a variety of tasks, and its existence has made life more comfortable and enjoyable. Technology continues to benefit people, from accessing massive amounts of data on a global scale to simply living a better life. Most people in the millennial generation own personal devices such as phones, laptops, tablets, computers, gaming consoles, and so on. They can access the internet from anywhere and at any time, and there are several ways in which technology has made life easier (McArthur, 2016).

The Internet of Things (IoT) is a fascinating concept in advanced technologies that transforms inanimate objects into intelligent virtual objects. Most people are unaware, but IoT is now a part of their daily lives. It benefits people not only by giving them control of things around them, but also by allowing them to know the state of things that are now commonly used in houses, such as home appliances, gadgets, transportation, and systems (Madakam, Ramaswamy, & Tripathi, 2015).

IoT refers to the networking of passively intelligent things that may transfer and exchange information among themselves without the need for human involvement (Navghane, Killedar, & Rohokale, 2016). It was

also referred to as "information society structures" since it allows for the collection of mass information from various sources, such as gadgets kitchen and home Appliances and any physical thing that can be assigned an internet protocol address to facilitate data transfer over a network can be included in an IoT system (Monika, Rao, Prapulla, & Shobha, 2016).

In a generation when systems are more efficient for working and completing tasks quickly, a good example of where IoT may be implemented is in garbage monitoring, as one of the primary concerns of the community is effective waste monitoring, which has an impact on the cleanliness of the community. The observation of trash cans is a major challenge for today's generation. The obsolete method of manually examining litter inside receptacles is a difficult process that requires additional human work, time, and money that can be avoided by utilizing new technologies that are available today (Chaware, Dighe, Joshi, Bajare, & Korke, 2017).

The smart garbage monitoring system is an innovative method that can assist in keeping communities clean by monitoring and informing cleaning officers about the state of garbage that needs to be collected through the use of an embedded system with ultrasonic

sensors attached to the garbage bin that detect the garbage level (Garbage Monitoring System, n.d.).

Garbage disposal has recently been a major source of pollution. concern in the world. There is a large amount of garbage. created is disposed of in ways that harm the natural world. The most popular form of trash disposal is accomplished through unplanned and uncontrolled open dumping at the landfill. sites. This practice is harmful to human health as well as plant and animal life. Rag pickers play a vital role in recycling in India. of urban solid waste. Dependence on ragpickers can be problematic. reduced if municipal segregation occurs at the source. The production of rubbish When garbage is separated into basic categories. The trash has a higher concentration in wet, dry, and metallic streams. potential for recovery, and hence recycled and reused. The moist waste component is frequently turned into compost or biogas. either methane gas or both. The advantages of doing so include the fact that a greater quality of material is maintained for recycling, implying that more value may be recovered from trash.

The researchers were inspired by the above infrastructure concepts to create a study titled "Cleverbin: Smart Sorting Bin with Iot Notification" It is a system that automates garbage monitoring, allowing them to be more productive with less effort. Furthermore, it aims to assist the community in obtaining garbage faster and keeping the community clean.

As a result, the researchers created a garbage monitoring system called "Cleverbin: Smart Sorting Bin Iot Notification" which is extremely useful in remotely monitoring waste bins. Using a smart bin monitoring system, garbage retrieval becomes faster and more efficient, allowing the users to maintain the cleanliness of the area by avoiding overflowing garbage bins.

General objective

To develop a system CleverBin: Smart Sorting Bin With IOT Notification

Specific objectives

To design an immerse device with the following:

- a. Monitoring level
- b. Sorting non-metal and metal object

To design a Mobile Application with the following

- a. Garbage information
- b. Garbage level

To build a system with a mobile application embedded with the succeeding software and materials.

- a. Blynk Application
- b. Arduino IDE
- c. Arduino Uno R3
- d. Capacitive proximity sensor
- e. Inductive proximity sensor
- f. Servo motors
- g. Power adaptor
- h. DC-DC adjustable regulator
- i. Double relay board
- j. Jumper wires
- k. Trash bin
- l. ESP32
- m. Buck Converter
- n. Ultrasonic Sensors

To test the system using alpha testing case.

To assess the software using ISO 25010 in terms of the following.

- a. Functional suitability
- b. Usability
- c. Reliability
- d. Maintainability
- e. Performance Efficiency
- f. Compatibility
- g. Security
- h. Portability

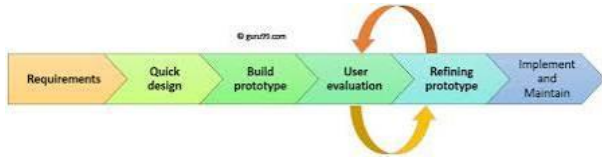
To deploy in metal fabricators work on a number of projects for manufacturing companies and resellers.

Scope and limitation

This cleverbin has features that can separate metal to non-metal such as separating paper, plastic, and non-metal items from metal. the proponents were gathering information, data, and article that are related to the study. The hardware that used is Arduino Uno, Servo Motor, Capacitive Proximity Sensor, Inductive Proximity Sensor, Double Relay Board, ESP32, Buck Converter and Ultrasonic Sensors to make the Smartbin an IOT device. Programmers used Blynk Application for the IoT notification, Arduino Uno and ESP32 as the main control. In order to make the system researchers used schematic diagram to design the possible back end and front end of the system Smartbin will have the following

features: automatic opening closing, separating metal to non metal and monitoring the level of the garbage

The Arduino Uno R3 is a free and open-source integrated microcontroller based on the



Atmega328 chip module. This mechanism also includes 14 digital (input/output) pins, a B-type USB connection connector, 6 analog input pins, an onboard ceramic resonator (16 MHz), an ICSP header, a DC power jack, and a microcontroller reset button. Furthermore, the Arduino Uno R3 includes everything needed to support the microcontroller as well as simple mechanisms.

With the inductive proximity sensor, metal targets approaching the sensor can be detected without physical touch. According to the functioning principle, inductive proximity sensors are roughly grouped into three types: high-frequency oscillation, magnetic, and capacitance.

While the capacitive proximity sensor are similar in function to inductive sensors but have certain unique design specifications and operating parameters. They rely on the principle of capacitance to detect small objects and can handle both conductive (metallic) and non-conductive material, including unprepared mechanical surfaces and items moving along a conveyor. The capacitive proximity sensor output is typically

fabricators work on a number of projects for manufacturing companies and resellers.

SYSTEM DEVELOPMENT METHODOLOGY

In this section, uses of the design of a smart sorting trash bin and the analysis plan to explain how they work together will be discussed. The project is implemented using systematic methods and techniques.

The researchers would use the prototyping method to develop the system Cleverbin: Smart sorting trash bin because of the flexibility and the efficiency that suits the project development.

The prototyping methodology allows you to design a working “prototype” or early sample of

what's to come. It begins with analysis and requirements, followed by a quick design to give feedback on an “idea” of a system or product. The feedback enhances the build of the initial prototype

System development procedures are consist of different phases adapted to the prototyping method like planning, analysis, design, implementation, system prototype and system output.

Figure 1 Prototyping Methodology

Requirements gathering

In this phase, all the research requirements were collected and assessed. Requirements are used to served as the guidelines for the development of the system. Information that is needed and used by the system are gathered. Data to what is needed, to what should be expected are planned. Functionalities and constraints are also determined in this phase.

The researchers gathered requirements by reviewing studies and previous related literature about the study it is done to give the researchers more idea and knowledge about the system. During this phase, the problems and goals of the study are identified.

Quick design

Reviewing and planning are applied in the subsequent phase that leads the researchers to construct a design based on the gathered requirements. In this stage construction of preliminary design of the system is created it is not a detailed representation. However, it contains the important aspects of the system which gives an idea to the user on how the system will look like and function.

Build prototype

In this phase, an early sample of the system is built. A prototype serves as an incomplete version of the system, it is tested and by its result, the modification, revisions and improvements are identified.

In this stage, the researchers would build a prototype regarding on the system design. The hardware and application are developed with the use of different software and components such as sensors, microcontroller, modules. These devices will manage to control each segments of the hardware to work. Therefore all the device should function as one to complete

the prototype. Moreover, testing and integration are done by the researchers in this phase to check if all devices are properly working to each other.

User evaluation

At this phase, after building a successful prototype the system is examined by alpha tester for additional changes and feedbacks which are expected. During this phase the researchers conducted alpha testing, the researcher utilized the software quality characteristics of ISO 25010 to evaluate the application performance thoroughly.

During alpha testing researchers purposively approached three (3) IT experts, they are chosen based on their expertise, hardware engineering, programming, mobile application developing and designing to evaluate the application, their feedbacks and suggestion are important for it serves as a guidelines in improving the system.

Refining prototype

At this phase, recommendation, suggestions, additional features and feedbacks based on the alpha tester are considered and added to improve the system. During this phase, the researchers return to quick designing phase wherein researchers made changes to the first prototype while adding and considering all the suggestions gathered from the preceding phase. The requirements is a must when improving the system.

Engineer product

After several iteration, until the successful prototype is achieved and passed the user requirements, engineering the product takes place wherein the researchers developed the final output of the system which is tested and accepted by the user.

Implementation is planned wherein the researchers plan to implement the developed system to the metal fabricators work on a number of projects for manufacturing companies and resellers. The researchers will provide demonstration to the users so they will be familiarized on the system.

Schematic diagram

A schematic diagram is a designed representation of a system's elements using abstract, graphic symbols. It often omits

aspects that are unrelated to the important information it conveys, and may include oversimplified elements and supplementary information organization.

Purchase inventory

These are the parts bought by researchers to build the system. All of these hardware, were purchased through online shopping and other materials needed bought in physical stores to build the system.

System final output/deployment

After the process and testing phase, the technical adviser, panelists, and Cleverbin: Smart Sorting Trash Bin are effective, develop, and improve. Now the researcher is ready to deploy in fabrication shops, and resellers have metal fabricators work on a variety.(See Appendix E for final output)

RESULT AND OUTCOMES

The researchers were able to achieve the system prototype requirements and objectives of the study .Upon detecting object by the sensor the lid will automatically open and the servo motor will move furthermore the user will also have segregated for metal non metal . A smart waste management system includes smart bins. They contain Capacitive proximity sensors (CPS) are sensing device designed to detect both metallic and nonmetallic targets and Inductive Proximity Sensors replace limit switches, microswitches, and other mechanical switches. They detect metal or aluminum targets without contact.

IT experts are subjectively selected as respondents for the alpha testing because of their expertise on the field, their feedbacks and recommendations are valuable for the enhancement of the system.

The developer uses a presentable homepage with a clear icon for another screen and a when for another homepage, and then see if open the ho, you will see if your device is online or offline. While the screen shows the level of garbage inside your bin needs to collect the next time he throws it away,n you open the homepage you will see your device if it is online or offline. While the second screen shows the level of the garbage inside your bin and for the user to know that the next time he throws it

away if he needs to collect it. The third screen shows the notification when your bin is full, and it will be notified in the application itself and by email. Also written here are the day, date, and time when the bin is full. The fourth screen shows the profile. Here you can see your profile, billing, my organization, settings, help, about, log out, and privacy policy. Open the left-side menu and press My Profile." Here you can edit your profile information by tapping the input fields. Organization: here you can view and edit organization info, manage users, and switch to sub-organizations you have access to. Here you can enable or disable the following application settings: notifications and sounds, interface, and security. For help Use the left menu for top-level documentation navigation and the right menu for in-article paragraph transitions. Here you can view general app information, set up logging options, send logs, and view third-party library lists. In Log Out, sometimes you may want to log out, e.g., to sign in under another account or as a part of issue-solving. Tap "Log Out" in the left menu and confirm the action.(See appendix I for mobile user interface)

The researchers created a smart bin aligned with the objective of the study. When the researcher completed the system's core functionalities, the other members of the group conducted a series of tests to check that the system features were working consistently and effectively. Refer to the illustration below for the system prototype process and testing.(See Appendix C for building process)

After building a successful prototype the system is examined by alpha tester for additional changes and feedbacks which are expected. During this phase the researchers conducted alpha testing, the researchers utilized the software quality characteristics of ISO 25010 to evaluate the application performance thoroughly.

The test cases functionality of the system. Prototype keep in mind that each hardware feature has been thoroughly tested. Ensure that the IoT components are working accordingly. While conducting the test cases, manual operation is possible by plugging the system into an outlet and connecting it to the internet connection on the mobile app.

The automatic operation is done when the specified time period is over. Note that the researchers tested the automatic operation through the sensors. It was tested to ensure that it gave the expected outcome.

The sensors, including the arduino uno, dc to dc buck converter, double relay board and servo motor consistency, were captured and achieved through recorded videos. The researchers screenshot some of the test cases for presentation and documentation purposes.

DISCUSSIONS

This section discussed the conclusions and recommendations based on the analysis of the result of the study entitled Cleverbin: Smart Sorting Bin with Iot Notification.

General Conclusion

The study focused on the development of IoT based Cleverbin: Smart Sorting Bin with Iot Notification

Based on the analysis, testing and thorough evaluation of the system the researchers created a system that enables the users to monitor the level of garbage inside the bin and sort non-metal to metal object using inductive and capacitive proximity sensors. Plus a mobile application that notifies users.

The objective were achieved utilizing the prototyping methodology. Under this, is a repeating trial and error development that takes amongst the researchers and end user. Therefore, its phases are repeated until the acceptable and

The researchers collected data and consulted with the technical adviser, before studying the system to be developed. And after that, the researchers went in search of system hardware. And the system derived the concept from the schematic design. the expected output of the system attain by the researcher throughout their effort and dedication for their study.

Recommendation

With the final output and conclusion or the study, the researchers mention some advanced studies and researches for future enhancement of the system, the following recommendations are listed below:

1. Enhance the design of the bin wherein the embedded device is more secure
2. Improve the documentation (if needed)

3. Improve the embedded device by adding automatic opening and closing of the lid. And add a solar panel to the system which is also good alternative solution in the system in case of power outage.
4. Enhance the mobile application where the user can add more bin.

REFERENCES

- [1] United Nations Environment Programme. (n.d.). Solid waste management. UNEP. <https://www.unep.org/explore-topics/resource-efficiency/what-we-do/cities/solid-waste-management>
- [2] Prototype Smart Trash Can for Implementation Smart Environment in the Smart City based on Arduino and Android | KnE Social Sciences. (n.d.). Prototype Smart Trash Can for Implementation Smart Environment in the Smart City Based on Arduino and Android | KnE Social Sciences. <https://knepublishing.com/index.php/Kne-Social/article/view/4133/8505>
- [3] Heller, K. (n.d.). Smart Bins. SEGD. <https://segd.org/smart-bins>
- [4] Gelsin, D. A. (n.d.). Smart Waste Management Solutions for Smart Cities. Smart Waste Management Solutions for Smart Cities. <https://www.beesmart.city/en/solutions/smart-environment/smart-waste-management-solutions-in-smart-cities>
- [5] 6 Reasons Why Cities Need Smart Bins for Waste Management & Conure. (2022, June 27). Conure. <https://www.conurets.com/6-reasons-why-cities-need-smart-bins-for-waste-management/>
- [6] Mohammed, M. A., Abdulhasan, M. J., Kumar, N. M., Abdulkareem, K. H., Mostafa, S. A., Maashi, M. S., Khalid, L. S., Abdulaali, H. S., & Chopra, S. S. (2022, July 28). Automated waste-sorting and recycling classification using artificial neural network and features fusion: a digital-enabled circular economy vision for smart cities - Multimedia Tools and Applications. SpringerLink. <https://doi.org/10.1007/s11042-021-11537-0>
- [7] prototyping methodology - Google Search. (n.d.). Prototyping Methodology - Google Search. https://www.google.com/search?q=prototyping+methodology&rlz=1C1ASUM_enPH919PH919&oq=prototyping+methodology&aqs=chrome.69i59j0i512l5j69i60l2.3407j0j7&sourceid=chrome&ie=UTF-8
- [8] S. (2019, January 30). Top 5 Challenges Of Smart Waste Management. Medium. <https://medium.com/@swachhcoin/top-5-challenges-of-smart-waste-management-59ecf3e24b6d>
- [9] SmartBin system with waste tracking and sorting mechanism using IoT. (2021, November 25). SmartBin System With Waste Tracking and Sorting Mechanism Using IoT - ScienceDirect. <https://doi.org/10.1016/j.clet.2021.100348>

D.A.Ki.T.S.: Dau Apalit Kiosk Ticketing System

Nicole J. Dingalan

Jimbo B. Leyson

Nicho B. Bayan

Ritchelle Z. Escoto, MIT (Technical Adviser)

ABSTRACT

This paper aims to provide detailed information of the research and development efforts exerted in the design and development of an android based ticketing system kiosk that will provide solution to the daily trouble of commuters in Dau-Apalit terminal. The commuters can freely choose whether to ride the queueing vehicle or the arriving vehicle from another terminal. This will provide a specific user-friendly interface for quick access. The significance of this research is to provide convenience to the daily commuters by giving them extra time to do errands. It will also simplify various day-to-day operations and innovate the old operation and will enhance administrators and commuter's experience.

INTRODUCTION

The Public Utility Vehicle Modernization (PUVM) Program of the Philippines aims to transform the road sector of public transport through the introduction of safer and climate-friendly vehicles, improved regulation, and industry consolidation. The program aims to improve the urban quality of life, reduce economic losses due to time lost in travel, reduce health costs and premature deaths, reduce greenhouse gas (GHG) emissions and improve the economic situation of the operators and industry by improving service quality levels. [1]

One of the biggest pros of jeepney modernization is that it can provide the country with more jobs. The jeepney modernization potentially raises the need for skilled drivers and operators. With newer models needed, there is also a higher demand for workers and laborers in vehicle manufacturing. The program calls for the phasing-out of jeepneys, buses and other Public Utility Vehicles (PUVs) that are at least 15 years old and replacing them with safer, more comfortable and more environmentally-friendly alternatives over the next three years. [2]

D.A.Ki.T.S. is an android mobile application designed and developed to help commuters monitor modern jeeps. Its android-based kiosk is integrated with Firebase Realtime Database where the users can monitor the status of modern jeeps in real time. This kiosk system will save commuters' precious time as it will

allow them to view and monitor the time when the next available modern jeep was dispatched and its estimated time of arrival. In addition, the commuter can still complete that one last errand without having to stay in line or worry that they might miss the next vehicle. It is also synced with a Bluetooth printer to print the ticket for the chosen vehicle.

General Objective

To develop a stand-alone kiosk system named D.A.Ki.T.S. - an android-based kiosk system for the modern jeep terminal in Dau.

Specific objectives:

1. To gather data through interviews
2. To identify the software and hardware requirements
3. To design using the following tools:
 - 3.1. Flowchart
 - 3.2. Data flow diagram
 - 3.3. Use case diagram
 - 3.4. Conceptual framework
4. To evaluate the mobile application using the evaluation tool ISO 25010 for;
 - 4.1. Functionality
 - 4.2. Accuracy
 - 4.3. Usability
 - 4.4. Maintainability
5. To deploy D.A.Ki.T.S. in Dau Terminal (3 Big Boys)
6. To maintain the system

Scope and limitation of the study

The researchers have gathered data from related studies and literature from open sources on the web.. They have also contacted local owners/operators through messenger

chat and interviews (see Appendix H), which provided enough ideas, information, and a deep understanding that helped develop D.A.Ki.T.S.. Ms. Jemalyn Manasan, the admin/owner of the terminal, approved that we can make a system for their terminal (see Appendix H). In addition, the researchers used the internet to hold brainstorming sessions through virtual meetings and in gathering scholarly ideas. To develop this system, the researchers used different software (JavaScript, Android Studio, Firebase) and hardware tools (Laptop, Personal Computer, tablet and mobile phone). Each of them has contributed significantly to the design and completion of this mobile system application.

Android Studios was used to design the system while Firebase was used for the real-time database. The plan is to install the application on a tablet that's continuously connected to the internet and to a Bluetooth printer to print tickets.

Listed further below are the features and functionalities of the application:

The administrator can use any internet connected mobile phone to add, delete or update the kiosk without going to the kiosk.

- The system interface shows the vehicle information and status: body number, count of available seats, origin (terminal), departure time, estimated time of arrival (ETA) and daily sales per modern jeep unit.

- The body number is the reference information of the commuter to determine the next available modern jeep. The commuters will also see information on the count of available seats, including the point of origin and destination.

- The departure time displays the time that the modern jeep left its point of origin.

- The estimated time of arrival (ETA) provides commuters enough information to plan their commutes ahead.

- The proponents also hoped that the feature that displays the sales metrics is beneficial for the owners/operators' business planning and analytics.

The other access capabilities of administrators include but are not limited to: updating fare/fees as needed, setting up of mandatory discounts i.e. students, seniors and PWDs.

Required identification (IDs) must be presented upon entry.

For the system administrator, the level of access will be but not limited to: adding a vehicle to the queue, dispatching, setting up their status i.e.

- “Arrived”, “In Transit”, etc. The system prints a ticket with the body number of the vehicle.

The system was not designed to accept payments and display on-the-road delays (traffic, accidents, etc.); the system only displays the vehicle's ETA.

The test plan consisted of integration testing, alpha and beta testing, respectively. Integration testing included end to end testing and the evaluation using the evaluation tool ISO 25010. Alpha testing included end to end by IT experts. Beta testing on the other hand is end to end by select users. Feedback, suggestions and recommendations were captured and assessed for feasibility of integration or as future enhancements. Similarly, defects were captured, logged and fixed and re-tested accordingly.

The mobile-based system (D.A.Ki.T.S.) was deployed in Dau Terminal named 3 Big Boys.

METHODOLOGY

The researchers adopted the Modified Waterfall method for the system development. The D.A.Ki.T.S. is an integration of the mobile application user interface as a ticketing kiosk system. The figure given below describes the said design model. The first stage in the model was the Requirement Gathering and Analysis; in this stage, the researchers gathered ideas, inputs, resources and issues on what topic to be used for the system. The second stage in the model was the System Development stage; in the development stage, the different tasks were identified and designated to each member. Members were designated in the front and back end of the system to achieve the look and functions needed for the system. The fourth stage in the Waterfall Model was the Testing stage. The fifth and sixth stages were the Deployment and System Operation stages respectively. Figure 1 shown below describes the steps how the final product was achieved.

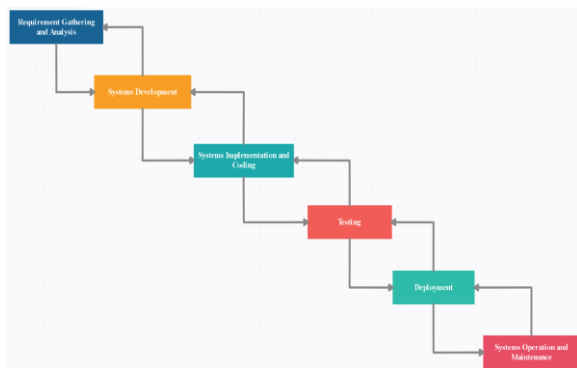


Figure 1. Modified Waterfall Methodology

Requirement Gathering and Analysis

The requirements defined the required functionality and operation of the final package. These were driven by what the end-user expected of the system. The group searched at the scheduling phase for problems, references, and inputs that might have been applicable to the researchers' required subject. The researchers studied and examined the information gathered during the interview which were then used in this project.

System Development

The second phase is the designing phase. In this stage, a simple design of the system was created including flow chart, data flow diagram, use-case diagram, conceptual framework and storyboard. Usually consulting the would-be users, we've gathered information on their needs, analyzed and injected those in the system requirements design. An overall system architecture then was followed by a detailed design of the systems and interfaces.

System Implementation and Coding

In this stage, the researchers used Android Studio IDE and applied the dependencies required for the development of D.A.Ki.T.S. For the front-end the researchers used XML and for the back-end the researchers used Java and Firebase. The admin inputs are stored in the Firebase Realtime Database and retrieved real-time in the kiosk device.

Testing

In the testing stage, the researchers conducted a series of testing that compared the expected behavior versus the actual output. The researchers tested the system to ensure that the mobile application was working as

designed, it was user friendly, reliable and accurate in calculating and displaying the expected outputs. User Acceptance Testing was also conducted to evaluate the system in terms of: Accuracy, Functionality and Usability. Prior to user testing, the researchers did integration testing to evaluate the system in terms of maintainability for alpha testing. The researchers used a simple mobile application UI to ensure the mobile application is user friendly and understandable.

The IT Experts evaluated the system maintainability. The researchers found two IT Experts who evaluated the mobile application maintainability. For reference please see Appendix J.

The researchers used survey questionnaires to evaluate the overall functionality, accuracy, usability and maintainability of the system. The researchers used remarks to evaluate the system.

Deployment

After the testing stage, and post re-evaluation and defect management as well as the go / no-go decision, the system is now ready for deployment.

Systems Operation and Maintenance

The final stage: Systems Operation and Maintenance. This is when the system has been fully developed and deployed for use. The stakeholder may encounter some issues, system maintenance is conducted at this point.

RESULTS AND OUTCOMES

This section discusses how the study's main objective was met: to provide a mobile-based application kiosk for the Dau Apalit terminal that users can utilize for a more comfortable commuting experience including ticket printing. It also includes the discussion of the requirements gathering, design and development, and testing results in this chapter.

The study primarily covered the design, development, and testing of the mobile application entitled "D.A.Ki.T.S.: Dau-Apalit Kiosk Ticketing System." The mobile-based application ticketing kiosk.

The researchers have successfully gathered data from related studies and literature from open sources on the web. Consecutive interviews with potential beneficiaries like local

operators and commuters alike provided further substantial data that helped develop the D.A.Ki.T.S. App. Ms. Jemalyn Manasan, the admin/owner of the terminal also approved the deployment to her operated terminal.

In addition, the researchers identified and used the required hardware and software tools in the development process of the mobile application. The researchers used the modified waterfall methodology (see figure 1) to guide and track the mobile application phase development. The researchers discussed each task, documented each development phase output work, and ensured all task targets were achieved at the most expected output of the developed mobile application.

Moreover, the researchers designed and illustrated the system using a design tool to provide the overview of the system's appearance and layout. The Use Case Diagram was used for that purpose.

Furthermore, the researchers identified and used the required software (see figure 2 and 3) in the development process of the D.A.Ki.T.S. application. To do this the researchers used Android Studio for coding and Firebase for its real time database for back end to save all the required data inputs attached by the admin.

Lastly, the research developers successfully developed and created a mobile application and system using the required hardware and software (see Appendix D). The system has two user levels: the commuter to print tickets and the admin to control the admin panel (see figure 6). The developed system has the functionality to print tickets, login access, update fare, update vehicle status and static information.

All of the planned features and functionalities of the app were fully realized, designed and successfully deployed. Notable additions were: the admin access to delete the vehicle information if the owner of the vehicle is going home; the commuter can print two types of tickets - the on-terminal ticket and the traveling ticket. The former will show the ticket number, the body number of the assigned vehicle, its point of origin and the total fare payable to the cashier; the latter will show the same exact information plus the ETA.

The researchers gathered information from the locals through face-to-face interviews. The team

also used the internet to search published scholarly articles and related studies to gather ideas about the systems' potential features. Following the shared and gathered ideas, the researchers came up with the study entitled: "D.A.Ki.T.S.: Dau-Apalit Kiosk Ticketing System."

The researchers illustrated every flow and feature of the system using diagrams such as use case diagrams, data flow diagrams, and flow charts. Using diagrams mentioned earlier, the researchers could better understand how to develop the mobile application system.

In designing mobile application systems after the layout has been done, the researchers used Android Studio and Firebase to execute the exact plan. The researchers use Android Studio for coding and designing the mobile application and Firebase for realtime database to save the data from admin.

The researcher created a test case to verify and validate the developed mobile application system, its functionality, usability, accuracy and maintainability for the more stable performance of the mobile application and better use of the user (see Appendix I).



Figure 2. Administrator Login

Figure 2 shows the administrator login. The admin needs to login to access and control the admin panel then after using the default login the admin can change password in the account panel.

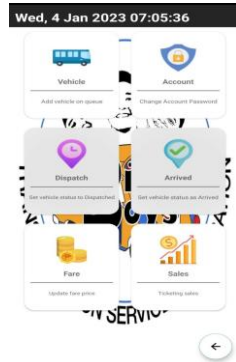


Figure 3. Admin Panel.

Figure 3 shows the admin's control panel. The researcher designers created six features on the admin panel: Vehicle, Account, Dispatch, Arrived, Fare and Sales. In the Vehicle panel, the admin can add vehicles using their body number. In the Account, the admin can reset/change passwords here. In Dispatch, the admin can mark the vehicle that has left the terminal. In the Arrived panel, the admin can mark the vehicle that's arriving at the terminal. In the Fare panel, the admin can update the minimum fare when there are changes. In the Sales panel, you can see the sales of every vehicle and it can be filtered by entering the date.

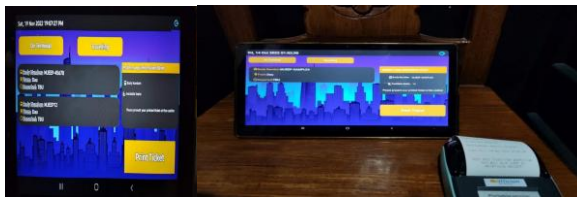


Figure 4. User Printing Ticket.

Figure 4 shows the main page of the kiosk where the commuter can get and print the ticket. The main page shows if there is an available vehicle on the terminal and also shows the other vehicle's status. In the modern jeep info panel, it will show the body number, available seat, and ETA for the traveling modern jeep.

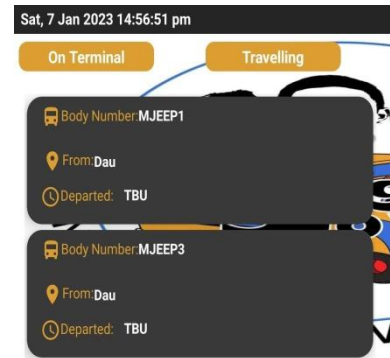


Figure 5 Menu of On-terminal and Travelling

Figure 5 shows the modern jeep options for either on-terminal or traveling. This gives the commuters the option whether they want to take the already available modern jeep at the terminal, or wait for the arriving one.

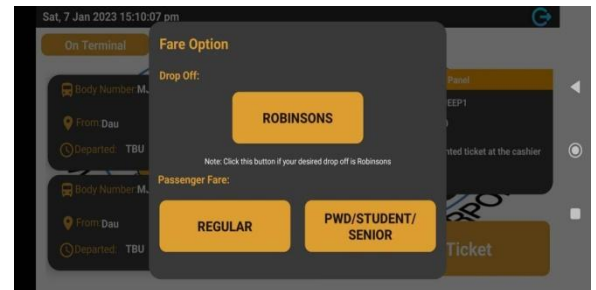


Figure 6. Fare discount

Figure 6 shows the discount option and route of the modern jeep. In the above example, the route was Robinsons. There's also the government mandated discount option for PWD/Students/Senior.

DISCUSSIONS

This section consists of the summary of findings, conclusions and recommendations based on the results of the study D.A.Ki.T.S.: Dau-Apalit Kiosk Ticketing System.

To achieve the Dau-Apalit Kiosk Ticketing System android-based ticketing kiosk system output product, the researchers used the steps of a modified waterfall model. Specific objectives were formulated according to the requirement gathering and analysis, system

development, system implementation and coding, testing, deployment, and system operation and maintenance. The researchers conducted trials to check the functionality, accuracy, usability, and maintainability to ensure that the system is accurate, reliable, and user friendly.

Conclusion

The developed system was found to be one-hundred percent (100.0%) functional. In addition, the system is also one-hundred percent (100.0%) accurate in terms of Functionality, Accuracy, Usability and Maintainability. Also, the objectives stated where achieved. The researchers also concluded that the system solved the stated problem.

In order to do this, the researchers created a plan by gathering data in creating the system. These became the basis of the research. The researchers based the system on similar previous studies.

Recommendations

The researchers recommend this study for future researchers and developers to construct a much more advanced android-based ticketing kiosk, and we recommend to put GPS trackers on the PUVs and embed Google Maps to the system to improve the system's accuracy in tracking the vehicle and make it less hassle to the administrators of the terminal. The researchers suggested to the future developers to find a better way to make the system fully automated without admin supervision from time to time.

REFERENCES

- [1] N. Larco, "Transportation Network companies," [Online]. Available: <https://www.urbanismnext.org/technologies/transportation-network-companies>.
- [2] "Evolution of Philippine Transportation; Then and Now," [Online]. Available: <https://www.bria.com.ph/articles/evolution-of-philippine-transportation-then-and-now/>.
- [3] E. Conrad, "Waterfall model," 2011. [Online]. Available: <https://www.sciencedirect.com/topics/computer-science/waterfall-model>.
- [4] Sungur, "Smart Bus Station-Passenger Information System," 24 April 2015. [Online]. Available: <https://www.semanticscholar.org/paper/Smart-Bus-Station-Passenger-Information-System-Sungur->

- Babaoglu/65d0225bcc76f66d8b80169513f2ba09aa70754e.
- [5] S. Bergweiler, "Integrating a Multitouch Kiosk System with Mobile Devices and Multimodal Interaction," 7 November 2010. [Online]. Available: https://www.academia.edu/73714949/Integrating_a_Multitouch_Kiosk_System_with_Mobile_Devices_and_Multimodal_Interaction.
- [6] Y. Furui, "Conventional stand-alone kiosk systems," 06 August 2002. [Online]. Available: <https://ieeexplore.ieee.org/document/568893/authors#authors>.
- [7] A. Cruz, "The Web-Based Enrolment Kiosk (WBE)," 2000. [Online]. Available: <https://ejournals.ph/article.php?id=9108>.

DANUM: “Web-Based Water Billing Management System with SMS Notification in Pueblo Real Water District”

Magbanua, Glenn Dale Q.
Manaloto, Jaycel Jetzemaine
Manuguid, Erieca Anne
Mariano, Mark Angel V.
Tornato, Edgardo
Dessa Lyn J. De Castro (Technical Adviser)

ABSTRACT

The researchers developed Danum, a web-based water billing management system with SMS notification for the residents of the Pueblo Real Water District located at Pueblo Real Subdivision Barangay Anupul Bamban, Tarlac. The system allows the water billing management to send the water bill of each and every client via SMS, email and user page notification bar, automate the payment transaction using PayPal and any other transactions related to water billing such as client information, service record module, statement of accounts and all details. The online system can be accessed by the administrators and meter reader of the water district and as well as the clients. The administrator can access all the modules of the project; hence the meter reader can update the water consumption of a household. Whereas the client can view their water bill, payment transaction history, billing records and pay their bill, online. This research talks about the major findings of the challenges of the manually operated water billing management and payment system and suggests a possible solution that will help solve the challenges that are currently faced. Thirty (30) residents of Pueblo Real were selected using purposive sampling technique which based on ISO/EIC 25010 categories. The alpha and beta testing went successfully; no errors were found, and the system was still functioning properly. To comprehend the purpose and nature of the investigation, the researchers employed the Iterative Project Model-Design to design the system. The developed system met all the necessities composed within the targets objectives and scope of this study. From gathering the necessary data of the water district, the software and hardware requirements to the development and the results are ready to be used. Future studies may broaden the payment transaction and integrate Gcash API, and add other features such as smart water meters.

INTRODUCTION

One of humanity's most fundamental needs is water. The average domestic water use per family member is 90.09 liters per day, with a standard variation of 32.03 for uses including drinking (2%), cooking (16%), cleaning (30%), and personal hygiene (44%). This number only depicts the daily water intake of a particular person. The estimated 326 million cubic miles of water that make up 71% of the earth's surface may be roughly divided into fresh water and salt water. 97% of all water is salt water, which is mostly present in our oceans and seas. Glaciers, lakes, ponds, rivers, streams, wetlands, groundwater, and even dams all contain fresh water. [1]

Dams are widely utilized for a variety of reasons, such as the construction of reservoirs, averting floods, supplying irrigation water, generating electricity via hydro turbines, and

other domestic uses. By 2022 there will be an estimated fifty thousand (50,000) major dams in use around the world. China has the most dams, with a staggering nineteen thousand (19,000), while the United States has five thousand five hundred (5,500), ranking second in the globe. At the same time, the Philippines has fifteen (15) water dams that feed both public and private water districts. Others rely on a large water pump connected to a well that draws water from the subsurface. In addition, this fresh water source is continuously gathered, cleaned, and supplied to every family.

There are three different types of communities in the Philippines: rural, urban, and suburban. Rural

areas typically contain farms where there is a wide variety of flora and fauna on land. Towns still exist

in rural areas but they tend to be smaller with fewer buildings or companies. Cities have urban areas

within the municipality. In these neighborhoods, where people live near to one another, a frequent activity or noise of some sort. Urban areas frequently have access to the newest and best items. Also, urban areas have several resources for a sizable population, as well as numerous housing possibilities. Urban and rustic elements coexist in the suburbs. The amenities of the urbanize are the same as the suburb's locations. Along with some natural surroundings, the suburbs have space to stretch out and roam about. [2]

The Water Billing Software is designed to assist in the management of water services, including compiling customer bills and tracking payments for those bills. The system helped clients get rid of the

manual way of preparing customer bills, receipting, and ledgers and registers, therefore, reducing the time used for billing and paper budgeting. The Water Billing System project can be beneficial for a water provider's business or company by helping to manage the bills of their customers. This system stores necessary information from the customer and creates an invoice detailing the charges incurred.

The system store also the payment records of the customer which will be the source of data for the payment report. This water billing system generates reports of Invoices, Payments, and Taxes. [3] Water supply system, infrastructure for collecting, transmitting, treating, storing, and distributing water for use in households, business enterprises, industry, and irrigation, as well as for public purposes such as firefighting and street flushing. The provision of drinkable water is possibly the most important municipal service. People depend on water for drinking, cooking, washing, disposing of waste, and other needs around the house. Systems for delivering water must also meet the requirements of residential, business, and industrial customers. The water must always conform to requirements for both amount and quality.

Because of the aforementioned factors, the water supply requirements of each community differ. The Pueblo Real Water District provides

water to Tarlac municipality subdivision. It is a subdivision of 582 houses, with an average monthly consumption of 21,534 cubic meters, for a total annual consumption of 258,408 cubic meters. Each household has a monthly water bill due, and due to the increased number of water demands, Pueblo Real is having difficulty managing a pile of water bills. Manually managing water bills is prone to human error. Manually managing water bill information also takes a lot of time and effort because the data is entered manually, this can lead to inconsistent records.

Furthermore, this process required a large amount of paper and took a long time to complete. And, as advanced technology advances, this may be used as a benefit to reduce the use of paper in billing and to reduce human intervention.

Objectives of the Study

The general objective of this study is to develop a system entitled Danum: "Web-Based Water Billing Management System with SMS Notification in Pueblo Real Water District". This study aims to achieve the following specific objectives:

1. To gather data for the system:
 - 1.1. To gather relevant information on the business processes of Pueblo Real Water District
 - 1.2. To identify hardware and software requirements needed in the system development
2. To design the system with the following tools:
 - 2.1 Visual Table of Contents
 - 2.2 Use Case
 - 2.3 Entity Relationship Diagram
3. To develop the web-based application with the following features:
 - 3.1 Water Billing Management System
 - 3.1.1 Add new Client
 - 3.1.2 Update Client's Information
 - 3.1.3 Archive Client
 - 3.1.4 Automate Calculation of Water bill
 - 3.1.5 Print Client's Water Bill
 - 3.1.6 Pay Water Bill
 - 3.2 Payment Digital mode via PayPal
 - 3.2.1 Digital Notifications
 - 3.2.2 SMS and Email Notification
 - 3.2.2.1. Water bill
 - 3.2.2.2 Advisory

3.3 User access:

3.3.1 Admin for the Clerk/Accounting Personnel

3.3.2 Meter Reader

3.3.3 User Account

4. To test the system using ISO/IEC 25010 according to the following parameters:

4.1 Functional Suitability

4.2 Compatibility

4.3 Usability

4.4 Security

4.5 Portability

5. To implement the system through a web hosting service platform.

Scope and Limitation of the Study

Researchers develop a system to simplify the administration of the water accounting system of the Pueblo Real Water District, the official water utility of the Pueblo Real Subdivision in Barangay Anupul Bamban, Tarlac. Furthermore, the study aims to automate the water billing management system and speed up the delivery of water bills using SMS and email notifications. In addition, it will meet the needs of water district personnel by reinforcing old water billing procedures specifically to provide good service to the residence.

The target users of the system are the residents, accounting personnel, and meter reader/collector of the Pueblo Real Water District. The researchers visited Pueblo Real Water District and conducted interviews with the accounting personnel and 4 residents to gather relevant information for the system.

Both software and hardware are needed for the system. The target system's features and functionalities are described in the software requirements in the development. This includes the search engines, programming software, system programming interface, and editing software which is critical in the development of the system.

Hardware requirements are the required specifications for a device to develop a system such as a CPU with a minimum requirement of one (1) GHz and RAM of at least 2GB capacity. The ability to create, write, test, and debug the system is provided by programming software. The researchers used the PHP: Hypertext Preprocessor to develop this system with the MySQL database software that

consists of a multithreaded SQL server that supports different back ends which is suitable for storing data of user and admin. The researchers also utilized the use of HTML5 as the backbone of the web system with CSS for the design such as Bootstrap 5.1. Some features of the system integrate API to support the functionality. This includes Twilio for sending bulk SMS and Sandbox for payments. The researchers used different designing tools to help simplify the design process. This includes a visual table of contents, use case, and entity relationship diagram. The visual table of

contents shows the menu contained in the system. (See Appendix C. for Visual Table of Contents of Danum). The use case consists of several potential interactions between people and systems in a certain environment that are connected to a specific objective. The procedure generates a document that lists each step a user took to finish an activity. (See Appendix D. for the Use Case Diagram of Danum) A particular sort of flowchart that shows how "entities" like people, things, or concepts link to one another inside a system is called an entityrelationship (ER) diagram. Most frequently, relational databases are designed or debugged using ER Diagrams. (See Appendix E. for Entity Relationship Diagram of Danum)

Water Billing Management System The system offers the important feature of this study which is water billing management. This would help the accounting personnel to speed up the process. The system allows the administrator to make an action "Add New Client" with the required information. This includes the name of the client, address, account name, cellphone number, and email address. Once the client is eligible for a discount. Then, the system would store the entered data in the database and display it on the table of the admin side. Considering human error like the entered data is incorrect, the system also offers "Update Client's Information" that would edit the incorrect information. In addition, the admin would be allowed to archive the client's data in the system by clicking the "Archive Client" button. Once the admin updates the current water consumption in a cubic meter of a specific client, the system would automatically computes the water bill. Based on the current

water meter subtracted from the previous water meter afterward, the system would multiply the cubic meter into the suited rate. This would automate the calculation of the water bill.

Subsequently, the admin can execute an action “Print Client’s Water Bill” to print a hard copy of the water bill. In addition, customers can manually pay water bills to accounting staff mapped to the system. The admin should be able to key in the “Pay Water Bill” button to update the payment. The

System would analyze the payment whether it is less than the amount of the water bill, the system would set the payment as “Partial Payment” while if the payment is equal and greater than the amount of the water bill it would display as “Fully Paid”.

Payment Digital mode via PayPal

The client can pay its water bill online using PayPal. On the other hand, the user can settle its dues

by selecting Payment in the navigation bar. The system would display the billings of the user. Once

the user pays the water bill online, the system would connect the user to the PayPal API. The user should input its credentials to automatically pay the water bill. The user and the admin can view the “Payment Transaction” to track the payment history.

Notifications

A notification is a message to provide the user with reminders and timely information from the system. The system would utilize the “SMS and Email Notification” to the clients/users. The notification includes the “Water Bill” and “Advisories” to be sent to the cellphone numbers and email addresses of the clients/users.

User Access

An Administrator is someone who has the authority to make modifications to a system that would impact other users. The system has a security feature which is the login form for the admin. This would assure the security of the important data of the system. When the admin finally entered the correct credentials, it would prompt to the Dashboard which includes the Monthly Report of the Income, total clients, and total web users. In the Billings navigation bar, it would display the account number, name of the client, address account name,

consumption in a cubic meter, discount, total bill, status, and balance. The admin can execute four actions namely; print the water bill, pay the water

bill if the client chooses to pay physically in the office, and send the water bill via SMS and Email notifications. The system can filter the necessary data of the users. The water billing and invoice module is embedded in this section. Similar to the last navigation bar, the information about the clients is shown in the Clients bar with the following functionality; add, view, update, and archive new clients, upload meter readings using CSV file, print client’s data, update the status from INACTIVE to

ACTIVE and vice versa and update water consumption of the client in cubic meter. Announcement bar is responsible for sending advisories via SMS and email notifications. It would require the admin to choose what type of notification and advisory would utilize. As with the previous side bar, it displays details regarding announcements such as kind, sending method, message, and date. The announcement data may potentially be deleted by the admin. Under the Reports bar, it would display the annual report from 2018 to 2022 using a chart.js line graph and the breakdown of the annual report. Subsequently, the Notification bar administers the user’s questions and payment confirmation to the system. In the Settings bar, the admin can configure and modify the rate per cubic meter and admin credentials. Finally, the logout bar destroys the administrator’s session.

Meter Reader

The Meter reader can update all readings for each household. There is another portal for accessing accounts. To do this, the meter reader must enter the access data in the registration form. After validating their credentials, the meter reader is presented with an index page where they can see customer information such as name, address, account number, and previous consumption. The meter reader can update the cubic meter of a specific client by hitting the Readings tab on the top navigation bar. The system will ask the meter reader to enter the account number and cubic meter consumption to update.

Accessing User Side

The web system is accessible online. Given the fact that it is significantly simpler to remember and enter web URLs when using a domain name rather than a numeric IP address to identify a location on the Internet. The user should enter the respective domain name of the system. Subsequently, the user would prompt to the home page of the web system. This includes About Us, Services, Customers, Contact Us, and Sign-in Navigations.

User Side

Registration, is where the clients/users can update the personal information to access the billings of the client's account on the admin side. Bill navigation bar, this would display the bill of the user's billing history and present water bill. The user can print the water bill of the user's account. Payment, in this section the user can pay the user's water billing through PayPal and receive a receipt of payment via SMS and email. Message bar has an embedded chatbot to answer frequent questions by the users. It would give ease to a user in inquiring. The Notification bar would notify the user in some advisories aside from SMS and email notifications.

The user can download the system for the connection of water by hitting the Account bar. The additional feature of the system is the retrieval of the password by simply hitting the Forgot Password on the login form. The system will send a token to the email to be used on the retrieval of password process of the user to verify its identity.

Testing the System using ISO/EIC 25010

The researchers intended to test the system in terms of functional suitability, compatibility, usability, security, and portability. This would identify bugs and issues in the development process before the implementation of the system. Web-based systems are available on the Internet. Researchers apply the hosting platform to upload the system and get the domain name. In this regard, researchers use purposive sampling when testing. This helps researchers identify and select the people, cases, or events that can provide the most information to reach their research goals. Due to design constraints, the payment method would be sole via Paypal. The said online

payment method requires the system to upload confidential data of the water district. The admin has the option to utilize the SMS notification since it has a monthly subscription. Also, the Email Notification is limited to sending messages and receiving a reply from the client/user.

SYSTEM DEVELOPMENT METHODOLOGY

General Methods Used The researchers utilize the Software Development Life Cycle (SDLC) is a process followed for a software application, within a systematic approach. It is a detailed strategy that outlines how to develop, maintain, replace, and change or improve specific software. The life cycle defines a methodology for improving software quality and the development process in general.

This section deals with the method of research used in the study. The techniques used under the methodological approach are stated and will be further explained as well as the techniques used in

developing the software and the data-gathering procedure. The research design encompasses the method and procedures employed to conduct scientific research. The researchers used the Iterative Project Model Design to understand the nature and function of the study. This has been chosen by the researchers as the research design in the study and the development of the DANUM: Water Billing Management System with SMS Notification in Pueblo Real Water District.

Data Gathering Instruments

With the use of several instruments, the researchers have gathered data. The gathered information has allowed the researchers to have a more comprehensive understanding of the system requirements that will be important for the creation of the Water Billing Management System. The instruments used by the researchers are as follows:

Interview

This instrument is a type of data collection technique in which the interviewee's data is gathered either verbally or in writing by the interviewer. Both sides must communicate with one another during a verbal interview to conduct the question-and-answer session by speaking with one another, either in person or on the phone. Face-to-face and online

interviews are conducted by posing the interviewee with a series of questions. The researchers have compiled a set of questions regarding the water billing process of the Pueblo Real Water District that will serve as interview questions that can help the researchers to identify the problem perceived. The researchers also compiled some questions regarding the schedules of the water meter reading, due dates, sending water bills, and notice of disconnection. The interview was conducted face-to-face, via text message and through chat to acquire the necessary information needed for the study. The different hardware and software requirements for the system's development were discovered by the researchers.

Research

This is an instrument that can help generate new ideas and information by reading and understanding published articles and works that were conducted before as a basis and reference for the study. The researchers have utilized this instrument by studying numerous relevant articles and works published over the web. Online research has guided the researchers in gathering data and important information that helped in the compilation of ideas needed to conduct the study.

Procedures

Iterative Project Model-Design is known as the project model that does not attempt to show the fully developed system requirement at its first implementation. The System or Project of this study will be implementing its subset of software requirements until it iteratively enhances and meets its fully developed system requirement. The study will use Iterative Project Model-Design as its guide.

Iterative Model

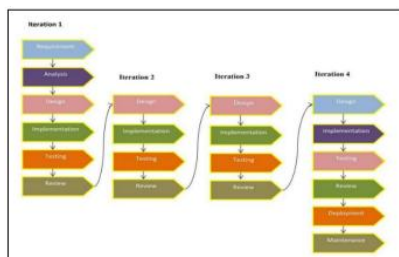


Figure 1: Iterative Model of the Danum: "WebBased Water Billing Management System with SMS Notification in Pueblo Real Water District.

Data Analysis

Descriptive statistics were used in this study. Descriptive statistics summarized the data to identify the points around which the data are located and the spread and dispersion of the data. The following statistical treatments were used for data reduction:

1. Frequency Distribution

Frequency distribution was used in the study to indicate the number of cases at each score. The scores of the demographic profile of the respondents were grouped into categories defined by step intervals, each of which was a set of contiguous possible scores. A variable with values that indicate the order of the cases was divided into several categories. The number of cases tabulated in any category was the frequency. [62]

2. Percentage

In order to obtain a measure of the relative frequency of the respondents' demographic profile on a nominal scale and to determine the relationship of their categories with each other, percentages were used. A ratio or figure stated as a fraction of 100 is called a percentage. [63]

3. Mean

The mean is the average or a calculated central value of a set of numbers and is used to measure the central tendency of the data. The sum of the observations divided by the total number of observations is the definition of the mean formula in statistics for a collection. The mean formula for a set of given. [64]

Iteration 1

Requirements Gathering and Analysis

An overall description of the system for managing water billing is given in this phase. The Researchers The two areas on which to concentrate are the first evaluation and study feasibility. For the clients of Pueblo Real Water District which is the official water supplier of the Pueblo Real Subdivision, Barangay Anupul Bamban, Tarlac, a preliminary assessment needs review before the manual system is changed to the new system as the systematic technique. In addition to researching the proposed system operation and gathering ideas to enhance it, the proponents also examined and studied the existing billing system. The accounting personnel and the engineer for the water district participated in face-to-face interviews with the researchers. At this phase,

all issues were addressed to develop a reliable system that would handle the water district's new water billing management system and replace the paper/excel water billing procedure. The researchers for this study also made a wide range of observations.

Design

After acquiring the needed data requirements, the researchers started the designing phase. In this phase, the researchers used diagrams, flowcharts, and related concepts to present the flow and features of the system. First, the researchers used a Modified Visual Table of Contents Diagram. The diagram displays the menu that is built into the system. (See Appendix C. for Modified Visual Table of Contents Diagram of Danum) Secondly, the use case diagram is used to present the scope of the system and how users interact with it. (See Appendix D. for Use Case Diagram of Danum) Finally, the researchers created an Entity Relationship Diagram to illustrate the logical structure of the web-based billing management system database and the links between entity sets stored inside. (See Appendix E. for Entity Relationship Diagram of Danum) In this phase, the researchers utilize the use of a Gantt chart. Nevertheless, especially helpful for streamlining complex projects. To aid in the planning and scheduling of projects of all sizes. (See Appendix F. for the Gantt Chart of Danum)

Implementation

In the first phase of developing or implementing the system design developers or researchers focus on the user interface of the system.

Testing and Review

After completing the interface, the researchers perform an initial developer testing of the User's interface of the system. In the review phase, the behavior and correctness of the created system are examined; if any flaws are discovered, the process is restarted at requirement gathering.

Iteration 2

Design and Implementation

After completing the user interface for the second phase, the researchers move on to designing the user access. As this is the first interface of the system, the researchers develop the user access as well as the database for the user and admin for the water billing management system. In the

second phase, the researchers or developers also started to develop the water billing system functionality as one of the main goals of the system, along with other interfaces and functionalities for each feature. **Testing and**

Reviewing After

After completing the interface, the researchers perform the final developer testing of the User's interface of the system. The review phase is performed to check the behavior and validity of the developed system. The researchers will move on to the following iteration if there are further functionalities to add.

Iteration 3

Design and Implementation

After reviewing the system that was developed in the second phase the researchers decided to add more functionality that will improve the system. During this phase the researchers design and developed the APIs for the SMS notification and online payment. The researchers also added the uploading file section, editing the client's information instead of uploading a pdf file for the client's information of the client, and sending SMS, and email notifications to the clients.

Testing and Reviewing

After completing the added functionalities, the researchers perform an Alpha testing on the entire system. The review phase is performed to check the behavior and validity of the developed system. And

if there are more functionalities to add, the researchers will move to the next iteration.

Iteration 4

Design and Implementation

Following a review of the system developed in the third phase, the researchers decided to add a few features that would complete the system. The developers or researchers added a function which is the chatbot to simulate conversation. The hint questions and answers are stored in the database. **Testing and Reviewing**

In the final iteration, the researchers perform beta testing on the entire system through its paces with 30 testers/respondents who are the target users of the system. The statistical methodology and frequency distribution of the study are also identified by the researchers. Beta testing is less focused on discovering and fixing bugs and more concerned with ensuring that the site is clear and easy to use for all of

the expected user groups. The developers or researchers have developed a working water billing management system with SMS notifications along with the database, including the user and admin access granting permissions.

Deployment

The developers upload the entire system to the hosting site which could be accessed with specific hardware and software requirements.

Maintenance

In the maintenance phase, after the system's deployment in the working environment, there may be some bugs, some errors, or new updates are required. Maintenance involves debugging and adding new features.

RESULTS AND OUTCOMES

This section presents the requirement analysis and documentation, data requirements gathering, development technique and testing, system prototype and description, implementation strategy, and results.

Requirements of the System

A complete system analysis was performed to guide the system's development. The researchers collected data by interviewing and researching via the Internet. The collected data has given the researchers a broader understanding of the system requirements that resulted in the completion of the DANUM: "Web-Based Water Billing Management System with SMS Notification in Pueblo Real Water District".

Interviews

The second step after doing the initial investigation was an interview with the Pueblo Real Water District, which is the designated water supplier for the Pueblo Real Subdivision in Barangay Anupul Bamban, Tarlac. Customers had the opportunity to provide requests, feedback, and suggestions regarding the system's planning and development. After gathering the necessary information, the researchers produced a preliminary design for the suggested system.

Hardware and Software Requirements

The researchers identified the various hardware and software requirements for the system's development. This includes browsers, operating systems, programming languages, APIs, and editing tools for the software need. For

hardware requirements, a two-core central processing unit with a high frequency, 4 gigabytes or more random access memory, and 150 gigabytes of a hard disk drive is required.

The researchers used JavaScript, Ajax, PHP, HTML/CSS, Bootstrap, Visual Studio Code, Notepad ++, and Composer to develop the system. For the database development for and web-based server, the researchers used PhpMyAdmin.

Design and development phase

By designing diagrams such as Feature Diagrams, Use Case Diagram, and Entity Relationship Diagram, the researchers essentially illustrated every feature and flow of the system they intent to provide. The researchers were able to gain a better understanding of how to design the DANUM: "Web-Based Water Billing Management System with SMS Notification in Pueblo Real Water District" by using these diagrams.

Development and testing results

For the evaluation of the system, the researchers conducted alpha and beta tests. The system was tested based on ISO 25010 categories, namely Functionality, Compatibility, Usability, Security, and Portability.

Alpha Test

The alpha test was conducted by the developers of the system using a different version of the devices to measure the performance of the system based on the given ISO category. The test case is answerable by "Yes" or "No". (See table 3 of Appendix I: Alpha testing of Danum: "Web-Based Water Billing Management System with SMS Notification in Pueblo Real Water District").

Table 4. Alpha Tester Likert Scale of Developed System

Range	Verbal Interpretation
80-100%	Excellent
60-79.99%	Good
40-59.99%	Moderate
20-39.99%	Marginal
0-19.99%	Poor

The researchers utilized the Likert scale to assume that the strength/intensity of an attitude is linear, i.e. on a continuum from “Yes” or “No”, and assume that attitudes can be measured in this study.

Table 5. Summary of Alpha Test of the Developed System

Criteria	Mean	Verbal Interpretation
Functional Suitability	100%	Excellent
Compatibility	100%	Excellent
Usability	100%	Excellent
Portability	100%	Excellent
Security	100%	Excellent
Total	100%	Excellent

The overall system functional suitability, compatibility, usability, portability, and security has garnered a percentage of 100% with a verbal interpretation of “Excellent”. This percentage only means that the three (3) alpha testers agreed that the system's major features such as registration, billing, payment, and notification system were completely functional. Furthermore, the testers were satisfied with the system's compatibility with various browsers, databases, operating systems (OS), mobile devices, networks, and hardware. In addition, the penetration to the database is tested, and the tester acceded to the full security of the system.

Beta Test

The beta testing was conducted by thirty (30) respondents using purposive sampling from the clients of the Pueblo Real Water District. The developers conducted face-to-face beta testing. The beta test used ratings, one (1) is the lowest, and five (5) is the highest. (See table 4 of Appendix K: Beta testing of Danum: “Web-Based Water Billing Management System with SMS Notification in Pueblo Real Water District”).

Table 6. Beta Tester Likert Scale of the Developed System

Response	Value	Range	Verbal Interpretation
Strongly Agree	5	4.21-5.00	Excellent
Agree	4	3.41-4.20	Good
Neutral	3	2.61-3.40	Moderate
Disagree	2	1.81-2.60	Marginal
Strongly Disagree	1	1.00-1.80	Poor

The researchers utilized the Likert scale to assume that the strength/intensity of an attitude is linear, i.e. on a continuum from strongly agree to strongly disagree, and assume that attitudes can be measured in this study.

Table 7. Summary of Beta Test of the Developed System

Criteria	Mean	Verbal Interpretation
Functional Suitability	4.37	Excellent
Compatibility	4.17	Good
Usability	3.88	Good
Portability	3.93	Good
Security	5.00	Excellent
Total	4.27	Excellent

A verbal interpretation of “Excellent” was given to the system's overall functional adequacy, interoperability, usability, portability, and security, which received a mean score of 4.27. This figure merely indicates that all thirty (30) beta testers thought the main functionalities of the system—such as registration, invoicing, payment, and notification—were fully operational. The system's adaptability with different browsers, databases, operating systems (OS), mobile devices, networks, and hardware was also praised by the testers. Additionally, the tester acknowledged the system's complete security and tested the breach into the database.

Table 8. Summary of Alpha and Beta Test

Criteria	Alpha Mean	Verbal Interpretation	Beta Mean Result	Verbal Interpretation
Functional Suitability	100 %	Excellent	4.37	Excellent
Compatibility	100 %	Excellent	4.17	Good
Usability	100 %	Excellent	3.88	Good
Portability	100 %	Excellent	3.93	Good
Security	100 %	Excellent	5.00	Excellent
Total	100 %	Excellent	4.27	Excellent

Despite the fact that the researchers used a variety of test case types, the two testers, Beta and Alpha Tester, produced verbal interpretations of Excellent. This shows that the random clients, accounting staff, meter reader, and IT staff all satisfied the DANUM: "Web-Based Water Billing Management System with SMS Notification in Pueblo Real Water District" intended functionality. The investigation was successful, and the Pueblo Real Water District is ready to take over the system to address the locality's current problem.

DISCUSSIONS

This chapter contains a summary of findings, conclusions, and suggestions from an assessment study of the participation arrangement and participation program of the Water Billing Management System with SMS Notification.

Summary of Findings

Based on the given results from designing, development, and testing all features stated in the scope of the study for DANUM: "Web-Based Water Billing Management System with SMS Notification in Pueblo Real Water District" are working as expected.

An effective water billing management system that can speed up the manual computation of the water bill and sending process to notify

every household and avoid delay of payments. The Administrator has the highest level of privileges and has full access to the system's functions. While the User can access its water bill and payment transaction with the correct credentials that are reflected in the database. In addition, the Meter reader is responsible in updating the waterconsumption of the client.

Through the used use case diagram, the researchers can identify the interaction between the system and the user and design the interface. [38] We also utilized the used of entity relationship diagram to shows how "entities" like client, user or billing history link to one another inside the system. [39] Lastly, the developers maximize the use of visual table of contents shows the menu contained in the system. [40] The automation of the water billing management system was also successful. After adding a new client, the admin can input the water consumption of the household and the system will automate the water bill. The system can print the water bill and send it via SMS and email notification. An application programming interface (API) was used to successfully integrate SMS notifications and digital payment which are essentials in the system. When the admin utilized the SMS notification in sending water bills and advisories to the client, the system automatically connects to the SMS API to share the needed data for Twilio (A third-party website for sending SMS). [3][33] The AI chatbot is also functional in the system, this will eliminate human intervention in terms of queries. Where in the question hints and answers were stored in the database.

The purpose of this system is to simplify the management of the water billing system in Pueblo Real Water District which is the official water supplier of Pueblo Real Subdivision. The system was created with a user-friendly environment, and the staff and clients of the water district would discover the work as simple and proficient.

Conclusions

The researchers concluded that Danum, Web Based Water Billing Management System with SMS Notification in Pueblo Real Water District met all the necessities composed within the targets objectives and scope of this study. From

gathering the necessary data of the water district, the software, and hardware requirements in the development. Also, the researchers utilized the use of design tools which included the visual table of contents, use case, and entity relationship diagram. [38][39][40] The water billing management system was successfully created by adding new clients, updating clients' information, deleting clients, automating the calculation of water bills, printing clients' water bills, and paying water bill features. In addition, the developers integrate payment digital mode via PayPal digital, SMS, and email notification for water bills and advisories. [3][33] [42] With three user access namely, the admin for the clerk/accounting personnel, the meter reader and the user account. The testing phase of the study has been successfully conducted using ISO/IEC 25010 according to the parameters such as functional suitability, compatibility, usability, security, and portability to ensure the quality and functionality of the system. [43] And lastly, the system was uploaded to the internet with the hosting platform, Hostinger. This will enable the availability and accessibility of the system on the internet. Furthermore, the results of the test cases and the SMS notification ensured that every feature within the project is working as expected.

Recommendation

The researchers would like to extend the following innovations of the developed system:

1. Integrate Gcash and Paymaya in the digital payment of the water bill;
2. Install smart meters;
3. Delinquent list auto-generation features and;
4. The researchers recommend that the system should be upgraded in the future to cover all water district functionality.

REFERENCE

- [1] "ESTIMATING AND FORECASTING DOMESTIC WATER .. - MPSPC." <https://www.mpspc.edu.ph/index.php/15-abstracts/167-estimating-andforecasting-domestic-water-demand-and-supply-in-bontoc,-mountain-provincea-catalyst-to-water> (accessed: Nov. 18, 2022).
- [2] "A History of Dams: From Ancient Times to Today - Tata & Howard." <https://tataandhoward.com/a-history-of-dams-from-ancient-times-to-today/> (accessed: Nov. 18, 2022).
- [3] "Water Billing System for Beginners using PHP/MySQLi with Source ." <https://www.sourcecodester.com/php/5131/water-billing-system.html> (accessed: Jan. 13, 2023).
- [3] "SMS Meaning - What is SMS? Short Message Service Definition ." <https://www.bandwidth.com/glossary/sms/> (accessed: Nov. 18, 2022).
- [4] "Admin." <https://www.google.com/amp/s/www.techtarget.com/searchnetworking/definition/system-administrator%3famp=1> (accessed: Nov. 15, 2022).
- [5] "What is API: Definition, Specifications, Types, Documentation ." <https://www.altexsoft.com/blog/engineering/what-is-api-definition-types-specifications-documentation/> (accessed: Nov. 21, 2022).
- [6] "What Is a Work Breakdown Structure (WBS) In Project Management?" <https://www.projectmanager.com/guides/work-breakdown-structure> (accessed: Nov. 22, 2022).
- [7] "Cubic meter Definition & Meaning - Merriam-Webster." <https://www.merriamwebster.com/dictionary/cubic%20meter> (accessed: Nov. 19, 2022).
- [8] "Danum Translation of "danum" into English" <https://glosbe.com/pam/en/danum> (accessed: Nov. 18, 2022).
- [9] "End User." <https://www.google.com/amp/s/www.techtarget.com/searchnetworking> (accessed: Nov. 15, 2022).
- [10] "What Is a Gantt Chart? | Definition & Examples | APM." <https://www.apm.org.uk/resources/find-a-resource/gantt-chart/> (accessed: Nov. 22, 2022).
- [11] "What is a Graphical User Interface (GUI)? - Definition from Techopedia." <https://www.techopedia.com/definition/5435/graphical-user-interface-gui> (accessed: Nov. 22, 2022).
- [12] "Household Meaning" <https://www.stat.go.jp/english/data/jyutaku/pdf/25terms2.pdf> (accessed: Nov. 18, 2022).
- [13] "How to Read your Water Bill | Statement of Account." <https://www.mayniladwater.com.ph/how-to-read-your-water-bill/> (accessed: Nov. 18, 2022).
- [14] "Interface Editing." <https://docs.oracle.com/en/middleware/fusionmiddleware/fmwlc/application-server-products-new-structure.html> (accessed: Nov. 22, 2022).
- [15] "What is a Software Program? - Definition from Techopedia." <https://www.techopedia.com/definition/25084/software-program> (accessed: Nov. 21, 2022).
- [16] "Receipt: Definition, Types, and IRS Rules." <https://www.investopedia.com/terms/r/receipt.asp> (accessed: Nov. 18, 2022).
- [17] "What is Search Engine? - Definition from Techopedia." <https://www.techopedia.com/definition/12708/search-engine-world-wide-web> (accessed: Nov. 19, 2022).
- [18] "What is Short Message Service (SMS)? - Definition from Techopedia." <https://www.techopedia.com/definition/24275/short-message-service--sms> (accessed: Jan. 13, 2023).

- [19] "What is Software? - Definition from Techopedia." <https://www.techopedia.com/definition/4356/software> (accessed: Nov. 18, 2022).
- [20] "The purpose of accounting — AccountingTools." <https://www.accountingtools.com/articles/what-is-the-purpose-of-accounting.html> (accessed: Jan. 13, 2023).
- [21] World Wide Web - MDN Web Docs Glossary: Definitions of Web .." https://developer.mozilla.org/en-US/docs/Glossary/World_Wide_Web (accessed: Nov. 22, 2022).
- [22] "What is Google Chrome browser? - Definition from WhatIs.com." <https://www.techtarget.com/searchmobilecomputing/definition/Google-Chrome-browser> (accessed: Nov. 19, 2022).
- [23] "What is Internet Explorer (IE)? - Definition from WhatIs.com." <https://www.techtarget.com/searchenterprise/desktop/definition/Internet-Explorer> (accessed: Nov. 22, 2022).
- [24] "Hostinger Web Hosting Review | PCMag." <https://www.pcmag.com/reviews/hostinger-web-hosting> (accessed: Nov. 19, 2022).
- [25] "About the XAMPP project." <https://www.apachefriends.org/about.html> (accessed: Nov. 19, 2022).
- [26] "What is PHP? - Manual - PHP." <https://www.php.net/manual/en/introwhat.php> (accessed: Nov. 19, 2022).
- [27] "HTML5 - MDN Web Docs Glossary: Definitions of Web-related terms." <https://developer.mozilla.org/en-US/docs/Glossary/HTML5> (accessed: Nov. 19, 2022).
- [28] "CSS (Cascading Style Sheet) Definition." <https://techterms.com/definition/css> (accessed: Nov. 19, 2022).
- [29] "What is a Bootstrap and how does it work?" <https://www.techtarget.com/whatis/definition/bootstrap> (accessed: Nov. 19, 2022).
- [30] "composer - Official Image | Docker Hub." https://hub.docker.com/_/composer (accessed: Nov. 19, 2022).
- [31] "What is Notepad++?" <https://www.computerhope.com/jargon/n/notepad-plusplus.htm> (accessed: Nov. 22, 2022).
- [32] "What is Visual Studio?" <https://www.computerhope.com/jargon/v/visual-studio.htm> (accessed: Nov. 22, 2022).
- [33] "What is AJAX." https://www.w3schools.com/whatis/whatis_ajax.asp (accessed: Nov. 22, 2022).
- [34] "What is JavaScript? - Learn web development | MDN." https://developer.mozilla.org/en-US/docs/Learn/JavaScript/First_steps/What_is_JavaScript (accessed: Nov. 19, 2022).
- [35] "What is Twilio? An introduction to the leading customer engagement." <https://www.twilio.com/the-current/what-is-twilio-how-does-it-work> (accessed: Nov. 22, 2022).
- [36] "What is Photoshop? Definition from WhatIs.com." <https://www.techtarget.com/whatis/definition/Photoshop> (accessed: Nov. 22, 2022).
- [37] "What Is Canva? a Guide to the Graphic Design Platform." <https://www.businessinsider.com/guides/tech/what-is-canva> (accessed: Nov. 22, 2022).
- [38] "VTOC diagram Visual Table of Content (VTOC) diagram" https://www.researchgate.net/figure/TOC-diagram-Visual-Table-of-Content-VTOC-diagram-shows-the-menu-contained-in-the-game_fig2_331128309 (accessed: Nov. 22, 2022).
- [39] "Use Case Diagram Tutorial" <https://www.lucidchart.com/pages/uml-use-casediagram> (accessed: Nov. 22, 2022).
- [40] "ER diagram tool" https://www.lucidchart.com/pages/landing/er-diagramsoftware?utm_source=google&utm_medium=cpc&utm (accessed: Nov. 22, 2022).
- [41] "SDLC - Iterative Model in Software Engineering" <https://www.scaler.com/topics/software-engineering/iterative-model-in-software-engineering/> (accessed: Nov. 22, 2022).
- [42] "What Is PayPal and How Does it Work?" <https://www.investopedia.com/terms/p/paypal.asp> (accessed: Nov. 22, 2022).
- [43] "ISO/IEC 25010" <https://iso25000.com/index.php/en/iso-25000-standards/iso25010> (accessed: Nov. 22, 2022).
- [44] "Simple Random Sampling | Definition, Steps & Examples" <https://www.scribbr.com/methodology/simple-random-sampling> (accessed: Nov. 22, 2022).
- [45] "What is Purposive Sampling?" <https://www.alchemer.com/resources/blog/purposive> (accessed: Nov. 22, 2022).
- [46] A. Pelandiana et.al. "Web-Based Billing and Collection System for a Municipal Water and Services Unit". 2017 . (accessed: Nov. 22, 2022).
- [47] "How do online payments." <https://gocardless.com/guides/online-paymentsguide/online-payments-credit-debit-card/> (accessed: Nov. 22, 2022).
- [48] "What are SMS Notifications? | Twilio | www.twilio.com." <https://www.twilio.com/docs/glossary/what-are-sms-notifications> (accessed: Nov. 22, 2022).
- [49] "Web-based Billing and Collection System ." <https://knepublishing.com/index.php/Kne-Social/article/view/2371/5222> (accessed: Nov. 22, 2022).
- [50] I. Sulaiman "DESIGN AND IMPLEMENTATION OF SMS BASED WATER BILLING SYSTEM (A CASE STUDY OF BAGUDO LOCAL GOVERNMENT WATER BOARD)". 2014. Access on April 15 2022
- [51] "Bill Information | Manila Water Company, Inc." <https://www.manilawater.com/customer/bill-information> (accessed: Nov. 19, 2022).
- [52] "Angeles City Water District." <https://www.angelescitywd.gov.ph/paymentcenters.php> (accessed: Nov. 19, 2022).
- [53] "How to Read your Water Bill | Statement of Account."

- <https://www.mayniladwater.com.ph/how-to-read-your-water-bill/> (accessed: Nov. 19, 2022).
- [54] Davao Water Billing System (no date). Available at: <https://www.davaowater.gov.ph/home/pages/post.php?link=BtclJyeHYMhfGjTYlRkb> (Accessed: November 12, 2022).
- [55] Metro San Fernando Water Billing (no date) MSFWD. Available at: <https://msfwd.gov.ph/> (Accessed: November 12, 2022).
- [56] "MWD | Homepage." <https://www.mwdh2o.com/> (accessed: Nov. 22, 2022).
- [57] "MTWD." <https://mtwd.gov.ph/> (accessed: Nov. 22, 2022).
- [58] PWD." <https://pwd.gov.ph/> (accessed: Nov. 22, 2022).
- [59] Santa Maria Water District." <https://smwdbulacan.gov.ph/> (accessed: Nov. 22, 2022).
- [60] "Bongabon Water District" <https://bongabonwaterdistriict.gov.ph/> (accessed: Nov. 22, 2022).
- [61] "CONCEPTUAL FRAMEWORK." <https://www.slideshare.net/lendiibanez22/conceptual-framework-17064069> (accessed: Nov. 19, 2022).
- [62] "Frequency distribution" <https://www.abs.gov.au/statistics/understandingstatistics/statistical-terms-and-concepts/frequency-> (accessed: Nov. 19, 2022)

E-PARK: An IoT and Web Based Premium Parking Reservation System

Rouzhhan Cunan

Allaine Marie M. David

Keanu S. Grey

Denice Denim R. Nuqui

Archie M. Patio

Jerhico Luis L. Rodriguez

Engr. Ernie Lee E. Pineda, MIT (Technical Adviser)

This study developed an Internet of Things and web-based premium parking reservation system, E-PARK. Reservation is made online with the use of the web application designed to make reservation quicker and easier. Users are required to create an account to access the web app's reservation feature. A QR Code that will be displayed in the user page will serve as the gate pass for the IoT barrier. The IoT barrier gate used Node MCU as the microcontroller, servo motor to serve as the barrier and a QR code scanner to scan the QR code pass. The system underwent alpha and beta testing to assure that it meets the objectives and the system requirements using the ISO-25010 standards, considering the following criteria on functional suitability, usability, reliability, and security. The researchers used evolutionary prototyping as a guide to complete the E-PARK prototype and its web application.

INTRODUCTION

According to a study conducted by researchers at the University of British Columbia [1], having the choice to spend your time productively can make you significantly happier. Also, doing simple activities that bring us joy—eating a well-prepared meal with a spouse, going on a casual walk with a friend, reading a book to a child, these trivial things can greatly improve our moods and well-being. This is why as much as possible we try to avoid the time-consuming rubbish that brings us down, but there are inevitable things that hinder us from having enough free time like traffic and the almost impossible search for an open parking space. The first is a problem we have had for a long time and have yet to solve, while the second is still something, you can say, new.

Even though we take countermeasures to try to avoid them by leaving so early before the sun even rises or so late to avoid rush hour, sometimes we just cannot escape from it. "Time is gold" an old saying but still as true as ever, and all that time that is wasted in traffic or while looking for a parking spot, could have been allotted to doing other productive things. Based on the study of Elid on technology [35], yearly a growing amount of people purchase a car, and it was only a matter of time before this had an impact on our parking system in the

Philippines. Parking, or rather looking for a parking spot, has become as annoying and frustrating as driving on our clogged roadways. People sitting in their cars with their hazards on, eagerly waiting for someone to depart, is something that we frequently witness in malls and restaurants. Cars can also be seen continuously circling the parking lot, looking for an open spot. People now must endure not only long food lines, but also the long and almost never-ending parking queue.

In a study that was conducted by Rappler in Manila [2], out of the 4,397 respondents 38% said that the average waiting time for searching for a parking spot is 5 to 10 minutes. More than a third of respondents (37%) stated they wait an average of 20 minutes for a parking spot to free up. Car owners have complained online that even sidewalks and actual roadways are being used as parking spaces, further making the traffic congestion worse.

Finding a parking spot on any establishment is a costly nightmare for many. Most spend a lot of time looking for a parking place for their vehicles. They will have to pay a large parking fee if they are lucky enough to acquire one. This arrangement eliminates the fact that they can travel quickly and be on time. The complex in locating a parking spot wastes time and makes driving a car unsuitable. It's hard to accept, but that is the reality with which we are

currently facing. And with all the time and money wasted queued up for parking spaces, we could be doing so much more.

SYSTEM DEVELOPMENT METHODOLOGY

The SDLC or Software Development Life Cycle prototyping methodology is used in this study by the proponents, which is appropriate for investigations that call for creating and refining a prototype as the project develops. In this study, IOT and web-based premium car parking reservation systems started with minimal functionalities. This approach makes it simple to foresee how the prototype will be constructed in order to gradually meet the system requirements. Data gathering, system design, building a prototype, testing, refining the prototype, and the final output are the six stages of evolutionary prototyping.

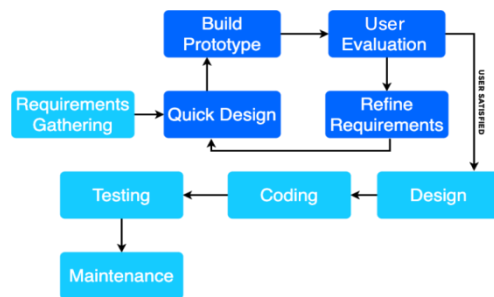


Figure 5: Software Development Cycle (SDLC) Prototyping Diagram

Requirement Gathering

This is where the requirement gathering phase where the researchers brainstorm what would be the system's functionality. Meetings and discussing the whole plan of the study were conducted online through Facebook and personally. The researchers gathered and read a lot of literature studies to widen the knowledge in the chosen topic and to further understand what are the requirements that will be needed. The researcher also visited parking spaces, free and private parking spaces to observe the manual business process of the paid parking and free parking and also observe on how efficient is the paid parking other than free parking specially during weekends and holidays. The researchers planned and talked about how to develop a web application that can help the user reserve a parking spot for the

vehicle to reduce the time for looking for a parking slot upon arrival. The software that would be used in the development of the web application was also identified by the researchers. The researchers have decided on the software requirements, which include Visual Studio Code, PHP scripting language, Adobe Illustrator, and Heroku. The study also aimed to develop a device that can prevent users who did not make a reservation from entering. The hardware requirements that were used are node mcu servo motor qr code scanner and jumper wires. And lastly, the researcher brainstormed on how to build the model of the device.

Quick Design

In the system designing phase, the researchers have started to purchase the hardware requirements from online shopping platforms to score some good deals. Arduino IDE was also the chosen programming software that will be used to bring the hardware component together. In accordance with this, the team also made a graphic visualization using a flowchart, block diagram, entity relationship diagram and use case diagram to envision its flow and to determine where the system hardware and software requirements will be put in place. The researchers documented the design and narrated the whole planning of the prototype from beginning to end. The researchers also have decided that the web application will have 3 user access levels: Admin, Clerk and User. This is where the development of the web app will revolve. Once the researchers came into an agreement on the system design. The schedule to meet up face-to-face and a virtual meeting was made for better execution of the system development.

Build Prototype

The build a prototype phase is making the system design into existence. The researchers started by checking each hardware component to determine which is functional or non-functional. With this, the researchers started developing the web app with its full functionality and deployed it online with Heroku. The web app has 3 user access levels: User, Clerk and the Admin. It also has the following initial features: Online Parking Reservation, choose a parking slot, User login, User parking history, Clerk login, Admin login,

Confirm/Cancel Parking, change price range, and Logs of in and out. After accomplishing the development of the web app, next is the IoT device. Once that's done, the system prototype group starts to connect all components such as the servo, QR code scanner, and node to the laptop. The researchers then started coding to create a specific set of instructions for the IoT devices to be able to communicate with the web app and work as one, meeting the objectives of the study progressively. The initial device was completed with 90% functionality and was ready to present to the technical adviser. The device is now able to scan the QR Code and control the servo to open and close the barrier. The barrier will only open if it scans a QR that is registered in the web application.

User Evaluation

After consulting the technical adviser and making sure that there are no bugs in the system, the researchers proceeded to the User Evaluation phase. The evaluation with the user's phase is when the prototype development was done and the researchers presented it to the intended users. The researchers conducted alpha and beta tests using the ISO 25010 criteria. In the alpha testing, three (3) IT experts were asked to test and evaluate the whole system, namely Ms. Ella Gopez, software engineer.; Ms. Haizminne Jhoie Altre, Application Development Associate.; Ms. Jelly Ross Mangaya, IT Personnel. They were selected based on their professional experience in the field of Information and Technology.

For the beta testing, the researchers surveyed thirty (30) private vehicle owners as their respondents. They are the intended users of the system.

Refine Requirements

During this phase, the suggestions and review comments are discussed. The recommended additional features were implemented by editing the web app's source code. Some changes were also made with the manuscripts with the correction given from the researcher's technical adviser. The researchers worked on the manuscript to proofread and edit what was needed to ensure that it also met the recommendations. Some bugs were encountered during the redevelopment of the system but the developers persevered to make

it through thoroughly. The finished system underwent extensive testing with the IT experts and evaluation with the users to make sure it's free of any errors. Eventually, while the researchers find it challenging to solve the faults, considering the complex areas of the system prototype, research continues, and constant teamwork makes the system achievable.

Final Product

The final product phase is the validation and verification of the system prototype functions according to the technical adviser recommendations. The researchers put the system prototype in a complete package to properly show how it operates. The researchers made a miniature of the parking lot in the Mabalacat City College to show how the device will be set up. Before placing the device at its designated station, the team thoroughly planned and cleaned the environment to avoid breaking any components of the system prototype. The researchers conducted a series of test cases that would accommodate possible scenarios in real-life situations. After ensuring that the objectives and recommendations are met the researchers presented the final product to the capstone panelist. This made the demonstration more clearly in the defense for the panelist.

RESULTS AND OUTCOMES

The researchers were able to achieve the system prototype requirements and objectives of the study. The web application included access level for the admin, clerk and user. Each of the access levels had specific access control and function in their system. The system's primary function is to cater to the online reservation that is connected to the IoT QR code-based barrier system.

As a reference for the study, the proponents searched for the past research and studies to gain more insights or ideas about the correct process that was needed for the online parking reservation.

The researchers used Node.js framework to save time on writing codes for the design and classes, it also gives a benefit for making a web-based system responsive. PHP, SQL and JavaScript were also used to write the logical

part of the web script and to customize the backend.

The E-Park web application is now accessible online which also shows and reserves the available parking slots. Users need to register an account and verify the email address to be able to login and reserve a parking space. After reserving and successfully paying, with the clerk's confirmation, the user will receive a QR Code that will serve as the gate pass for the IoT barrier device to enter the parking premises. If the QR Code is not scanned within 3 hours of its generation, the reservation will be automatically canceled.

Clerk and Admin can also monitor and manage the parking lot. Clerk can confirm and cancel the user's reservation if the user fails to pay within the time allowance. Clerk also can view the user's QR Code pass for back up when the user doesn't have a copy and no access to their QR Code pass. Admin can view entry and exit logs of the parking. Only the admin can delete and create accounts for the clerk.

The IoT barrier device was successful and performed well. It works while connected to a computer. It was able to read the QR code, process it through the microcontroller, then control the servo to open and close without error. It is able to distinguish the QR code that is registered with the system and not open the servo if it's not registered. The gate will only open when the QR code scanned matches with the system. Repeated tests indicated that the system is highly accurate.

System Design

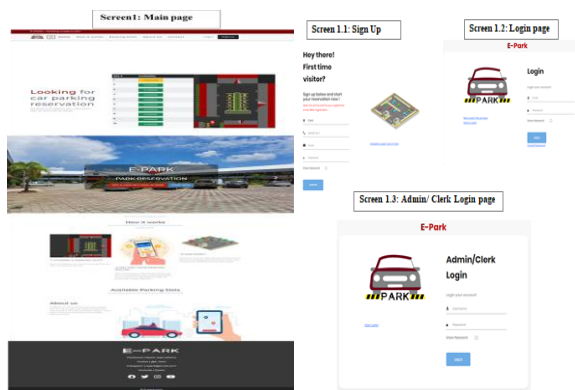
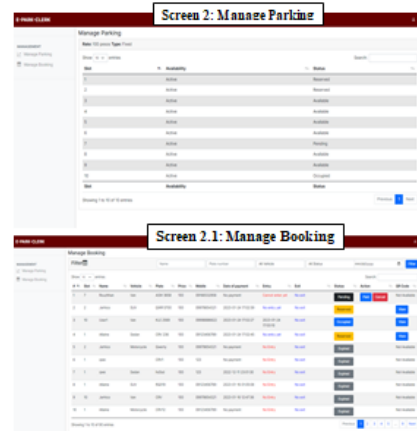


Figure 6. Web application Main Page Interface

The figure above shows the E-Park web application interface. In Screen 1, the developer used a vertical scrolling layout to create a visually appealing home page with excellent documentation on parking reservation web apps, how to reserve a parking space, and a brief description of the web app created.



Screen 1.1 shows the signup page where the user can create an account. Screen 1.2 shows a login page where the user can log in to reserve a parking space and use the "Forgot Password" button if they forget their password. Screen 1.3 shows the admin and agent/employee login page.

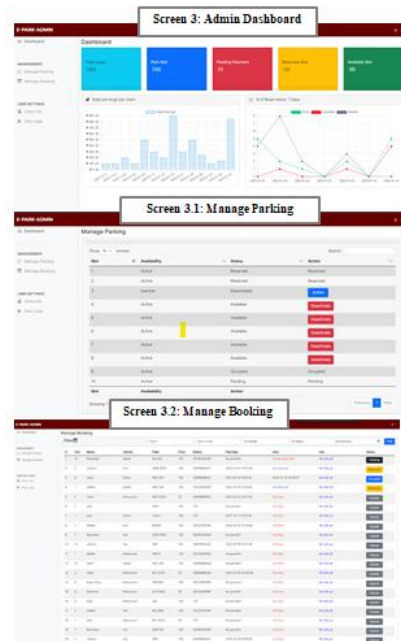


Figure 7. Web application Clerk Interface

The figure above shows the user interface of E-Park's Clerk web application. Screen 2 shows the clerk page with a parking management area where the clerk can check the status of the parking spaces. Screen 2.1 displays the booking management screen. Here the clerk can mark the user as paid once the money is received and cancel the reservation if the user does not pay. Clerk also can view the user's QR Code pass for back up when the user doesn't have a copy and no access to their QR Code pass. It also displays information about the user, such as: Reservation slot, user's name, phone number, date of payment, entry/exit time, status (pending, paid, reserved, occupied, done).

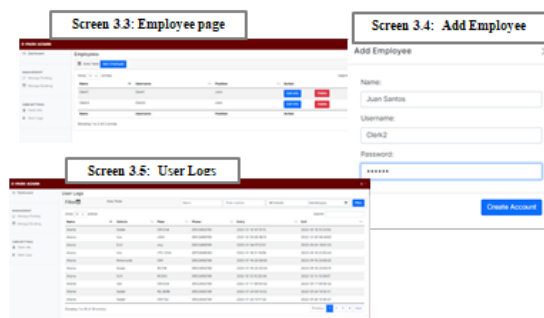


Figure 8: Web application Admin Interface

The figure above shows the administration interface of the E-Park web application. Screen 3 shows the admin page showing the dashboard his area where the admin can see the total number of users, parking spaces, pending payment, reserved slots and available slots. It also shows here the daily earnings report and daily total of reservations report. Screen 3.1 shows the Manage parking page where the administrator can see the following information such as slot count, availability, status, and actions. Actions allow administrators to put a particular slot under maintenance in case there is a problem (activate, deactivate). In the 3.2 screen, the administrator can see the information of users who have just entered the facility, such as: pending, paid, reserved, occupied, done). On the screen 3.3 and 3.4 The Employee Information screen displays where administrators can add and edit employee information. Also, only administrators can add

employee accounts. Screen 3.5 here shows the information of the user entering the site.

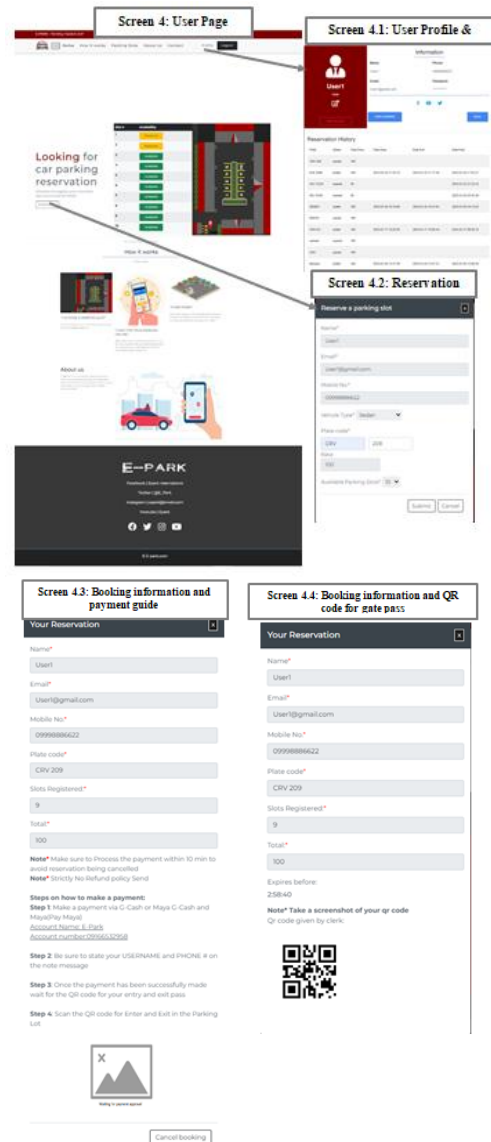


Figure 9. Web application User Interface

The image above shows the user interface of the E-Park web application. On Screen 4, the developers used a vertical scrolling layout to create a visually appealing homepage with good elements about the parking reservation site, how to reserve a parking space, and a quick description of the site. The screen 4.1 displays the user profile card where the user can update their information and view their parking history. Screen 4.2 displays the reservation

form where the user will fill in the necessary information and the total payment that the user will have to pay. Screen 4.3 displays information and steps on how and where to pay to receive the QR code. Screen 4.4 displays information and a QR code generated by the store clerk to allow the user to enter and exit the car park.

Build a Prototype and Processes Screen Shots

The researchers created E-Park, with an IoT device and web app that is aligned to the objectives of the study. When the programmer of the group completed the system's core functionalities, the other members conducted a series of testing to check if the device features are working consistently and effectively. Refer to the illustration below for the system prototype process and testing.

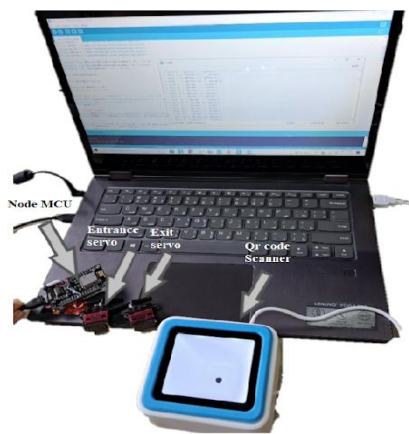


Figure 10. IOT device

Figure 10 displays the initial prototype of the study. It has 2 servos for entrance and exit, a QR code scanner, a node MCU and laptop for the clerk. The power of the node MCU and QR code scanner is connected to the laptop of the clerk.

Evaluation with Users

The system has undergone an alpha and beta using the ISO-25010 standards, considering the following criteria on functional suitability, usability, reliability, and security. For the alpha test, three (3) Information Technology experts, namely Ms. Ella Gopez, software engineer.; Ms. Haizminne Jhoie Altre, Application Development Associate.; Ms. Jelly Ross Mangaya, IT Personnel; have tested the system using test cases for the IoT, Admin and Clerk

UI for the web app. They are selected based on their professional experience in the field of Information and Technology.

For the beta test, a survey using the ISO-25010 with the same criteria was conducted to evaluate the User account UI of the web app. For the intended user of the system, the survey involves the participation of thirty (30) vehicle drivers as the respondents using the purposive sampling technique.

Refine Prototype



Figure 11. E-Park IoT device Refined Prototype

The illustration above depicts the study's final prototype. The image represents the IoT component of the study. It is in charge of the entrance and exit records of users who reserved a parking place using their QR code, which was issued to them by the clerk once they paid. Several tests were performed to check that the prototype is working properly.

Final Product and Test Cases

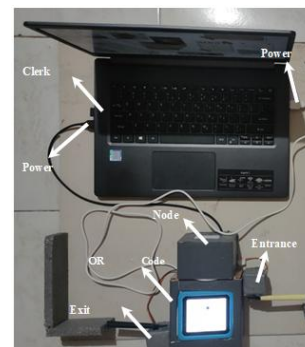


Figure 12 Installation of the E-Park IoT device's prototype

The installation of the E-Park IoT device in the small model is depicted above. The E-Park IoT device creates a miniature model of the parking space. The node MCU, together with the QR

code scanner, is placed in the center of the gate, where users can scan their QR codes to enter and exit. The entry servo is then positioned on the right side of the QR code scanner, while the exit servo is placed on the left. The laptop is near the clerk booth in the miniature.

Alpha Test Cases Results Prototype

Table 1. Functional Suitability Test Cases Results of E-Park Prototype

Category/Characteristics = Functional Suitability	YES	NO
Hardware	3	0
Does the QR code scanner work?	3	0
Does the servo motor gate open after scanning a reserved QR Code?	3	0
Does the servo motor gate close after 10 seconds of opening?	3	0

The table displays the test cases for each system prototype functionality. Keep in mind that each hardware functionality is tested three times by the IT experts to ensure that the IoT components are functioning properly. During the test cases, the researchers discovered that the rotation of the servo motor is dependent on the degree; in this case, the rotation of the servo motor is 90 degrees. The researchers also tested the QR code scanner's functionality. When users scan the QR code, the entrance gate opens and the exit gate responds properly. The consistency of the QR code scanner, laptop, and two servo motors was captured and achieved through recorded videos. Some of the test cases were screenshotted by the researchers for presentation and documentation purposes. It should be noted that the testing of the servo motors for entrance and exit was done on purpose by using the E-park reservation online. The system's core functionalities were found to be operational after five trials for each servo motor. However, there have been reports of jumper wires becoming disconnected from IoT components, causing the system prototype to malfunction. However, before installing the

device in the miniature, the researchers soldered the wires together to secure the wires to the IoT components.

The researchers discovered that the laptop supplies enough power to the Node MCU and QR code scanner. The IoT device was already placed on the Miniature while conducting the test cases. After running all of the necessary test cases, it was discovered that the system prototype met all of the study's recommendations and objectives.

Alpha Test Cases Results Prototype

Table 2. Usability Test Cases Results of E-Park Prototype

Category/Characteristics = Usability	YES	NO
System Feature	3	0
Is the device easy to understand?	3	0
Is the device easy to maintain?	3	0
Is the device easy to operate?	3	0

The researchers ensure that the E-Park system prototype is simple to use and free of user confusion. Aside from being simple to use, the prototype was also created with the user in mind. To keep it simple and easy to use, the group's IoT developer included small buildings in the miniature. Despite the fact that the application is simple and easy to use, the researchers ensure that it performs well.

The IoT is simple and easy to use and the researchers ensure that it performs effectively.

Alpha Test Cases Results Prototype

Table 3. Reliability Test Cases Results of E-Park Prototype

Category/Characteristics = Reliability	YES	NO
Expected Results	3	0
The device sends data to update the slots availability on the web app.	3	0
The web application should always generate unique QR Code.	3	0
The gate will open and only open if the scanned QR code matches with the web app.	3	0
The gate will close within 10 seconds of opening.	3	0

The above table shows the system's dependability. It's worth noting that the system underwent a lot of test cases to ensure that the system is functioning properly. The parking slot availability is always updated while running the test cases. Every reservation is also assigned a unique QR code by the web application. Furthermore, the servo motors that served as the gate will only open once the QR code that was scanned is matched and will close within 10 seconds of opening; it was discovered that it also works consistently and effectively after five attempts.

Alpha Test Cases Results Prototype

Table 4. Security Test Cases Results of E-Park Prototype

Category/Characteristics = Security		
Expected Results	YES	NO
Only vehicles with valid reservations can enter.	3	0

Table 4 shows the test cases results for the device's security. The results show that the device consistently can determine the QR Code passes that are reserved in the web app and only opens the barrier gate when the scanner scans a valid QR Code that matches with the web. This is an important factor to ensure the security of the parking space and prevent the entry of unreserved vehicles.

Test Cases Results from Web Application User Interface

Table 5. Functionality Test Cases Results for Web Application Admin Interface

Category/Characteristics = Functional Suitability		
Admin Interface Test Cases	YES	NO
Does the web application display the parking slots status? (e.g., Available/Reserved)	3	0
Does the web application allow reservation for available slots?	3	0
Does the web application not allow reservation for reserved slots?	3	0
Does the web application show the timer for payment before the reservation gets canceled if it's still unpaid?	3	0
Does the web application	3	0

allow cancellation of reservation?		
Is the user able to receive the QR Code pass?	3	0

Alpha Test Cases Results Prototype

Table 6. Functionality Test Cases Results for Web Application Admin Interface

Category/Characteristics = Functional Suitability		
Admin Interface Test Cases	YES	NO
Does the web application display the parking slots status? (e.g., Available/Reserved)	3	0
Does the web application allow the modification of payment price?	3	0
Does the web application allow the admin to create a clerk account?	3	0
Does the web application allow the admin to delete a clerk account?	3	0
Does the web application show the entry and exit logs?	3	0

The above table contains the test cases used to validate the web application's functionality. Each test case receives three trials to ensure that the web application responds in accordance with its corresponding features. The administrator is in charge of changing the payment amount and payment type for parking slots. The status of parking slots can be viewed in this admin interface. Furthermore, only the administrator has the ability to create and delete clerk accounts for employees. This interface also displays information about the users who enter the premises, such as their name, plate number, phone number, entry and exit logs, and the amount they paid. After running all of the necessary test cases, it was discovered that the system prototype met all of the study's recommendations and objectives.

Alpha Test Cases Results Prototype

Table 7. Functionality Test Cases Results for Web Application Interface

Category/Characteristics = Functional Suitability		

Clerk Interface Test Cases	YES	NO
Does the web application display the parking slots status? (e.g., Available/Reserved)	3	0
Does the web application allow clerks to confirm the parking reservation?	3	0
Does the web application allow the clerk to cancel the parking reservation?	3	0
Does the web application allow clerks to view user parking details?	3	0
Does the web application allow the clerk to view the user's QR codes?	3	0
Does the web application show the entry and exit logs?	3	0

The test cases in the table above are used to validate the web application's functionality. Each test case is subjected to three trials to ensure that the web application responds in accordance with its corresponding features. The assigned clerk can also view the parking statuses. The clerk is also the only one who is responsible for validating and confirming each user's reservation once the clerk receives payment. The clerk can also view the QR codes of the users. The clerk may also cancel a user's reservation at the user's request. Furthermore, the clerk can monitor the entry and exit of each vehicle that enters the premises, including name, plate number, phone number, entry and exit logs, and the amount that they paid. Following the completion of all necessary test cases, it was discovered that the system prototype met all of the study's recommendations and objectives.

Alpha Test Cases Results Prototype

Table 8. Usability Test Cases Results of E-Park Web Application

Category/Characteristics = Usability		
System Feature	YES	NO
The web application has a user-friendly interface that makes it easy to use for any target user.	3	0
The functions and features can be learned easily	3	0
It is easy to operate and control.	3	0

The researchers ensure that the E-Park web application is simple to use and free of user confusion. Aside from being simple to use, the application was also created with the user in mind. To keep it simple and easy to use, the group's web application developer included images, an appealing color palette, readable context, and minimalist buttons. Despite the fact that the application is simple and easy to use, the researchers ensure that it performs well.

Alpha Test Cases Results Prototype

Table 9. Reliability Test Cases Results of E-Park Web Application

Category/Characteristics = Reliability		
System Feature	YES	NO
The web app is accessible when required to use.	3	0
The web app produces accurate outputs - all inputs are properly processed, resulting in data consistency.	3	0

The above table shows the system's reliability. All the reliability tests have been passed by the system validated by the IT experts that tested the system. The parking slot availability is always updated while running the test cases. The web application is accessible whenever the users need to use it. The web application also produces accurate outputs - all inputs are properly processed, resulting in data consistency.

Alpha Test Cases Results Prototype

Table 10. Security Test Cases Results for Web Application Interface

Category/Characteristics = Security		
System Feature	YES	NO
Only the admin and clerk are permitted to enter data, modify data, or view information.	3	0
The entry and exit logs can only be viewed by the admin and clerk.	3	0
The web app keeps track of the entry and exit logs of the parking area.	3	0

User Interface Questionnaires	YES	NO
Does the web application display the parking slots status? (e.g., Available/Reserved)	30	0
Does the web application allow reservation for available slots?	30	0
Does the web application only allow reservation for unreserved slots?	30	0
Does the web application have a timer for payment before the reservation is canceled if it is not made?	30	0
Does the web application automatically cancel the reservation once the user wasn't able to process payment within 10 minutes?	30	0
Does the web application allow cancellation of reservation?	30	0
Is the user able to receive the QR Code pass?	30	0
Does the web application show the timer for QR code validity before scanning the QR on the entrance?	30	0
Does the web application automatically cancel the QR code pass and reservation once the user wasn't able to enter and scan it within the given time?	30	0

The above table shows the system's security test cases result. The system is user-protected. The system provides different access levels for different users to secure the data and records that are in the system. Only the admin and clerk are allowed to enter and modify data or view information of the parking web application. The web app also has the capability of recording the logs of entry and exit of the parking lot.

Beta Survey Questionnaire Evaluation Results
Table 11. Functionality Survey Questionnaire Evaluation Results for Web Application's User Interface

Category/Characteristics = Functional Suitability

According to ISO 25010 standards, functional appropriateness refers to how well a product or system fulfills both explicit and implicit needs. The measure of a comparison between what

software can accomplish and what software should do is called functional suitability.

The respondents' assessments of the web app on the level of functional acceptability are shown in Table 10. As shown, all 30 or 100% of the respondents have answered yes to all the questions. This demonstrates clearly that the produced web application satisfies the functional requirements and needs of the end customers, that is, an online parking reservation system. Furthermore, it suggests that the respondents acknowledge and approve the web app's completeness, accuracy, and suitability for the job at hand.

Beta Survey Questionnaire Evaluation Results
Table 12 . Reliability Survey Questionnaire Evaluation Results for Web Application's User Interface

Category/Characteristics = Reliability

User Interface Questionnaires	YES	NO
The web app is operational and accessible when required for use.	30	0
The web app meets the needs for reliability under normal operation.	30	0

Table 12 shows the results of the web app's reliability. As shown, all the indicators were answered 100% "yes" by the respondents. The web app is operational and is accessible when required to be used. As long as the user has the prerequisite to operating the system which are internet and electricity, it can be assured that it will run. Which the web app meets the need for reliability under normal operation.

Beta Survey Questionnaire Evaluation Results

Table 13. Usability Survey Questionnaire Evaluation Results for Web Application's User Interface

Category/Characteristics = Usability

User Interface Questionnaires	YES	NO
Is the web application easy to understand?	30	0
Is the system easy to maintain?	30	0
Is the system easy to operate?	30	0
Is the web application user interface appealing?	26	4

According to ISO 25010, The degree to which a product or system may be used by specific

users to achieve specific goals with effectiveness, efficiency, and satisfaction in a specific context of usage is referred to as usability. Table 13 shows that all the questions are answered as “yes” except for the last one that states if they find the web app UI to be appealing, which 4 of the respondents answered “no”. This implies that there are things in the web app’s UI to be improved but this also shows the high 97% acceptance rate of the web app usability. Further, the result shows that the web app is easy to learn and use. Respondents did not encounter any difficulties or problems in using the web app.

Beta Survey Questionnaire Evaluation Results

Table 14. Security Survey Questionnaire Evaluation Results for Web Application’s User Interface

Category/Characteristics = Security

User Interface Questionnaires	YES	NO
The web app ensures that data is accessible only to those authorized to have access.	30	0
The web app prevents unauthorized access to, or modification of, computer programs or data.	30	0
The web app can be proven to have taken place, so that the events or actions cannot be repudiated later.	30	0

Security is the level of information and data protection that a system or product provides, allowing users or other goods or systems to access data to the extent that is appropriate for their types and levels of authorization. Table 14 shows the results of the web app security rating which all have a 100% “yes” results. The developers made a user parking history which shows the user’s past parking transaction which helps with the accountability where events or action can be proven to have taken place so actions cannot be repudiated later or can be traced back.

DISCUSSIONS

It could be concluded from the evaluation's previous results, which were made using ISO 25010 standards criteria, that the system successfully met the required specifications.

The prototype was able to scan the QR code, process it through the microcontroller, then control the servo motor without a problem. The QR code scanner was able to constantly read new QR codes presented after being idle with excellent accuracy. It can be deduced that the prototype performs well at a small scale and that the design can be actually applied to a model at a larger scale model. The results from the tests show that the system can be an effective, efficient and quality online parking reservation system. The system was tested by three (3) IT experts and by thirty (30) private vehicle drivers as respondents using the ISO 25010 criteria to test the system prototype and web application functionalities. Based on the results of the test cases and the survey, both are working properly and passed all the tests that were conducted.

The researchers were able to identify the requirements needed to construct an E-Park IoT device. The gathered related literature and studies were used to deepen the knowledge of the researchers to help construct the E-Park system.

The researchers were able to design a web application with the use of Visual studio to program the web app. It allows the user to reserve a parking slot, the clerk to confirm paid the user or cancel the user’s reservation and allows the admin and clerk to view the entry and exit logs of the car park. Also allows the admin to change the pricing fee and pricing type of the parking reservation.

The researchers were able to build the initial prototype of the study. The system core functionalities are achieved including, Web Application and the QR code-based barrier or the IoT device.

The researchers were able to perform a series of test cases to verify that the preliminary prototype of the system is functional. Based on the results, all IoT components integrated into the system prototype are performing effectively. The researchers were able to install the complete package of the E-Park system in a miniature setup. It allows the capstone panelists to properly see the system in a small model setup.

Recommendations

The following are recommended features that can be added to further improve the system:

- SMS Notification - The system also sends an SMS message to the user's registered phone number. This will notify the user about their booking time, parking reservation status and their parking time left.
- Sensors - Installing sensors in every parking slot and by the barrier. By installing a sensor in every parking slot this can work as an accurate way of knowing if the space is empty or already parked and show the real time status on the web app. Installing a sensor on the barrier will be useful for its automated closing when it senses the car has passed.
- Mobile application - This will cater those people who prefer using an app version. This will help to promote the system more.
- Loyalty points - Users are able to collect points by using the app, which they can exchange for prizes. This may include discounts or free parking hours. As a result, this will encourage more users to use the online reservation system.

REFERENCES

- [1] A. WHILLIANS et al. "Valuing Time Over Money Is Associated with Greater Happiness". 2016. <https://journals.sagepub.com/doi/10.1177/1948550615623842> [Vol 7 issue:3 p:213-222]
- [2] RAPPLER. "Rappler readers share how they really feel about Manila traffic and parking issues" RAPPLER, <https://www.rappler.com/brandrap/data-stories/190406-rappler-traffic-parking-online-survey> [2018]
- [3] J D. A. E. Silva, "Tracking cruising for parking with an online system of curb parking space reservations," Case Studies on Transport Policy, <https://doi.org/10.1016/j.cstp.2016.11.004> [Vol 5, 2 June , 2017].
- [4] K. Martens, "Urban parking space reservation through bottom-up information provision: an agent-based analysis," Computers, Environment, <https://doi.org/10.1016/j.compenvurbsys.2017.01.002> [Vol. 64, pp. 30-41, 2017].
- [5] Y. Huang, "Smart Parking Guidance, Monitoring and Reservations: A Review," Institute of Electrical and Electronics Engineers, <https://ieeexplore.ieee.org/abstract/document/7904775> [Vol 6, July 2017].
- [6] M. Alam, "Real-time smart parking systems integration in distributed ITS for smart cities," J. Adv. Transport. <https://doi.org/10.1155/2018/1485652> [Vol 2018].
- [7] G. Wang, "Smart Parking System with Automatic Cashier Machine Utilize the IoT Technology," International Conference on ICT for Smart Society (ICISS), <https://ieeexplore.ieee.org/abstract/document/8969793> [2019].
- [8] P. S. Barve, "QR Code based Smart Parking System," International Conference on Communication and Signal Processing (ICCSP), <https://ieeexplore.ieee.org/abstract/document/9182180> [28-30 July 2020].
- [9] P. Sadhukhan, "An IoT-based E-parking system for smart cities," International Conference on Advances in Computing, Communications and Informatics (ICACCI), <https://doi.org/10.1109/ICACCI.2017.8125982> [13-16 Sept. 2017].
- [10] S. Kaeswaren, "Reserve Parking and Authentication of Guest Using QR Code," IEEE International Conference on Automatic Control and Intelligent Systems (I2CACIS), <https://ieeexplore.ieee.org/abstract/document/9140192> [20 June 2020].
- [11] H. X. Zhang, "Design and Module Simulation of a Smart Parking System Based On QR Code and Drone Monitoring for Open-Space Temporary Parking Lots," IEEE International Conference on Consumer Electronics and Computer Engineering (ICCECE), [15-17 Jan. 2021].
- [12] M. Khalid, "Real-Time Car Parking System Using Arduino Control," Review of Computer Engineering Research, <https://doi.org/10.18488/journal.76.2021.82.41.63> [2021-11-01].
- D. Rama, "Automated Car Parking Management System With Onlinereservation And Cashless Payment" College Of Computer Studies, https://www.academia.edu/35579048/IT_research [page 1-2]
- [13] M. Karaliopoulos, K. Katsikopoulos, and L. Lambrinos, "Bounded rationality can make parking search more efficient: The power of lexicographic heuristics," Transportation Research Part B: Methodological, <https://ideas.repec.org/> [vol. 101, pp. 28-50, 2017].
- [14] L. Balmes, R. M. P. Alejandro, J. M. L. Gamo and A. M. T. Ilagan, "PARADA: Parking Space Rental and Leasing Application System," 2022 IEEE 12th Annual Computing and Communication Workshop and Conference (CCWC), [2022, pp. 0851-0856, doi: 10.1109/CCWC54503.2022.9720838.]
- [15] A. Aaasha, "iValet - A smart parking reservation system" Thesis. Rochester Institute of Technology. Accessed from. <https://scholarworks.rit.edu/> [December 12, 2021.]
- [16] X. Yunqiang , Lin Cheng, Ping Lin, Jing An, Hongzhi Guan, "Parking Space Reservation Behavior of Car Travelers from the Perspective of Bounded Rationality: A Case Study of Nanchang City, China", Journal of Advanced Transportation, <https://doi.org/10.1155/2020/8851372> [vol. 2020, Article ID 8851372, 13 pages, 2020.]
- [17] M H Ali and D Kurniawan, "Design of Information Systems Web-Based Car Parking Place Mall." IOP Conference Series: Materials Science and Engineering. <https://iopscience.iop.org/> [2019 IOP Conf. Ser.: Mater. Sci. Eng. 662 022011]
- [18] W. Xiaotian, W. Xin, "Flexible parking reservation system and pricing: A continuum approximation approach" Transportation Research <https://par.nsf.gov/> [Transportation Research Part B 128 (2019) 408-434]
- [19] L. Jan, B. Ladislav, "The issue of addressing the lack of parking spaces for road freight transport in cities - a case

study” Open Engineering. <https://www.degruyter.com/> [March 10 2020]

[20]Abdeen, Mohammad A R et al. “A Balanced Algorithm for In-City Parking Allocation: A Case Study of Al Madinah City.” *Sensors* (Basel, Switzerland). <https://www.ncbi.nlm.nih.gov/> [vol. 21, 9 3148. 1 May. 2021.]

[21]D. Mahak, K. Sahil, “A Case Study: Growing Parking Issues and Effective Parking Management Strategies” An ISO 3297: 2007 Certified Organization. <http://www.ijirset.com/> [Vol. 6, Issue 2, February 2017]

[22]A. James and A. Prince “Smart Car Parking with Reservation System Using QR Generator” *OP Conference Series: Materials Science and Engineering*. <https://iopscience.iop.org/article/10.1088/1757-899X/396/1/012019/meta/> [396 (2018) 01-2019]

[23] Francis Cuerto “GCash claims 60 million users in PH” <https://www.manilatimes.net/2022/05/25/business/top-business/gcash-claims-60-million-users-in-ph/1844877> (May 25 2022)

[24] What is IoT? ORACLE <https://www.oracle.com/ph/internet-of-things/what-is-iot/> 2022

[25] The QR Code is everywhere, but where did it come from? TECHGOV <https://www.tech.gov.sg/media/technews/2020-09-24-the-qr-code-is-everywhere-but-where-did-it-come-from> 24 SEP 2020

[26] GCASH CIMB <https://www.cimbbank.com.ph/en/digital-banking/our-partners/gcash.html#:~:text=GCash%20is%20an%20internationally%2Dacclaimed,the%20need%20for%20any%20cash.2022>

[27] UI vs. UX: What’s the difference between user interface and user experience? USER TESTING <https://www.usertesting.com/blog/ui-vs-ux> October 16, 2018

[28] What is an IDE? Published REDHAT <https://www.redhat.com/en/topics/middleware/what-is-ide> January 8, 2019

[29] Svinicki, M. D. (2010). A guidebook on conceptual frameworks for research in engineering education. *Rigorous Research in Engineering Education*, 7(13), 1-53.

Ferjan PharmaSite: A Multi-Level Ecommerce Pharmacy for D.M. Ferjan Drug Store

Cinderella B. Bacani
John Paulo D.V Gadia
Aira-Mae B. Lacanlale
Shaineley D. Parma,
Jomai Christian M. Tua
Lovely Ruth C. Valdez (Technical Adviser)

The project's purpose is to develop an Ecommerce platform that will offer an ordering, Delivery, inventory and other ecommerce related system and eliminate the manual business process of D.M Ferjan pharmaSite. In this retail drugstore, a customer gets medicine directly as per prescription. In Mabalacat City, Pampanga, the pharmacy offers branded and generic medications along with cosmetics, toiletries, first aid supplies and general Merchandise. The project's focus for the website is to have separate accounts for the admin, cashier, customers, and rider. an ordering system and an inventory management system. The modified waterfall methodology was used for planning and developing the web-based system. The Project undergo 2 series of testing. Alpha and Beta testing using ISO 25010 that help to adjust and work according to designated objectives of the project and user interface of the was adjusted based on the result of research and Testing. The project is now deployed to DM. Ferjan Management for the company used purposes only.

INTRODUCTION

The researcher all know the importance of medicine in everyone's daily life, this serve as weapon to fight against different kind of diseases like flu, cough, fever and so on, medicine help us live longer and lessen the pain every time the we suffer from diseases that's why the researchers consider medicine as the necessity that we can't live without specially right now that we are still experiencing social crisis that every people must be cautious about whenever they go outside because of the threat of Covid-19. However, because of this pandemic the demand in the medicine is also increasing which is resulting to the shortage of drugs in the researchers pharmacy in accordance with statista.com shows that Philippines household expenditure in medicine rise from 345 billion pesos in 2017 to 626 billion pesos in 2021, this indicate the massive increase of demand in medicine for the past years that's why it is reasonable to experience shortage in drugs due to so many reason like panic buying wherein they buy big quantity of medicine to keep because they afraid to be run out of medicine, this problem is very common in the researchers society right now that's why the researcher planning to use this modern way of tracking

supply of medicine in the researchers pharmacy called "business process automation" and "inventory management". The "Business process automation (BPA) integrates process design to application integration services in order to facilitate the automation of business process implementation and to allow the execution of workflows involving various heterogeneous applications". This means that business process automation is a technique for using technology to carry out routine tasks or processes in an organization where manual effort can be replaced. This will assist a firm reduce burden, boost productivity, and save costs on a daily basis. "Inventory management is the activity which manages the availability of commodities to the consumers [1]."

To suit the demands of marketing, it coordinates the functions of purchasing, production, and distribution. This demonstrates that inventory management is a process of tracking of inventory or supply on a daily basis until it has been sold; In order to avoid shortages, this procedure aims to have the appropriate amount of the desired good (medication) available when it is needed. The provision of new products, consumables, replacement parts, outdated goods, and other

supplies are all included in this job description. Ferjan Drug store is a pharmacy that is focus on selling drugs that are branded and generic medicines, as well as other medical utility and personal care products, this two method the researcher stated earlier will be used in the researchers website that are dedicated for the researchers client which is Ferjan Drug store that are lack of inventory management and business process automation, furthermore the researcher notice that D. M Ferjan Drug store is experiencing difficulty in selling drugs because of pandemic that's why the researchers offer them assistance by developing a website that focuses on responding to the inquiries of customers, online selling, and even delivery of orders to their customers place online.

DM Ferjan is a drugstore owned by Mrs. Elena Natividad D. Gonzales and established on March 29, 1999, at San Francisco, MacArthur Highway, Mabalacat City, Pampanga. D.M Ferjan Drugstore is a retail drugstore with a single branch where a customer gets medicine directly as per prescription. The drugstore also offers toiletry items, first-aid supplies, cosmetics, and generic and branded drugs.

According to the Pharmacist Assistant's statements, the only thing they do when inventorying is write on paper. As a result, it causes delays and extra workload. They want to increase their customer base and help customers who cannot go to their physical store due to illness. In the delivery process, they want a rider they can trust.

Based on the data the researchers obtained from the interview with one of the pharmacist assistants, the researchers developed a website with the necessary functions to help alleviate the drugstore's problems, such as their manual inventory system. The researchers decided to create a web-based ordering and inventory management system in response to the aforementioned problems. The manual inventorying of pharmacist assistants can be replaced by the inventory management system. Customers who are unable to visit the real business in Mabalacat City, Pampanga, may still fulfill their demands with the aid of the ordering system. The user level for customers and administrators in the ordering and inventory management system is the same. Yet

the researchers will develop a rider user level that will assist in the delivery process of their riders in order to address the potential issues that their riders may experience. The pharmacy will be able to expand its customer target area, thanks to the web-based Ordering and Inventory management system, and inventory records will be digitally stored.

Objective of the Study

The general objective of this study is to design, develop, implement, and innovate business process for a functional Digital Web Drugstore with Business Management System for FERJAN DRUGSTORE: An Online Drugstore so the customers can buy medicines through safe and excellent quality online pharmacy.

This study aims to achieve the following specific objectives:

- To Gather the Information:
 - To gather information on D.M Ferjan Drug Store through an interview,
 - To gather information on other drugstore and pharmacy website through online research, and
 - To gather information about Ecommerce Platforms through online research.
- To Create Design and Flow Charts.
 - Flow Charts
 - Virtual Table of Contents
 - Data Flow Diagram
 - Use Case Diagram
 - Organizational Chart
 - System Designs
 - Admin Level
 - Summary Overview
 - Website Settings
 - User Management
 - Website wireframe
 - Customer Level
 - User Credential (System Account)
 - Cart System
 - Checking Out
 - Payment System
 - Delivery Item
 - Cashier Level
 - Customer Information
 - Inventory Management
 - Ordering system
 - Order Daily summary

- Delivery Rider Level
 - Customer Location
 - Order Summary
 - Order Function
- To Identify Hardware and Software Requirements.
 - Hardware Requirements
 - Desktop / Laptop
 - Software Requirements
 - Website Type Platform
 - NOTEPAD ++
 - HTML 5 +
 - PHP
 - JAVASCRIPT
 - AJAX
 - CSS
 - MYSQL
 - XAMMP
 - Hosting Platform
 - Domain
- To Implement the Designs to Create the System.
 - Inventory Management
 - Add New Product
 - Update Product Information
 - Delete Product Information
 - Delivery Structure
 - View All Delivery Transactions
 - Update Delivery Transactions
 - Cashier Point of Sale
 - Add New Order Information
 - Update Order Information
 - Front End Interface
 - Update Front End Interface/ Customer View Reference
 - Ordering Module
 - Add To Cart Function
 - Check out Function
 - Payment Method
 - COD
- To Test the System by The Use of Test Cases in Terms of ISO 25010 Evaluation
 - Check Functionalities with D.M Ferjan Drugstore Management
 - Diagnose Check Per User

- To Deploy The D.M Ferjan Drugstore System

Scope and Limitation of the Study

The study covers the products of the researcher's client's General Pharmacy. Due to the current pandemic, it is challenging to go outside and purchase items from a pharmacy. This website will help us buy through online order. Since the researchers are providing a website for the client. The website will be focusing on selling, inventory management, ordering management, Dashboard, All users. And for the user overview, it will have Registration, My Account, About Us, Shop, Cart, Checkout and Payment with COD.

The researchers collected data from DM Ferjan drugstore through interviews. After the interview with the client, the researchers did online research to find websites to help build a website for the client. After looking for references, the researchers also looked for the functionalities of the e-commerce platforms. Because as per the client interview, it is good to use e-commerce platforms to expand their sales through online transactions.

After gathering the needed information, the next step is identifying the most appropriate hardware and software. The "to identify hardware and software requirements" is aligned with the methodology "requirement gathering and analysis" the researchers added "to gather the information" in the first step of the specific objectives because of the needed data from the client.

The hardware requirements that the researchers used are a Desktop and a laptop. The developer used a desktop to create a website, with other researchers used Laptop to check the website's progress. The software requirements used by the developer to create a website are Notepad++, HTML, PHP, JavaScript, AJAX, CSS, MYSQL, XAMMP, Hosting Platform, and Domain. The developer needed those to build the website based on the designs made by the researchers.

Consequently, the researchers also utilized "Charts and System Designs". The charts contain a Flowchart, VTOC, DFD, Use Case Diagram, and Test Case. These charts are essential to make the solution more effective because these will be the developer's bases in creating a website.

The researchers also used Flowchart because is one of the bases of the developer in creating the website. VTOC to create a proper category for each website page the researchers will create. DFD to make an overview of the entire system, the purpose of this overview is for the client and developer to easily see the flow of data on the website. Test case to test the functional suitability, reliability, performance efficiency, usability, security, compatibility, maintainability, and portability.

Next is the "System designs". All the designs needed to implement the website are all here. In the system designs, the researchers created four user levels: Admin level, Customer level, Cashier level, and Rider delivery level.

"Admin Level Design". This is a summary overview for admin to view how much data each page of the admin user level contains. Website settings to modify the front end of the website without coding. User management to manage all accounts at the cashier and rider user levels.

"Customer Level Design". Has a user credential (system account) at the customer level. The user credential/customer account is the account the customer will use to order items on the website and Cart system, where all items added to the customer's cart are stored. Check out so the customer can check out the orders to proceed with the payment system. On Payment System, the customer will be given payment options; either G-cash or Cash on Delivery (COD). A delivery item where the customer can see the status of his order.

"Cashier level Design" The following are functionalities of the cashier-level design; 1.) Customer information: where you can add and subtract customer information.

This customer addition aims to speed up the transaction with repeat customers. 2.) Inventory Management system: so that the cashier can manage the inventory and know which item is in low stock so that they can immediately re-stock. 3.) Ordering Management System: where, all orders will be stored so the cashier can manage them. 4.) Point of sales: so that the cashier can track sales. 5.) Receipt Printing: to provide a physical receipt to customers that ordered online and walk-in after receiving their order. 6.) Order daily

summary: is for the cashier to track the orders on a daily basis.

"Rider level Design" The following are functionalities of the rider level design; 1.) The customer location will help the rider locate the customer's address using the google map connected to the website. 2.) Order summary: where the rider can check the customer's orders. 3.) Order function: where the rider can select the order of the customer who ordered online and update the customer on the status of his ordered item as the delivery rider of the order customer.

The developer has implemented all the designs to create a website that can solve the client's problem. Here there are four functionalities implemented by the developer: Inventory Management, Delivery Structure, Cashier Point of Sale, Front-end Interface, and Ordering Module.

Inventory Management. The purpose of this is for the cashier to monitor the quantities of available items on the website without producing an excess inventory or overstock. This inventory management has three functionalities; 1.) Add new product information: where the pharmacist can add more products with this functionality. 2.) Update product information. Where the cashier can update the missing or incorrect product details in the uploaded product. 3.) Delete Product Information: where the cashier can delete the products uploaded on the website when the item is out of stock, restocking is no longer possible, or a wrong item is uploaded.

Delivery Structure. The purpose of this is for the cashier user level to monitor the customer's ordered items that the rider needs to deliver. The cashier can also update the customer's item status so that the customer can determine the ordered item's status. This Delivery Structure has two functionalities: this is necessary at the cashiers' end for them to monitor whether the delivery of the ordered item to the customer is successful or unsuccessful from the rider's end, such as a damaged vehicle or accident. 2. Update order information: where the cashier could update the status of the customer's order so the customer is aware whether the ordered item is ready to be delivered.

Cashier point of sale. This allows the cashier to enter walk-in customer orders into the DM Ferjan drugstore system. The following are the cashier's point of sale functionalities: 1.) Add new order information: where the cashier can add walk-in orders in DM Ferjan drugstore system. 2.) Update order information: where the cashier can update order information if the walk-in customer wants to change the ordered item.

Front-end Interface. This is for the admin user to edit the front end of the website without coding. The researcher added this so that the admin can customize their website. The functionality mentioned above is called "Update front end". The reason behind this functionality is for the client to update the information on the website by themselves, and no longer need to hire a developer to update the information on the website.

Ordering module. This is for the customer user level for them to place an order. The following are the functionalities of the ordering module: 1.) Add to cart function: The most important function, and it is one of the standards that should not disappear from the ordering system, so that the customer can add items to the cart before checking out. 2.) Check-out function: for the customer to check out the items in the cart and proceed with the payment method, whether online banking system or cash on delivery. The functionality at the check-out function is the "Payment method" when the customer chooses what type of payment they want. GCASH or COD are the choices on this method.

The researchers also used the ISO 25010 evaluation to test the functional suitability, reliability, performance efficiency, usability, security, compatibility, maintainability, and portability of the website created by the researchers.

After testing and proving that everything on the website is functional and the website conforms to all the designs made by the researchers, it is ready to be deployed to the client's usage.

SYSTEM DEVELOPMENT METHODOLOGY

The research design model used by the developers was a Modified Waterfall Model. This model is an upgrade of the traditional waterfall model since it allows to return to a previous

stage and address issues where the traditional model does not allow to go backward.

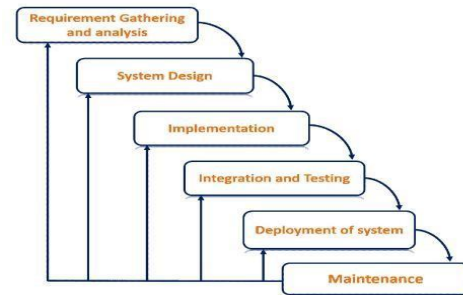


Figure 22. Methodology

Requirement Gathering and analysis

The Waterfall technique is predicated on the idea that all project specifications can be acquired and comprehended in advance. The project manager goes above to completely understand the project sponsor's demands. Each stage of the project, including the costs, presumptions, risks, dependencies, success indicators, and completion deadlines, is described in written specifications. These specifications are frequently given in a single document.

The drugstores in Mabalacat City that require system development and improvement were interviewed by the researchers. The D.M. Ferjan Drugstore is the one that needs the system to be improved and developed the most, according to discussions with representatives of other pharmacies. Employees of the drugstore manually write on paper for the inventory, the receipt, and the point of sale. To keep up with the growing industry, D.M. Ferjan Drugstore has to improve more.

The researcher gathered examples of how the D.M. Ferjan Drugstore may use e-commerce. See pages on websites that are studies linked to this page. The website that the researcher used as a starting point or as the D.M. Ferjan Drugstore's e-commerce platform. The most important way to increase the business of D.M. Ferjan Drugstore is to use information from the ecommerce platform, which is the basis of the global market that is always evolving.

In order to bolster the information, the researcher also conducted a thorough search of the internet to find the supplies required to build up an e-commerce platform. The researchers also determined the mandatory materials that were required. Since the

researcher developed a versatile data management system, they will, for instance, employ the Mysql database platform.

They used the information gathered to setup and create a function and designs for the Webpage they creating. The following are the identified platform needed to setup the

- Webpage.
- Hostinger (Hosting and Domain Plan)
- Ecommerce Platform
- HTML
- PHP
- JAVASCRIPT
- AJAX
- CSS
- MYSQL

The Following was utilized to create and implement the Webpage for D.M Ferjan Drugstore.

All of the researcher's cited data has been bookmarked for the sake of the backlog and documents.

System Design

Software designers create scenarios, layouts, and data models to provide a technological solution to the issues outlined in the background of the study. The project's objectives, scope, general traffic patterns for each component, and connectivity points are initially laid out in a higher-level or logical design.

The following are the charts used by the researchers:

Flow Chart

Process workflow is created as a guide of correct and functional flow of the website. This will serve as a path of each action created and will result a correct output. A Step is followed to create a specific flow chart of each function.

Define the procedure that will be shown. At the top of the work surface, type its title.

To determine whether other parties involved in the process (employees, supervisors, and customers) concur that the process is depicted accurately, go over the flowchart with them.

You may refer to the following for Flow char figures:

Customer Flow Chart(Appendix Q.1 – Customer Flow Chart)

Admin Flow Chart(Appendix Q.2 – Admin Flow Chart)

Cashier Flow Chart(Appendix Q.3 – Cashier Flow Chart)

Delivery Rider Flow Chart(Appendix Q.4 – Delivery Rider FlowChart)

VTOC

The researchers used the VTOC to show the Set of physical-sequential data that the system contains and the developer to see the data pattern that needs to be implemented.

Admin Level – A Multi-Level Admin Panel Design under Appendix M: (VTOC – Admin Level). This design is to tackle the appropriate functionality and user designated task. In this level, admin have the control of the functionalities of the website and as well as the changes to the customer interface.

Customer Level – This design is based on the gathered ideas from other websites and best approach to give customer a user friendly and functional approach to the ecommerce website you may refer to Appendix N: (VTOC – Customer Level) for reference.

Rider Level – In this level, a designated trusted delivery rider is hired to utilize the shipping of ordered item of the consumers. It will only have a limited access to the information of each consumer. The diagram was used as a basis and actual process of the rider. Reference Appendix O: (VTOC – Rider Level) for reference. As the researcher follows the guidelines of the Privacy act of the Law. A user level that gave the delivery rider a good flow of recognition of the information.

Cashier Level – The purpose of a User Level (Appendix P: (VTOC – Cashier Level) is to provide the function of catering orders taken over the counter, often known as walk-in clients. This end has a point of view also of the daily transaction of the Cashier.

DFD

Researchers used a data flow diagram to represent how information flows across a system or process visually. Appendix A shows the data inputs and outputs, data repositories, and the numerous subprocesses the data goes through.

Use Case Diagram

Here, the researchers utilized a used case diagram because of the complex systems, to create a simple model that will show the entire context of the system. Appendix B shows the

data flow and process of the customer, admin, cashier, and rider within the system.

Website wireframe

The rules that direct the development of the E-commerce platform's backend and frontend designs are listed below. The design serves as the framework for the ecommerce website, allowing researchers to wrap up their work and anticipate the system's output.

This section also includes the findings from the analysis of the data received from the various sources. In this instance, the combination of in-depth examination of each piece of information results in the entire outcome. The following step is to create a backend and frontend of the Admin page, Customer page, cashiers page, and Delivery rider for the website. All required pages, functions, and contents were considered in order to have a deeper understanding of the tasks that needed to be completed first.

The design is primarily focused on having a user-friendly approach for each level of user.

Website wireframe

Website wireframe of the Customer Panel – Drafted under Appendix K: (Website wireframe Customer Panel) are the primary designed as a basis of finalizing the final outcome of the platform.

Website wireframe of the Admin Panel – drafted under Appendix L: (Website wireframe - Customer Panel) Appendix K: (Website wireframe - Customer Panel) are the primary designed as a basis of finalizing the final outcome of the Platform.

Implementation

When the design is complete, technical implementation has started. This phase in the Waterfall process could be the shortest because of the thorough research and design that has been done. The programmers created programs during this phase based on project specifications, with some testing and implementation. Going back to the design phase is necessary when significant changes were needed during this phase.

Subsequently to designing the front end and back end, the D.M. Ferjan Drugstore researchers had sessions to decide whether to proceed with the software requirements finalization and setup for the e-commerce platform.

Regarding the necessary and optional data elements; features, and details that produce an effect and information, so that the system operates in accordance to the intended structure's design.

The researcher had to complete all necessary tasks to complete the Ecommerce platform, be aligned with the final implementation, and concentrate on the critical functions in order to complete this phase. The researcher followed the recommendations of the scope and constraints in order to stay in line with the study's main objective.

The researchers used necessary tools to accommodate the needs of each part of implementing the Ecommerce Platform. The following are the software tools and representation tools used to help the implementation step.

A. Software Tools

Visual Basic Studio – a device used to hard code the programs for each page of the e-commerce platform and compile them. It is connected to the usage of Javascript, CSS, HTML, and PHP. Each of these serves to illustrate and develop a procedure to adhere to each goal and range of the e-commerce platform.

Xampp – An External application that support the PHP platform for an offline use of the ecommerce platform.

Composer – This is use to compose additional components for library of the scripts and main sources of the programs. It supports the use of the PHP and any particular languages in programing industry.

Browser – This served as output platform of the ecommerce website. This is the primary medium to use the ecommerce platform. Since the Ecommerce platform is web type application it would support a domain access and can be accessible using a browser.

B. Backend and Frontend Requirements

Database Structure- Entity present are identified by the researcher to create a functional data base management of the platform of the website. Both the logical and physical data structures will be entered into the data specification language supported by your database management system when it comes time to build the real database. To ensure you have the performance level and

storage capacity the database will need, you should estimate its size at that time.

Integration and testing

Testing is necessary before a product is made available to users to make sure there are no flaws and that all criteria have been met, resulting in a positive user experience with the program. The testing team based their test cases on the personas, user case scenarios, design papers provided by the product manager, and ISO 25010 evaluation.

In the integration and testing department, the researchers developed the test cases and engaged with 3 IT professionals and 4 Ferjan Drugstore staffs to examine the system and get comments to enhance the constructed website. Appendix Z.1, Z.2, and Z.3 showed the personal information about the alpha testers, and Appendix Z.4, Z.5, Z.6, and Z.7 showed the personal information about the beta testers. This phase of the study is vital since the results of each test may lead to an unintended flow or a malfunctioning e-commerce platform that would affect how the implementation process moves forward.

Integrating involves allowing the e-commerce platform to operate in the format that it will ultimately utilize. Along with making the website's online access available to everyone. Given that the website was initially developed on a separate platform, integration may potentially cause issues. These are the potential factors the researcher could run against.

During the implementation phase, the researchers produced a testing table and a real-time testing. The testing table was used as a reference for completing each of the objectives listed in Chapter 1's objectives. A function or a process may alter at this stage to accommodate the right and more appropriate workflow for the e-commerce platform.

Since the researcher should produce a bug-free and misconception Ecommerce website, they created a testing parameter. Below is the graphed test case for the System.

A test case parameter was created to test and be the guidelines of the system functionality and objectives.

Deployment of system

The maintenance phase started after the program has been distributed to clients or

deployed in the market. A team was established to handle upgrades and the delivery of new software versions when bugs are discovered and user modification requests are received.

After the researcher applied all the objectives and recommendations in the ecommerce website. With the testing and suggestions from the adviser, it was verified that there were no issues and the website was in line with the right processes and procedures.

The researcher run a demonstrations and presentation to D.M Ferjan Drugstore Management for the flow and process of their Ecommerce Website. The Website researcher created the use of a Web hosting and Domain as the medium of the application can be used so that the D.M Ferjan Drug Store Management for the final Deployment.

Maintenance

After the researchers have gathered all of the comments from the IT expert and D.M Ferjan Drugstore, the system underwent another modification based on D.M Ferjan's and the IT expert's recommendations for system implementation.

The Ecommerce Website Platform also known as Ferjan Pharmasite is already running and has undergone a time-to-time Service Maintenance. As a tool or application, a series of upgrade was needed and this could help the Platform adjust and cope up with the advancement.

As the Researchers already expected this stage of maintenance, one of the objectives of the researchers is to create a free IT service for minimal or design feature of the application. This is for the researchers to added some settings under the Admin panel in-charge of the most common Client and IT transactions.

Testing and Implantation

Functionality, dependability, portability, usability, performance, security, compatibility, and maintainability were the major criteria used to evaluate the system. Two sets of category Alpha and Beta Testing were used for the test. Three people responded to each test. The average result of the alpha testing was 4.6, or Strongly agree. While the running test for the beta version received a mean of 4.986111, which is nearly flawless. In terms of overall

testing, the ISO testing receives a mean score of 4.820139, or 96.4 percent.

Table 1 Alpha(Appendix X Alpha tester ISO 25010)

Category	Score	Descriptive
Functionality	4.55556	Strongly Agree
Reliability	4.5	Strongly Agree
Portability	4.666667	Strongly Agree
Usability	4.77778	Strongly Agree
Performance	4.666667	Strongly Agree
Security	4.466667	Strongly Agree
Compatibility	5	Very Strongly Agree
Maintainability	4.6	Strongly Agree
Mean	4.6	Strongly Agree

Functionality, compatibility, usability, portability, and overall system

With a verbal interpretation of "Strongly Agree," security received a score of 4.6.

This percentage solely indicates that the system's four (4) user levels major were accepted by the three (3) alpha testers. Features including inventory, billing, payment, and notification systems were fully implemented. The testers also found the system to be fully functioning and compatible with there are several browsers, databases, operating systems (OS), mobile devices, networks, and Additionally, the infiltration into the database is checked, and the tester was granted access to the hardware the system's total security.

Table 2 BETA(Appendix Y Beta tester ISO 25010)

Category	Score	Descriptive
Functionality	4.888889	Strongly Agree
Reliability	4.5	Very Strongly Agree
Portability	5	Very Strongly Agree
Usability	5	Very Strongly Agree
Performance	5	Very Strongly Agree
Security	5	Very Strongly Agree
Compatibility	5	Very Strongly Agree
Maintainability	5	Very Strongly Agree
Mean	4.986111	Strongly Agree

The developers of this research employed the ISO 25010 to test FerjanPharmasite for beta and create it as an all-encompassing integrated system. This ISO uses many categories during the testing process. A system is put through a

series of actions known as a system test case to see if it truly satisfies system requirements and performs as intended. Its goal is to ascertain whether or not various system components are performing as anticipated and to validate that the system complies with all applicable standards, recommendations, and client needs. The Web application's testing is done in accordance with ISO/IEC 25010, an international standard for software engineering. This proved that the web application met all of the specifications and was appropriate for its purposes. Three users or Beta users evaluated the application's functionality, features, and competency. In order to safeguard both the program and its users, one of the most important characteristics that an application should have is security. This is done to make sure that the application's requirements for data and networking security are being followed. As per the Iso result of the beta Test of overall category 4.986111 or equivalent to "Strongly Agree".

Table 3 Grand Mean

Category	Score	Descriptive
Functionality	4.72	Strongly Agree
Reliability	4.75	Strongly Agree
Portability	4.83333	Strongly Agree
Usability	4.888889	Strongly Agree
Performance	4.833333	Strongly Agree
Security	4.7333333	Strongly Agree
Compatibility	5	Very Strongly Agree
Maintainability	4.8	Strongly Agree
Mean	4.820139	Strongly Agree

Functionality of the system was given a "Strongly Agree" rating, indicating that it can effectively and efficiently adapt to many types of operating or usage contexts as well as hardware and software.

Additionally, the system's reliability score was "Strongly Agree," meaning that it consistently makes it easier to complete the goals and objectives that are set forth in each module or panel. The designed system was operational and accessible when needed for usage, earning the best overall score among the many sub-criteria under the dependability category. The created system's portability criterion received a "Strongly Agree" grade.

The system can adapt to various hardware, software, or other operational standards since it received the greatest total score among the five indications under the portability criteria.

Additionally, the system's usability received a "Strongly Agree" rating. The accessibility indication was scored highest out of the many sub-indicators under usability because the system gives users more flexibility over how they may accomplish a task in a given use scenario.

Users had consistent bandwidth access during system testing at least 10 to 15Mbps Internet connection. When the system is operating, a higher bandwidth will provide it greater responsiveness, processing, and throughput. Additionally, the kind of resources needed to access the system will affect how well it performs.

The security rating of the system was likewise very high, with excellent ratings for the sub-factors of secrecy, accountability, and integrity. It offers several security log-in access features for all user types, which guarantees that only those with access rights may access the data. Additionally, it guards against unauthorized access to data modification and keeps auditable logs of all operations.

Additionally, the system's compatibility feature received a "Very Strongly Agree" rating overall. It demonstrates that the system successfully carried out the necessary tasks while utilizing shared resources and an environment with other items without having an adverse influence on resource utilization. The system's portability and compatibility are connected. It denotes that another device connected to a network may access the system, allowing for the usage and exchange of information.

Additionally, the Maintainability rating was "Strongly Agree." Testability received the highest mean score among the sub-indicators. The system allows the user to change the parameters without causing any errors or lowering the system's quality.

DISCUSSIONS

The summary of findings, conclusions, and recommendations from the study Ferjan PharmaSite: A Multi-Level Ecommerce Pharmacy for D.M. are included in this section.

The constructed Ecommerce Website is made from referenced website as well as personal knowledges. The website mechanism was able to fulfill the need of the different user level (Admin, Cashier, Rider and Customer). With this approach of having a different user level, the researcher gave different point of view reference to create an approach in terms of the final output.

Several trials and changes were made on the ecommerce website due to compatibility and data validation structure needed to implement the website. The later parameter mediums were digitally processed by the hosting and domain to the internet so that user could view it on their browsers. The ecommerce system reacted based on the information structure and good process workflow so that it will give the user of the platform the idea and fulfilment when using the system.

Conclusion

The "Ferjan Pharmasite" web-based system is the project's main topic, including its design, development, and evaluation. Following their examination, testing, and evaluation of the website, the researchers reached the following results:

The researchers collected the necessary data for the system through a series of interviews and observations at DM Ferjan Drugstore. Due to the interview, the researchers identified the problems of the locale that needs a solution.

The researchers successfully identified all the software and hardware required to create and access the website. Table 1 shows what the researchers used to develop and access the website.

The website's design, in appendix q, m, n, o, p, a, and b, shows the success of creating of Flow Chart, VTOC, DFD, and Use Case Diagram. To ensure that the solution to the problems mentioned in the background of the study will be effective before implementing procedures in the system.

The designs created was successfully implemented in Ferjan Pharmasite Website to provide a 4-user level function and flexible platform. The Website application interface have; Admin panel, Customer Panel, Cashier Panel and Delivery Rider Panel). Additionally, the Ferjan Pharmasite has the advantage offsetting the maintenance of the website thru

the admin panel Website setting. This will conclude that in any future changes in management the system can fulfill a change without modifying backend sources. Finally, The System is well appreciated by the Ferjan Drug store workers as it will help them create a new market and boost their business in innovative way. The ordering module also serves its purpose of managing the customer's order. Figures 38, 39, 40, and 41 showed the success of ordering products on the customer user level. In terms of the inventory system, the cashier was able to edit and monitor the list of products and out of stock products. The Gcash payment method was not completed due to the requirements needed by the Paymongo, the personal bank account of the DM Ferjan Drugstore owner.

The system testing of the "FerjanPharmasite.online" web application's conception, creation, and outcomes. The FerjanPharmasite successfully passed the deep testing using ISO 25010 based on the required classification for the testing requirement. Strongly Agreed was the outcome of the proponents' evaluation of the website's overall functionality through both alpha and beta testing. The responders make up both the primary and secondary parts of the system as a whole. The ISO 25010 Parameters are used to enhance and improve these results based on the testing parameter's findings.

Recommendations

- Upgrade the Platform to A multi-Store Users
- Create an Order tracker
- A more user-friendly approach

REFERENCES

- [1] M. e. al., "Aligning Process Automation and Business Intelligence," August 2004. [Online]. Available: <https://www.alexandria.unisg.ch/66514/1/2004%2520-%2520Melchert%2C%2520Winter%2C%2520Klesse%2520-%2520Aligning%2520Process%2520Automation%2520and%2520Business%2520Intelligence%2520to%2520support%2520CPM.pdf>.
- [2] "unleashedsoftware," [Online]. Available: <https://www.unleashedsoftware.com/inventorymanagement-guide/inventory-management-systems..> [Accessed 13 April 2022].
- [3] "webmd," [Online]. Available: <https://www.webmd.com/cold-and-flu/what-are-epidemicspandemics-outbreaks..> [Accessed 13 April 2022].
- [4] "collinsdictionary," [Online]. Available: <https://www.collinsdictionary.com/dictionary/english/world-wide-web..> [Accessed 13 April 2022].
- [5] "Inventory explain," [Online]. Available: <https://www.inventoryexplained.com/bookinfo/ordering-systems.html>. [Accessed 13 April 2022].
- [6] G. Prashanti, "A review on online pharmacy," *IOSR Journal of Pharmacy and Biological Sciences*, vol. 12, pp. 32-34, 2017.
- [7] R. Deepika, "STATUS OF E-PHARMACIES IN INDIA: A REVIEW," *Plant Archives*, vol. 20, pp. 3763-3767, 2020.
- [8] J. Liu, "Consumers' satisfaction factors mining and sentiment analysis of B2C online pharmacy reviews.," *BMC Medical Informatics and Decision Making*, vol. 20, pp. 1-13, 2020.
- [9] N. SARKER, "Online Inventory and Order Management System for Pharmacy," 2018.
- [10] M. K. A. Ali and S. Aminu, "Online Pharmacy System," 2021.
- [11] H. Han, "The Influence of Online Shopping Convenience and Sales Promotion on Behavioral Intention on Official Online Pharmacy Stores," pp. 1-5, 2021.
- [12] M. C. Y., "The Effect of Inventory Management on the Devaluation of Pharmaceutical Products," In *XV Multidisciplinary International Congress on Science and Technology*, pp. 135-146, 2020.

Furbies: An IoT Based Smart Home Pet Monitoring System Using Android Mobile Application

Allan Paul D. Aquino
Bridz Jude G. Guilas
Alchino V. Jorquia
Ezequiel L. Lising
Micaella C. Molina
Dexter P. Policarpio
Lorenzo C. Macam, MIT (Technical Adviser)

Modern technology has evolved into a valuable source of information that influenced users to create a variety of software and devices. Pets are both a source of happiness and stress reliever. The aim of this study is to develop a system that will help pet owners to ensure that pets can feed and monitor all the time by using the system entitled “Furbies: An IoT Based Smart Home Pet Monitoring System Using Android Mobile Application.” The researcher utilized the prototyping model to produced, tested, and modified as necessary feature of systems until an acceptable result was obtained from which the full system or product can be developed. The researcher successfully developed a mobile application that includes a controller to control the amount of food to low, medium and high that the IoT device has to give to the pets. The project device and mobile application have a push to talk feature: an ability to run a real-time call from mobile application to the project device, this is for the owner of their pets to hear them and to reduce or eradicate pet's stress and anxiety. The project also has a smart door, temperature checker that allows automatically turn on of exhaust fan, controllable on/off LED light bulb and automatic water server that continuously tops off the water container with a pet water spout. The ISO 25010 criterion was used to define and evaluate the application system. The findings of the application assessment and evaluation show that the Furbies mobile application and system features resulted to be very useful to its users.

INTRODUCTION

Modern technology has evolved into a valuable source of information that influenced users to create a variety of software and devices. Meanwhile, modern technology comes with modern problems, especially for pet owners. The Internet of things when it is developed properly can be used to keep an eye on our pets and feed them while we are gone. Pets are both a source of happiness and stress reliever. They also suffer from stress and anxiety when we are away from home, Pets require special treatment and attention. Due to today's hectic lifestyle, this task is no longer as simple as it used to be.[1] as a reward and show of love, we can offer our pets "Furbies".

Monitoring is a constant collection and analysis of information about a program, and comparing what happened against what was planned in order to assess how well the intervention is being carried out. [2] A monitoring system allows you to gather, process, analyze and distribute information among a group of users participating in the implementation of a project

in order to assist them in making decisions, accessing information, and learning from experience. [3]

The majority of pet owners find it impossible to part with their pets because they are concerned about what they won't be able to see their pets doing at home alone, they also worry that their pets aren't eating enough, eating at the proper times, or drinking enough water. Pets add vital energy to our homes and lives, according to Laura Staley [4]. Pets convey a variety of signals about connection and affection. Throughout their priceless lives, dogs should be treated with kindness. The heart is softened and expanded by the interspecies dance of love. All animals should be loved unconditionally throughout their lives. According to John Grogan, our pets have such brief lives with us, and they spend most of them waiting for us to get home from work every day. It is remarkable how much joy and love they bring into our lives, as well as how much closer we get to one another as a result [5]. Researchers develop a smart home for pets for the benefit of both pets

and pet owners as a method of returning the affection that our pets offer us. The concept aimed to assist pet owners in taking care of their pets. The project wanted to provide comfort for the pets by providing what they need while they are home alone: food, water, lights, the right temperature, and communication with their pet owners.

The researchers aimed to develop an IoT device and an android-based application entitled "Furbies: An IoT Based Pet Monitoring System using Android Mobile App" because nowadays pet owners always leave their pets in their houses since there is still a 7 pandemic. Many establishments don't allow pets in their inside premises. Pet owners also want an update regarding their pets that they left in their home. With this, the researchers came up with an idea and created a study, an IoT device that will help pet owners to monitor their pets and feed them even when they're away

General Objectives

The aim of this study is to develop a system that will help pet owners to ensure that pets can feed and monitor all the time by using the system entitled "Furbies: An IoT Based Smart Home Pet Monitoring System Using Android Mobile Application."

Specific Objectives:

1. To identify the software and hardware needed to develop the system;
2. To design the system with the following features:
 - a. Login and Logout;
 - b. Automated Feeder, Water and Door;
 - c. Manual Feeder and Door;
 - d. MP3 Music and push to talk;
 - e. Light;
 - f. Temperature.
3. To develop a system using the following software and hardware:

Software

- a. Visual Studio Code
- b. CloudMQTT
- c. Arduino IDE
- d. HTML
- e. CSS
- f. PHP
- g. JavaScript
- h. C++

Hardware

- i. Water pump

- j. GSM module 900
- k. Exhaust fan 220v
- l. Servo (360 degree)
- m. Servo (180 degree)
- n. Wires
- o. ESP32 board
- p. Mp3 Player Module
- q. Light bulb
- r. Temperature Module
- s. Pet water spout
- q. Ultra-sonic sensor
4. To test the system using ISO 25010:
 - a. Functional Suitability
 - b. Reliability
 - c. Performance Efficiency
 - d. Usability
 - e. Security
 - f. Compatibility
 - g. Maintainability
 - h. Portability

Scope and Limitation

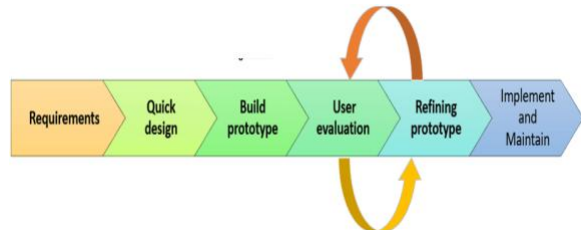
The central point of this study was to develop an interaction between fur-parents in terms of monitoring and feeding their pets even if the owner is not at home. The study helped to enhance the love of one's own pet. The mobile application includes a controller to control the amount of food to low, medium and high that the device has to give to the pets. The low selection gives 5 to 6 grams, the medium selection gives 10 to 12 grams while the high selection gives 15 to 17 grams. The project device and mobile application also have a push to talk feature: an ability to run a real-time call from mobile application to the project device, this is for the owner of their pets to hear them and to reduce or eradicate pet's stress and anxiety. The project also has a smart door for pets controlled using the mobile application: for the pets if they want to go inside or outside the house.

The smart door can only be used by pets that are 31 centimeters wide and 42 centimeters tall. The project also includes a temperature checker which can be seen in the mobile device to monitor the room's temperature; if the temperature turns to 34 degrees Celsius an exhaust or fan will automatically turn on and when the temperature goes lower than 32 degrees Celsius, the exhaust fan will turn off. The device also has a LED light bulb inside the pet's house controlled by the mobile device to

switch on and off. Additionally, the project includes an automatic water server that continuously tops off the water container with a pet water spout. Water level is sensed by an ultrasonic sensor built into the water container. If the water level drops by 30 cm, the ultrasonic sensor automatically activates a water pump from the reservoir to replenish the water container. The container holds 1.5 liters of water, and the reservoir holds 1 liter. The mobile application can be downloaded 11 to android devices only and only electricity was used to power up the project's device. It lacks a backup power source.

SYSTEM DEVELOPMENT METHODOLOGY

This section has discussed the process involved and methodology that were used to develop this system. A prototype was produced, tested, and then modified as necessary until an acceptable result was obtained from which the full system or product can be developed. This approach is known as the prototyping model. In situations where not all of the project needs are known in detail beforehand, this model performs best between the engineers and the users, it is an iterative, trial-and-error process.



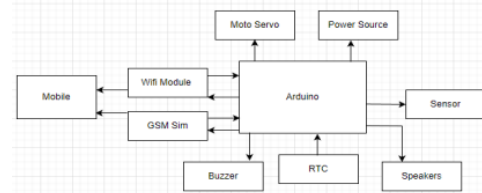
Requirements

Researchers looked at the project's usability and performance from the perspective of possible users during Requirement Analysis, and brainstormed on what the program should do. The conversation took place via video chat with MS Teams and Messenger and gave suggestions on how to improve the project. Every step of the documentation, hardware and design was done collaboratively by the researchers. The study considered establishing an application rather than a website will be considerably easier to build, access, and user-friendly for users.

Quick Design

During the Quick Design Phase, the researchers created a storyboard to construct

the system design that was appropriate for the fur parents. The researchers acquired ideas for the project's appearance and what may be added from the internet many new designs have been created for users with limited phone skills, such as the elderly and toddlers. The Leader gave his approval to all of the designs that were derived from each of the ideas.



The Block Diagram Arduino as the main source, moto servo use to serve water and food the sensor for monitoring the temperature, the power source, speakers for push to talk sound, RTC use for real time feed, buzzer for the door and indication that the device is turn on; and Wifi module for connection and GSM Sim also for push to talk features.

Build Prototype

The Build prototype phase was in charge of bringing the system design to life. The researchers examined each hardware component to see which ones are functional and which aren't. Following that, all of the components, including the Arduino, Battery, Speaker, WIFI, Feeding Tools, and Wire began to connect. The Researchers used Visual Studio Code for coding, Xampp for the local server and testing other languages was use are HTML to support the website structure, CSS for the design and layout, PHP as a server-side programming communication with database, Javascript for client-side programming as a user interface functions and Arduino IDE for the programming of the Arduino devices and other components to work together

User Evaluation

To improve the device the extended demand for the system prototype was thoroughly examined. Arduino, Wifi module, Speakers, and where the main tools will use its goal is to keep an eye on the pet. The adviser, panelists, and target customers will also be capable to provide early comments on design, usability, and user experience to the researchers.

Refining Prototype

After the refining phase, the researchers studied the causes of device and coding problems. Despite the team's difficulties in fixing the problems caused by the complicated portions of the system prototype, research continued, and constant teamwork brought the Furbies to life. Furthermore, the prototype was preserved and used to construct the actual application throughout the refining phase, and refining continued until the final system was built.

Implementation and Maintain

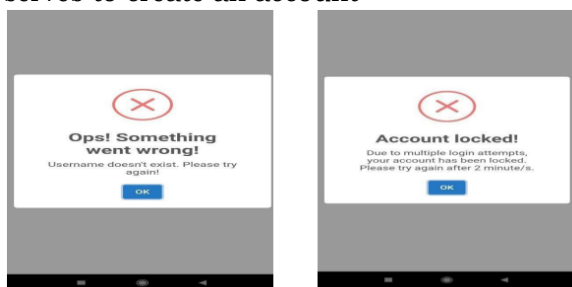
After going through all of the stages and iterations, the researchers were able to create a working application entitled “Furbies: An IoT Based Pet Monitoring System using Android Mobile App”. The finished application will be Published in the Market.

RESULTS AND OUTCOMES

The Mobile User Interface



The login page is shown in screenshot 1; after downloading and starting the Furbies application, you only need to sign in. The registration form is shown in screenshot 2, that serves to create an account

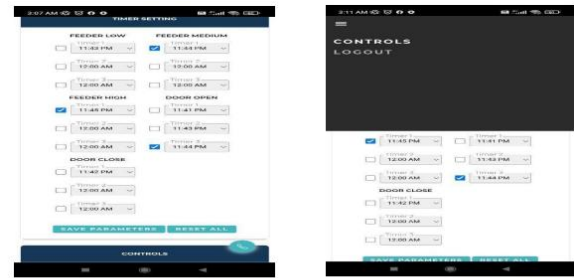


Screenshot 3: Warning Page

Screenshot 4: Locked Account

The Screenshot 3. This is the warning page when a user enters an unregistered account. In screenshot 2, the login page freezes for two minutes after a user enters an incorrect

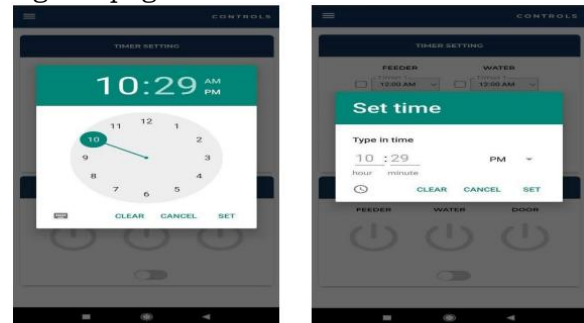
password three times.



Screenshot 5: Home Page & Controls

Screenshot 6: Log out Page

Screenshot 5 shows the home page and also the main feeding features, such as the food manual controls and the timer control. To use the timer control, one must configure the feeding time once, twice, or three times, and click the save parameters button additionally; the reset button will reset every feeding schedule. The second screenshot shows the log-out page.



Screenshot 7 & 8: Timer Page

The Screenshot 7 & 8. In this area you can use 2 different interface to set the time



Screenshot 9: Manual Control

The Screenshot 9 is the manual control for feeding; there are three buttons low, medium and high, also manual control for the door

lights. If one of the buttons was clicked, a green color will appear to indicate that the process was successful. Also the bottom left is the push to talk button.



Checking of Wires

As seen in this section the researchers checked each wire that is linked to the modules; some of them were functional, but some of them were not, so they made sure that all of the wires included in the modules were properly working, until there were no signs of broken wires.



Pet House Building

The Researchers made a financial plan to design and build the pet house woods. The researchers painted the pet house a maroon color on the outside to give it a more vibrant appearance.



Testing Push to Talk

The Researchers tested the push to talk part. Unlimited call is allowed as long the sim card has load. All tests were successful



Developers Testing

The automatic Pet Feeder called Furbies was tested for the first time by the researchers. The Developers tested all the components of the Device and Mobile application Buttons.

DISCUSSIONS

The objectives of the project have been set, and the findings for the data gathering method have been resolved and described. The majority of respondents who are pet owners, as per the data, struggle with the idea of leaving them at home. According to the information received from the responders, the smart pet feeder is a practical gadget. Due to the mobile application's review, the ISO 25010 Software was used to define and evaluate the application system. The development, design, and system functionality of the Furbies mobile application are quite advanced. In addition, according to the findings of the application assessment and evaluation, the Furbies mobile application features resulted to be very useful to its users.

Recommendation

The researchers recommend to the future researches to improve or add the following:

1. Addition of Camera module to the project device for the pet owners to monitor their pet's real time.
2. Addition of Backup power source or battery for the entire device to be able to function even if there is a power outage.
3. Upgrade to the automatic door that uses an RFID tag on the pets' collars to open the door as they approach.

REFERENCES

- [1] S.Subaashri, et al. "Automatic Pet Monitoring and Feeding System Using IoT". [https://www.sphinxssai.com/2017/ch_vol10_no14/2/\(253-258\)V10N14CT.pdf](https://www.sphinxssai.com/2017/ch_vol10_no14/2/(253-258)V10N14CT.pdf) [2017]
- [2] <https://www.ilo.org/global/lang-en/index.htm>, "BASIC PRINCIPLES OF MONITORING AND EVALUATION", 2017. [Online]. Available: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/documents/publication/wcms_546505.pdf?fbclid=IwAR0ozSNiSxXP5sXSRKzXLFXvTfw_jE3vu78EEk9LtsyfAQaTvKLYUDsY3yg . [Accessed: 2017]

- [3] N. Lauriac. "Design and implement a monitoring system." https://www.tdh.ch/sites/default/files/tdh_gmm_en_nouvelleversion_ang.pdf?fbclid=IwAR3LOCsbs932ZM6gC24_60yelAxRPkuzhDrmTCRGHC0waQEX9CrcqPU5Wjk .[Oct.2016]
- [4] L. Stacey. <https://www.goodreads.com/quotes/7728649-pets-bring-vital-energy-to-ourhomes-and-lives-pets> .[2017]
- [5] J. Grogan. " Marley and Me: Life and Love With the World's Worst Dog". https://www.goodreads.com/quotes/251797-such-short-little-lives-our-pets-have-ospendwith?fbclid=IwAR0TQeeK57HuSSU3PPW0IGuA38VeGQdS_iH3r0cBKb3BsInLVQRM7eSD3I8 . [2005]
- [6] Flan Mcgan. "Automatic Pet Feeder".[https://play.google.com/store/apps/details?id=flanmcgan.petfeederapp&hl=en&gl=US\(2022\)](https://play.google.com/store/apps/details?id=flanmcgan.petfeederapp&hl=en&gl=US(2022))
- [7] SkyRC Technology Co.,Ltd. "Petoneer".[https://play.google.com/store/apps/details?id=com.petoneer.pet&hl=en&gl=US\(2022\)](https://play.google.com/store/apps/details?id=com.petoneer.pet&hl=en&gl=US(2022))
- [6] S. Patel, et al. "Internet of Things-IOT: Definition, Characteristics, Architecture, Enabling Technologies, Application & Future Challenges". https://www.researchgate.net/publication/330425585_Internet_of_ThingsIoT_Definition_Characteristics_Architecture_Enabling_Technologies_Application_Future_Challenges . India. [May, 2016]
- [7] L. Ramasamy and S. Kadry. "Blockchain in the Industrial Internet of Things". https://www.researchgate.net/publication/351554927_Internet_of_things_IoT . Norway [2021]
- [8] <https://www.oecd-ilibrary.org/docserver/5jlwvzz8td0nen.pdf?expires=1649392926&id=id&accname=guest&checksum=CE2224B5F53682F2D50125F924AB00F2> . [Accessed: May, 2016]
- [9] K. Patel and S. Patel. "Internet of Things-IOT: Definition, Characteristics, Architecture, Enabling Technologies, Application & Future Challenges" Volume 6 Issue No. 5. [Online]. Available: <https://ijesc.org/upload/8e9af2eca2e1119b895544fd60c3b857.Internet%20of%20ThingsIoT%20Definition,%20Characteristics,%20Architecture,%20Enabling%20Technologies,%20Application%20&%20Future%20Challenges.pdf> . [Accessed: May, 2016]
- [10] Y. Chen and M. Elshakankiri. "Implementation of an IoT based Pet care System". https://www.researchgate.net/publication/343114482_Implementation_of_an_IoT_based_Pet_Care_System . Canada [April 2020].
- [11] G. Kotekar, et al. "Internet of Things: Real-Time Pet Monitoring System". http://proceeding.conferenceworld.in/SAIT_2019/14SgclWWxnOAeS533.pdf . India [May 2019].
- [12] L. Qi. "Wireless Dispenser System: Pet Care". http://eprints.utar.edu.my/3695/1/fyp_CN_2019_LWQ_1407702.pdf . Malaysia[2019]
- [13] R. Abdulla, et al. "IoT based Pet Feeder". https://www.academia.edu/42459095/IOT_based_Pet_Feeder .Malaysia [2020]
- [14] S. Kumari, and S. Yadav , " Development of IoT Based Smart Animal Health Monitoring System Using Raspberry Pi" (2018). International Journal of Advanced Studies of Scientific Research, Volume 3 Issue 8, 2018, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3315327 .India [2018].
- [15] K. Scoresby, et al. "Pet Ownership and Quality of Life: A Systematic Review of the Literature". <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8705563/> . U.S [2021]
- [16] <https://www.whatalife.ph/author/whatalife-contributor/> , "PH Furparents, pet owners increased since COVID-19: Here's Why ", 2021. [Online]. Available: <https://www.whatalife.ph/ph-pet-owners-increased-since-covid-19/> . [Accessed: April2021]
- [17] M. Jaiswal. "Android The Mobile Operating System And Architecture".https://www.academia.edu/61362568/ANDROID_THE_MOBILE_OPERATING_SYSTEM_AND_ARCHITECTURE . Kentucky, U.S [2018]
- [18] O. Novac, et al. "Comparative Study of Google Android, Apple iOS and Microsoft Windows Phone Mobile Operating Systems".<https://iranarze.ir/wpcontent/uploads/2018/06/E7634-IranArze.pdf> . Romania [2017]
- [19] G. Scoccia, et al. "Leave my Apps Alone! A Study on how Android Developers Access Installed Apps on User's Device". https://www.ivanomalavolta.com/files/papers/MOBILESoft_iam_2020.pdf .[2020]
- [20] <https://www.techopedia.com/> , "Mobile Applications (Mobile App)", 2020. [Online]. Available: <https://www.techopedia.com/definition/2953/mobile-application-mobile-app-what-does-mobile-application-mobile-app-mean> . [Accessed: 07-August- 2020].
- [21] J. Zhang, et al. "Advantages and challenges in using mobile apps for field experiments: A systematic review and a case study". https://www.researchgate.net/publication/319561030_Advantages_and_challenges_in_using_mobile_apps_for_field_experiments_A_systematic_review_and_a_case_study . California, U.S [2017]
- [22] H. Oza. "The Importance of Mobile Applications In Everyday Life!" [Online]. Available: <https://www.hyperlinkinfosystem.com/blog/the-importance-of-mobileapplications-in-everyday-life> .[Accessed: March, 2017]

FURNIFY: A Mobile-Based House Customization and Visualization using Augmented Reality Technology

Jenniel Jess S. Batul
Joren S. Gonzales
Merry Joice R. Gonzales
Myka Andrea B. Ilao
Paul Andre P. Tiongco
Ronnell Y. Tolentino
Jaypee P. Patdu, MIT (Technical Adviser)

Furniture is an important aspect of a home since it adds life and style to a space that can be seen just by looking at it. The varieties of furniture used may define the ambiance of space; it can seem simple, classic, beautiful, minimalist, spooky, hilarious, or anything the imagination can conjure up, which is why these goods not only provide life to a place but also the environment that a certain user desires. Today's technology can undoubtedly assist in speeding up the process of everything so that everyone may live a more pleasant life. As an example of these technologies, Augmented Reality makes life easier and only makes life easier, but it also allows users to visualize a non-existent object in reality, delivering satisfaction that a user may feel with the use of a gadget. This is where the researchers came up with the idea for "Furnify", an application that uses augmented reality technology to view certain furniture, that allows users to create and decorate a room in their home with various types of furniture that may be chosen based on their preferences.

INTRODUCTION

According to Casa Decor, a house is a place where people may find comfort, which contributes to a psychologically and physically healthy existence. A house with the décor and furnishings of their choice can provide them happiness, as these items may establish diverse moods, promote relaxation, and entertain guests, as opposed to bare homes [1]. According to Dela Cruz, et al., augmented reality (AR) is the expansion of this specific computer technology to mimic items in a variety of industries; such as education, entertainment, medicine, and gaming, as a result of the rise in the processing capability of mobile computers. Additionally, interactional technology by the computer with the advancement of 3D display tools expanded substantially in development support [2].

Let's start with the basics. According to Paul Farley, the installation of virtual things inside actual situations is known as augmented reality (AR), which differs from the functions of virtual reality (VR), a completely immersive computer-generated experience that often needs a cumbersome and costly array of headgear and motion paddles. This is often

accomplished via a mobile viewing device such as a smartphone or tablet [3].

According to Yi Fu, and Wenming Liu, using mobile or furniture modeled with computer technologies may be represented using virtual reality technology throughout the design phase, substantially reducing the development and cycle costs in the furniture design industry and increasing design efficiency. Towards this basis, smartphones and computer modeling technologies in home decorating are examined, and the application of ergonomic, formal aesthetic law, and function to furniture design viewpoints are investigated [4].

According to Carl H. Godoy Jr., the inclusion of information in a digital format that includes real-time film of a user's environment is known as augmented reality. Using augmented reality technology, consumers who want to build their own furniture would take their phones to a camera and position it where they want the furniture to be changed [5].

Because of augmented reality technology or also known as (AR), clients would be able to pick while in the comfort of their homes. The researchers intend to allow the users to customize their own designs and even pick the prior designs. This smartphone application

would be handy for individuals who wish to purchase home furnishings and decor without remorse. The researcher's purpose is to show the aid of an application to lessen the troubles within the furniture business by employing new techniques, and to create a more relaxing and comfortable environment for its users.

Choosing their own design based on their preference would bring satisfaction to the customers, the researchers want to design a mobile application named Furnify: A Mobile-Based House Customization and Visualization using Augmented Reality Technology. It is where customers would be able to see different designs or rather a figure where they can customize their own furniture according to their wants and preferred idea, color, and materials through the help of their phones.

Accompanying Augmented Reality with materials such as a 3D modeling piece was a trial of combining intelligence and creativity, making it a rewarding product for the researchers which is why this study was chosen as their project.

3D modeling, on the other hand, is a technique that takes skill and creativity for a user to accomplish a specific piece. 3D modeling through technology can enhance the abilities of a developer not just for their physical skill but also their mental analysis on how to design and create something out of the screen, that is why furniture 3D modeling was chosen as the material for visualizing in Augmented Reality.

Augmented Reality Technology was a challenging piece that requires careful coding for it to work with other material, making it a worthy segment in learning as information technology learners.

The researchers' aim is to show the help of an application to ease the problems within the furniture shop by using innovative ways. This is to create a more relaxing and enjoyable experience for its customers.

The goal of the research is to develop a smartphone application that would enable people to select and customize their own furniture without visiting a physical furniture store. Additionally, they are able to save time by staying at home and using the Furnify Application.

Objectives of the study

The overall objective of this research is to develop a system entitled "Furnify: A Mobile-Based House Customization and Visualization using Augmented Reality Technology".

In line with this, this study aspires to achieve the succeeding specific objectives:

1. To gather information about the system through the following means.
 - Online Research
 - Brainstorm Ideas
 - Educational Video Previews
 - Consultation with Professionals
2. To identify the needed hardware and software requirements of the project.
 - Blender 3D
 - Unity 3D
 - DOTweening
 - Adobe Photoshop
 - C# (C Sharp)
3. To design the study using the following tools for the design and analysis of the application.
 - Storyboard
 - Flowchart
 - Menu Tree Diagram
4. To create a system that includes the following features of the system.
 - 4.1 Set your home using AR
 - a. Furniture Categories
 - Balcony
 - Bathroom
 - Bedroom
 - Dining Room/Kitchen
 - Laundry Room
 - Living Room
 - b. Design and Customization
 - Materials Used
 - Dimensions and Size
 - 4.2 Catalog
 - 4.3 Preview in AR
 - 4.4 User Manual
5. To test the application using researchers made a test case adapted from software quality standards of ISO25010 in terms of:
 - Usability
 - Functional Suitability
 - Compatibility
 - Portability
6. To deploy the mobile application through Google Play Store.

Scope and limitations

The study entitled “Furnify: A Mobile-Based House Customization and Visualization using Augmented Reality Technology” focuses mostly on generating augmented reality and furniture visualization for a home using a smartphone. In order to complete the study, the researchers would create the aforementioned application using a variety of app-making and design applications. The application created is only to show a virtual representation of furniture to the real world using the aid of a device that is being processed as augmented reality.

The researchers gather reliable data information on the Internet (i.e., AR Creation, Plane Detection, Object Rendering, and Texture Image Application) to define the initial requirements for the application development. Moreover, the researchers had online sessions in order to brainstorm ideas, watched Augmented Reality tutorial videos, and consulted with professionals based on the characteristics of the application they would develop, thereby providing more information about the furniture, and improving the project to be implemented for future research purposes.

The researchers used a desktop computer powered by Microsoft Windows 10 Home with a hardware specification of a 3.6 GHz processor, 12 GB RAM, and a 500 MB free space drive. The researchers identified the needed software requirements to develop the Furnify mobile-based server by using the following software programs: Blender 3D, a free and open-source software. Blender is capable of supporting any type of 3D, which has the ability to model, sculpt, rig, and animate. The 3D artist made 3D furniture using Blender. Unity 3D is a cross-platform, animation-supporting game engine. The objective of employing Unity is to create augmented reality (AR) that enables purchasers to examine 3D furniture via a smartphone app. DOTweening is a free and open-source object-oriented animation engine made for Unity and designed primarily for C# users. It includes a multitude of smart features. C# (C Sharp) is a versatile programming language that can also be used to develop mobile applications and cloud-based services. Lastly, Adobe Photoshop is graphic design and image editing software created by

Adobe Systems. In addition to the potential to create beautiful images, Photoshop possesses a huge array of image-editing tools. Due to its reliability, Photoshop has become the standard for many creative professionals, and it is one of the first pieces of software that the majority of people learn to use.

The researchers designed the technique using the Storyboard, a visual representation of the diagrams of shot-by-shot evolution. It comprises parallelograms with visualizations or images portraying per shot of the mobile application user interface of the study, with remarks detailing the scene's action and dialogue during that shot. It is a graphic novel adaptation of writing [6] before it would be transformed into a working application.

As stated by Luciano, flowcharts may assist to discover the essential aspects of a process and give a broader perspective on the planning and creation process. It organizes tasks chronologically and by kind, such as method, decision, and data, among others [7]. When it comes to the creation and planning of a flowchart, it would be helpful for the researchers to identify the main phases and categorize the activities in order to identify them by process, data, decision, and other such categories.

A Tree Diagram is nothing more than a method of presenting a list of events in chronological order. In the field of probability, tree diagrams are especially helpful to the researcher since it would trigger a selection of AR and Catalog buttons to potential outcomes of room selection [8].

In order to create the application, the researchers identify the features of the application by transforming designed diagrams. In the main menu, there are four options. First is to set up their home using AR, which they would choose from furniture categories such as living room, bedroom, bathroom, dining and kitchen area, laundry area, and balcony. Each room has its own unique set of furnishings: the balcony has six (6) chairs, the bathroom has three (3) vanity cabinets, the bedroom has four (4) beds, the dining area/kitchen has six (6) chairs and one (1) cabinet storage, the laundry room has three (3) storage cabinets to organize the detergents, and the living room has two (2) bookshelves and seven (7) couches. Following

that, they can design and customize furniture based on materials, measurements, and sizes. The materials included narra, mahogany, birch, oak, marble, cotton, and silk. Users may modify the dimensions of the furniture by clicking the + (plus) or - (minus) buttons located in the measurement and sizes section. The Catalog button in the application has six (6) different types of furniture, and users can get a sneak peek at it by using the augmented reality camera to try out where the furniture will be placed in their homes. The Furnify application comes with a User Manual that explains how to use the application. (See Appendices A for the User Manual).

The Developer Testing and Beta Testing would be carried out by the researchers. In Developer Testing, researchers test their application on their smartphones. However, in Beta Testing, researchers would use Purposive Sampling, which comprises thirty (30) shoppers in a certain location, to test their application for them. Both phases of testing contain feedback.

During testing the application, the researchers would use the ISO25010 Software Quality Standard Criteria by choosing Functional Suitability, Usability, Compatibility, and Portability. Functional Suitability is evaluated through the following sub-characteristics: Functional Completeness refers to the collection of functionalities that addresses all of the tasks and user objectives provided. Functional Correctness refers to how successfully the application achieves the required outcomes with the required precision. Functional Appropriateness is the ability of functions to accomplish given tasks and objectives. Usability refers to how successfully, effectively, and efficiently the application could be utilized to attain specified goals. Compatibility pertains to how well the application can communicate information and perform tasks while operating in the same hardware and software environment. Portability refers to the ease with which the application can be transferred from one device to another.

In the gathering of data, the researchers conducted Developers Testing wherein the researchers themselves would test first their application and then took an online survey for them to rate the satisfaction of the application before undergoing and comparing it with beta

testing. The results gathered within it would be used for the comparison of the developers testing with the beta testing.

The study used Purposive Sampling as its sampling method, getting data from thirty specific individuals in a community who has knowledge about using smartphones and has at least a background in furniture and designing. In the gathering of data among the respondents, the researchers did Beta Testing with the use of Google forms for conducting and recording the survey. The researchers would use four of the ISO25010 criteria which were classified as Functional Suitability, Usability, Portability, and Compatibility. In getting the desired data, the researchers would use Frequency Distribution in getting the percentage and the mean score of the whole survey, which were classified afterward with the use of a Likert Scale that will show different representations of results that will be based on how the survey result would come out.

The application was deployed in the Google Play Store, where customers could download it and test it out on their mobile devices. The mobile application requirements for "Furnify: A Mobile-Based House Customization and Visualization Using Augmented Reality Technology" are Android 7 Nougat and later, excluding Huawei phones because Google's proprietary ARCore is not available on Huawei devices, and iPhone 6S or later for iOS.

Only 3D furniture models were covered in this study, the Bedroom, Living Room, Dining and Kitchen Room, Laundry Room, Bathroom, and Balcony since the furniture are mostly useful within these areas.

SYSTEM DEVELOPMENT METHODOLOGY

The researchers utilized the Modified Waterfall Model for developing high-quality software with well-defined methods. It consists of five management phases, including requirement analysis, system design, implementation, integration and testing, system deployment, and maintenance, with each step requiring the outcome of the preceding phase to continue. The waterfall technique is suitable for projects needing a high degree of predictability, such as software development, where the end result is well-defined before the project begins.

Steve McConnell presented the Modified Waterfall paradigm in 1996. The modified Waterfall model consists of the same phases as the conventional model, but it also permits phase overlap and project fragmentation. Due to the shortcomings of the original Waterfall model, the revised version was developed [54]. Dr. Winston W. Royce presented his Waterfall Model in a paper that was first published in the year 1970. Linear-Sequential Life Cycle Model is another name for the waterfall model, which may also be referred to as the standard waterfall model. This refers to the whole program being organized in a methodical fashion and is also known as the Strict Waterfall Model since the model is adhered to in an exacting way, much like a waterfall that flows down into a valley [55].

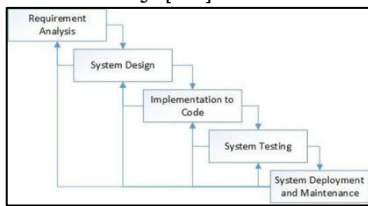


Figure 6. Modified Waterfall Model
(Source:

<https://www.researchgate.net/publication/323046269/figure/fig1/AS:631588777893891@1527593907166/Software-Development-Employing-Modified-Waterfall-Method.png>)

The Modified Waterfall Model focuses on the phases of software development as follows:

Requirement Analysis

The initial step was to understand what needs to be developed and its goal, function, etc. Here, the input, output, or final product specifications are checked and noted [56].

The researchers reformed their ideas through the help of online searching and watched Augmented Reality tutorials, and consulted with professionals to gather what requirements the system actually needed. The researchers identified the concept, design, and functionalities that the application would be having. Here is also the part where the researchers reassured the proper materials and ideas that the system application would be containing.

After obtaining the necessary resources, data, and information for the study, the researchers decided to conclude the following hardware and

software properties for the application's requirements:

Table 1. Hardware Requirements for Application Development

HARDWARE REQUIREMENTS	SPECIFICATIONS
CPU	AMD Pro A10-87506 R7
Hard Drive	500GB Storage
RAM	13 GB RAM
Graphics Card	12 Compute Cores 4C+8G

Table 2. Software Requirements for Application Development

SOFTWARE REQUIREMENTS	DESCRIPTION
Unity 3D	A platform for creating visual projects and games.
Blender 3D	A 3D platform program that enables to design, color, and sculpt 3D models.
Adobe Photoshop	A platform for pictures, objects, and image manipulation.
DOTweening	A program that works for the animations of buttons.
C#	A coding program wherein the structure of the application was created.

The following software was used by the researchers in the development of the application. First, Blender 3D was used to create and make furniture in the Balcony, Bathroom, Bedroom, Dining Room/Kitchen, Laundry Room, and Living Room. Second, the application's general structural development was conducted by the Unity 3D software. Third, DOTweening is the process of animating the application buttons. Fourth, Adobe Photoshop was used to edit the application buttons to make the design more appealing to the customers. Finally, the program was created in C# (C Sharp).

System Design

This phase examines the first phase's need specifications and prepares the application design. Application design contributes to the determination of the overall application architecture as well as the hardware and system requirements. Currently, software code is being developed [57].

After gathering ideas and resources, the researchers explored the overall possible structure of the application and hereby explain the official tools to be used for the creation of the system (Blender 3D, Unity 3D, Adobe Photoshop, DOTweening, and C#). The researchers are of course certain that the stated software would all be used for the progress of the application.

During the application development, the researchers used a Storyboard, Menu Tree Diagram, and Flowchart as the following diagrams in following the process of creating the mobile application. The storyboard depicts the planned interface of the application along with its navigations, buttons, panels, and controls, these portray the overall structure of the app development. Menu Tree Diagram was the tool to be used in portraying the function of the system since its branching properties were applicable to the foundation of the application, example when a specific interface in the application, the user can navigate to different buttons which can lead them to another set of user interfaces. In addition, the Flowchart was where the developers follow a specific process of data gathering diagram along with the flow of instructions with it.

Implementation to Code

Initially, the application is divided into units, which are then integrated into the subsequent phase based on application design feedback. Unit testing is the process of developing and evaluating the functioning of each unit [58].

With the resources gathered and the official software to be used all in line, the researchers started to develop and create the application utilizing the materials they gathered. Blender 3D was used for the creation of furniture models and structures. Unity 3D for the construction of the overall application and the location where the application would be connected as a mobile application to be subsequently placed on the Google Play Store.

Adobe Photoshop was used for the designs and editing of the images into different faces and how the UI of the application would look like. DOTweening is used for the animation of the object-oriented keys such as the interactive panels and buttons for the application. Lastly is the C# (C Sharp), wherein it was the coding software that was used by the researchers in making the application.

When it comes to an application, a collection of sequential drawings known as an animation storyboard is used to outline how the program functions. These drawings may contain the movement of the camera, speech, and other features that are relevant to the application. The flowchart diagram illustrates the order in which the process is necessary for the application to be completed. The movement of the application process is represented here by these forms, which are related to one another by arrows and lines. The tree diagram has branches each representing a different possible outcome to ensure that the application is functioning properly. The tree diagram also makes it easy to visualize the problem because it represents the possible outcomes of the application. These diagrams are helpful tools that may assist in better comprehending the information that is related to the application.

The major features of the application include the ability to decorate their house using augmented reality furniture, which comes in a variety of categories such as balcony, bathroom, dining and kitchen room, laundry room, and living room. In each category, there are a variety of pieces of furniture from which customers can select the pieces of furniture that best suit their needs. Following this, the customer is able to create and customize the customer's furniture based on the materials, dimensions, and other specifications that the customer provides. A variety of materials, including narra, mahogany, birch, oak, marble, cotton, and silk, were used in its design.

System Testing

After each unit generated during the implementation phase has been tested, the entire system is merged. Continuous software testing is necessary to detect defects and errors in a program. It is tested to ensure that the client has no problems installing the software [59].

With the application in progress, the process of testing was done by researchers through Developer and Beta Testing. Developer Testing was where the researchers tested their applications on their smartphones and in Beta Testing, the researchers use Purposive Sampling which included thirty (30) shoppers within an area to test their application for them. The survey had taken for two (2) days to further give time to those who are willing to test the application. Feedback is also included in both testing phases.

The researchers used the ISO25010 Software Quality Standard Criteria by choosing Functional Suitability, Usability, Compatibility, and Portability. These criteria were the most important in achieving the needed outcome while testing the application. With the use of Purposive Sampling, the researchers used the Likert Scale as the data-gathering tool along with frequency distribution as the statistical used in computing the percentage and mean of the data being computed.

Computing for the percentage is where it only includes every respondent that answered “Yes” on the survey. To get the mean score, the researchers added all of the results from the percentage then the result was indicated as the numerator, while the number of percentage results computed were placed on the denominator, then by dividing both the numerator result and the denominator comes the mean score. By following these statistical methods, the researchers determined the result of the survey by the use of the Likert Scale.

Table 3. Likert Scale

PERCENTAGE	VERBAL INTERPRETATION
81-100	Excellent
51-80	Good
41-60	Moderate
21-40	Very Low
0-20	Extremely Poor

The mean score that was shown as the result determines the rate of the respondents by looking at the Likert Scale.

System Deployment and Maintenance

The feedback and ratings for the application determined the overall function of the application. This started the maintenance

wherein the researchers would follow suggestions and receive bug reports from a number of users for the improvement and further development of the application in the future.

The researchers uploaded the application to the Google Play Store in order for customers to be able to install it and test it on their own smartphones to design their preferred furnishings. Customer feedback is significant since it provides a foundation for the application's advancement.

RESULTS AND OUTCOMES



Figure 10. User Interface and Navigation Controls

The screenshots show the user interface and navigations of the application, which consists of an AR Camera and a Catalog that includes a Balcony, Bathroom, Bedroom, Dining Room/Kitchen, Laundry Room, and Living Room.

Beta Test Administration



Figure 11. Survey Photos

These are images of people who agreed to be Beta Testers for the Furnify application. They used the application on their smartphones to test whether or not the application was functioning properly.

Beta Test Results

Table 4. Summary of Beta Testing

CRITERIA	PERCENTAGE	INTERPRETATION
Functional Suitability	98%	Excellent
Usability	98.2%	Excellent
Compatibility	94.6%	Excellent
Portability	96.2%	Excellent
Total Result	96.8	Excellent

The researchers conducted the survey online with the use of Google forms for the recording of answers and data. Since the study is about augmented reality and visualization of furniture with the use of an android device, the researchers decided to use of Google forms in conducting the survey along with the link attached to it that leads to the application's APK that can be downloaded through the Google drive.

In getting the percentage and mean score of Functional Suitability, Usability, Compatibility, and Portability, with the use of Frequency Distribution as the statistical tool, the researchers gathered all the data results of the survey on each category, then with each category, they added up every number outcome that answered the "Yes" option since they are aiming for the respondents' devices that the application worked, then the researchers divided the number by thirty (30) since the respondents needed for this survey consists of thirty (30) individuals then multiplying the outcome by one hundred to get the percentage needed result.

Finally, the percentage results for each question were completed, and the mean score was now able to take part by adding all percentages and then dividing them by five (5) since the questions for every category consist of five (5) questions. The result showed the mean score for that category.

In getting the mean score criteria for the whole survey, the researchers simply added every mean score from each category and then divided it by four since the categories used to consist of four, finally revealing the final outcome of the computation which is "96.8" and by looking at the Likert Scale, the result had fallen to the Excellent category, which means that the application had given excellent satisfaction with the respondents. This means that the application had given the best outcome to the beta testers, which gave them the judgment of the application as excellent from the criteria.

The Usability criteria was the highest rated result among the four criteria set by the researchers. It garnered an overall mean percentage of 98.2 percent with a verbal interpretation of "Excellent". This means that the beta testers have found out that the application was easy to learn and understand. Also, testers noted that the font and text color was readable.

In terms of the criteria with the lowest rated result, the Compatibility criteria garnered the score of 94.6 percent but when looked and compared it to a Likert Scale, it still falls on the excellent category. Although it already had shown as successful, the fact that two (2) or three (3) of the respondents that issued the application as it was lagging was still a problem to be taken care of, that is why the researchers continued to do maintenance on the application so that it can lessen or even remove the issues that caused the respondent's phones to lag when using the application.

Application Deployment at Google Play Store

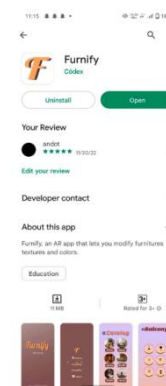


Figure 12. Uploaded application at Google Play Store

The image shows Furnify being installed on the Google Play Store, where users may download the application to their mobile devices and then evaluate it based on how satisfied they are with the features of the application.

DISCUSSIONS

This section consists of the summary of findings, conclusions, and recommendations based on the results of the study of Furnify: A Mobile-Based House Customization and Visualization using Augmented Reality Technology.

Summary of Findings

In order to achieve the mobile-based platform of Furnify, the researchers searched every possible hardware and software requirement that the project needed. The researchers utilized a desktop computer running Microsoft Windows 10 Home with a 3.6 GHz processor, 12 GB RAM, and a 500 MB free space drive for hardware requirements, and software requirements that the application needed, along with this, the researchers brainstormed every idea by searching online, asking professionals, and even watching Augmented Reality tutorials. With the use of Blender 3D, UNITY 3D, and Adobe Photoshop, the researchers created the overall design of the application while DOTweening and C# were used for the coding and structure of the application. The researchers have used Storyboard, Flowchart, and Menu Tree Diagrams as a designing tool in order to construct a process for the application, before it would be transformed into a working application.

The created application has an AR Preview and Catalog where the users can choose what type of furniture they want to customize: whether the Balcony, Bedroom, Dining Area/Kitchen, Laundry Room, and Living Room. Each home section has a different type of furniture, that users can customize and design based on materials included narra, mahogany, birch, oak, marble, cotton, and silk. After that, they can modify the dimensions of the furniture by clicking the + (plus) and – (minus) buttons.

Once the researchers are done in building the application, they conducted Developers and Beta Testing afterward. During the survey period, the researchers followed the process of

ISO25010 in which they had chosen Functional Suitability, Usability, Compatibility, and Portability as the processes. The researchers formulated 5 different questions that depend on the qualities of each category and they let the testers including themselves take the online survey questionnaire. After the survey, the researchers compiled the results of the survey form and prepared for the computation of the statistical treatment to be used which is the Frequency Distribution. Since the researchers used Purposive Sampling as their sampling method, this consisted of thirty (30) shoppers at a certain place to test the application can understand the function of the application, and with that, the researchers computed the results of both the Developers Test and the Beta Test, which had previously been classified as "Excellent" with the use of the Likert Scale, rendering the results as successful. The results garnered within the beta testing had shown 94.6 percent and were marked as excellent together with the developers' testing also gathered 85.08 percent with the same result as the beta testing. With the project being complete, the researchers had the file uploaded to Google Play Store, later on, to be further tested and maintained.

Conclusion

The researchers created this mobile application by using Augmented Reality, Augmented reality is a technology that enhances reality. In other words, augmented reality allows users to view the actual environment. Using this Furnify mobile application, users may preview their chosen furniture in reality, where they can locate their furniture in a specified location, and they can customize and design the furniture they want.

Achieving this mobile application will benefit furniture store managers and customers feel more at ease when shopping for furniture in person, avoiding hassle and overcrowding. Finally, the Developer and Beta Testing results show that the application complied with the requirements. Therefore, with all the evidence, the researchers concluded that the overall objectives of the study and application acceptance was achieved.

Recommendations

For future researchers who wish to take part in developing an augmented reality application or

even for furniture designing, they can use this study as a reference for their own studies.

The researchers recommend the following:

1. Adding different types of furniture.
2. Adding more texture options.
3. Adding more materials.
4. Improve the User Interface and Buttons.
5. Improve the animations of the application.
6. Further improve its navigations.
7. Adding user account system.
8. Applying a data-saving system.
9. Adding a camera shooting system for image saving just in case the furniture from the application would be used for purposes.

REFERENCES

- [1] CASA DECOR. 2021. The Psychology Of Interior Design. <https://www.casadecor.co.in/blog/the-psychology-of-interior-design>.
- [2] DENNIS DELA CRUZ. 2018. Design and Development of Augmented Reality (AR) Mobile Application for Malolos' Kameztizuhan (Malolos Heritage Town, Philippines). https://www.researchgate.net/publication/329067299_Design_and_Development_of_Augmented_Reality_AR_Mobile_Application_for_Malolos'_Kameztizuhan_Malolos_Heritage_Town_Philippines.
- [3] PAUL FARLEY. 2021. Ready for the AR revolution?. <https://www.furniturenews.net/resources/articles/2021/12/1570716103-ready-ar-revolution>.
- [4] YI FU & WENMING LIU. 2022. Application of computer modeling technology in future design. <https://www.spiedigitallibrary.org/conference-proceedings-of-spie/12168/1216803/Application-of-computer-modeling-technology-in-furniture-design/10.1117/12.2631175.short?SSO=1>.
- [5] CARLO H. GODOY JR. 2021. Augmented Reality for Education. <https://arxiv.org/abs/2109.02386>.
- [6] VYOND TEAM. 2022. What Is A Storyboard And Why Do You Need One?. <https://www.vyond.com/resources/what-is-a-storyboard-and-why-do-you-need-one/>.
- [7] LUCIANO, RILA. 2021. What is the significance of a flowchart?. <https://www.ucl.ac.uk/culture-online/ask-expert/your-questions-answered/what-significance-flowchart-updated#:~:text=When%20designing%20and%20planning%20a>.
- [8] STU CORK. 2019. An Introduction to Tree Diagram. <https://nrich.maths.org/tree-diagram-intro>.
- [9] HOSCH, WILLIAM L. 2022. Augmented reality. <https://www.britannica.com/technology/augmented-reality>.
- [10] FUTURELEARN. 2022. What is 3D modeling and what is it used for?. <https://www.futurelearn.com/info/blog/general/what-is-3d-modelling>.
- [11] KUKICH, DIANE S., VENABLES, JOHN D., GIRIFALCO, LOUIS A., MARCHANT, ROGER ERIC., McCULLOUGH, R.L. AND PATEL, C. KUMAR N. 2022. Material science. <https://www.britannica.com/technology/materials-science>.
- [12] BRITANNICA, THE EDITORS OF ENCYCLOPEDIA. 2022. Texture. <https://www.britannica.com/art/garden-and-landscape-design/Line>.
- [13] TECHNOPSIS. 2019. What Does Rendering Mean?. <https://www.techopedia.com/definition/9163/rendering>.
- [14] INDEED EDITORIAL TEAM. 2020. What Is User Interface (UI)?. <https://www.indeed.com/career-advice/career-development/user-interface>.
- [15] EILAND, MURRAY L. 2022. Rug and carpet. <https://www.britannica.com/technology/rug-and-carpet>.
- [16] GROOVER, MIKELL P. 2022. Automation. <https://www.britannica.com/technology/automation>.
- [17] MICHAEL GIRNYAK. 2021. Augmented Reality Presentation in Furniture and Design Sales. <https://postindustria.com/augmented-reality-presentations-in-furniture-and-design-sales-ar-furniture/>.
- [18] ADAM HAYES. 2020. Augmented Reality. <https://www.investopedia.com/terms/a/augmented-reality.asp>.
- [19] MICHAEL E. PORTER & JAMES E. HEPPELMANN. 2017. Why Every Organization Needs an Augmented Reality Strategy. <https://hbr.org/2017/11/why-every-organization-needs-an-augmented-reality-strategy>.
- [20] JESSICA BENNETT. 2020. Augmented Reality Makes Finding the Perfect Furniture So Much Easier. <https://www.bhg.com/news/augmented-reality-home-shopping/>.
- [21] K. BELL. 2022. Pinterest adds augmented reality furniture shopping to its app. <https://www.engadget.com/pinterest-furniture-augmented-reality-150002511.html>.
- [22] SHERRY HOLETZSKY. 2022. What is Custom Furniture?. <https://www.homequestionsanswered.com/what-is-custom-furniture.htm?fbclid=IwAR3UFl-avCT3DJjd3QKoDhOnTgxtG7B3DP0wKAFBG-58JQGju1P5h5CgWc#:~:text=Custom%20furniture%20is%20furniture%20th>.

- at,wood%2C%20stain%2C%20and%20fa
bric.
- [23] ANKITA. 2018. How Important is Furniture for a House.
<https://www.planndesign.com/articles/3077-how-important-furniture-house>.
- [24] ANTONIO. 2020. Importance of Furniture In Our Life. <https://avantifurniture.net/importance-of-furniture-in-our-life>.
- [25] BRIAN ANDERSON. 2017. The importance of the furniture in our daily life.
<https://www.linkedin.com/pulse/importance-furniture-our-daily-life-brian-anderson>.
- [26] ASPIRE DESIGN AND HOME. 2018. Why Furniture Is Important In An Office.
<https://aspiremetro.com/why-furniture-is-important-in-an-office/>.
- [27] THE FURNITURE PEOPLE (TFP). 2020. Why Is Important.
https://www.tfp.mu/index.php?route=blog/article&article_id=25.
- [28] ABE ABBAS. 2019. Top 12 Reasons To Buy Furniture.
<https://www.thespruce.com/top-reasons-to-buy-furniture-1391207>.
- [29] TARA MASTROENI. 2021. Why Furniture Matters Most When Redesigning A Room.
<https://www.mymove.com/home-inspiration/decoration-design-ideas/why-furniture-matters-most-when-redesigning-a-room/>.
- [30] EMILY RODRIGUEZ. 2020. Stylistic and decorative processes and techniques.
<https://www.britannica.com/technology/furniture/Stylistic-and-decorative-processes-and-techniques>.
- [31] EDUARDO SOUZA. 2020. Technologies Impacting Furniture Design and Manufacturing.
<https://www.archdaily.com/938308/4-technologies-impacting-furniture-design-and-manufacturing>.
- [32] ARSALAN. 2021. What is 3D Furniture Modeling?.
https://it-s.com/what-is-3d-furnituremodeling/?fbclid=IwAR20EUfBoSCptJmlaMSPqCEn_Yd2ZzldmAc_cSPSBYlr9CIEDHA6NDh6Drr0.
- [33] RYAN CHADWICK. 2022. Create Powerful Storyboards – Software Design and Development.
<https://ryanstutorials.net/software-design-and-development/storyboards.php>.
- [34] ASANA. 2022. What is a Flowchart? Symbols, Types, and How To Read it.
<https://asana.com/resources/what-is-a-flowchart>.
- [35] VAGISHA ARORA. 2021. What is a tree menu?.
https://www.planetcrust.com/what-is-a-tree-menu?utm_campaign=blog.
- [36] RYAN. 2022. What is Blender Software?.
<https://www.idtech.com/blog/what-is-blender-software>.
- [37] LINDSAY SCHARDON. 2022. What is Unity? – A Guide for One of the Top Game Engines.
https://gamedevacademy.org/what-is-unity/#What_is_Unity.
- [38] KATIE TERRELL HANNA. 2022. Photoshop.
<https://www.techtarget.com/whatis/definition/Photoshop>.
- [39] REHTSE STUDIO. 2022. Made With Unity | DOTween: `DOFillAmount()`.
<https://rehtse-studio.medium.com/made-with-unity-dotween-dofillamount-f3a7e2beac1c>.
- [40] MAHESH CHAND. 2020. What is C#?.
<https://www.c-sharpcorner.com/article/what-is-c-sharp/>.
- [41] KASSIANI NIKOLOPOULOU. 2022. What Is Purposive Sampling? | Definition & Examples.
<https://www.scribbr.com/methodology/purposive-sampling/>.
- [42] JILL BRITTON. 2021. What Is ISO 25010?.
<https://www.perforce.com/blog/qac/what-is-iso-25010>.
- [43] STEPHANIE ELLEN. 2020. Slovin's Formula Sampling Techniques.
<https://sciencing.com/slovins-formula-sampling-techniques-5475547.html>.
- [44] LEMKE GILLIAN. 2018. The software development life cycle and its application.
<https://commons.emich.edu/cgi/viewcontent.cgi?article=1588&context=honors>.
- [45] actiTIME. 2022. Waterfall Model: What Is It, When and How to Use It?.
<https://www.actitime.com/project-management/what-is-waterfall-model#what-is-modified-waterfall-mod>.
- [46] W RAMADHAN et al. 2021 IOP Conf. Ser.: Mater. Sci. Eng. 1098 062008.
<https://iopscience.iop.org/article/10.1088/1757-899X/1098/6/062008/pdf>.
- [47] S. MATSUTOMO, K. MITSUFIJI, Y. HIASA and S. NOGUCHI. 2013 "Real Time Simulation Method of Magnetic Field for Visualization System With Augmented Reality Technology," in IEEE Transactions on Magnetics, vol. 49, no. 5, pp. 1665-1668, May 2013, doi: 10.1109/TMAG.2013.2240672.
<https://ieeexplore.ieee.org/abstract/document/6514792>.
- [48] FUCHS, H. et al. (1998). Augmented reality visualization for laparoscopic surgery. In: Wells, W.M., Colchester, A., Delp, S. (eds) Medical Image Computing and Computer-Assisted Intervention — MICCAI'98. MICCAI 1998. Lecture Notes in Computer Science, vol 1496. Springer, Berlin, Heidelberg.
<https://doi.org/10.1007/BFb0056282>.
- [49] ZORNITZA YOVCHEVA, DIMITRIOS BUHALIS, CHRISTOS GATZIDIS. 2012. Overview of Smartphone Augmented Reality Applications for Tourism. e-Review of Tourism Research (eRTR), Vol. 10, No. 2, 2012.
https://eprints.bournemouth.ac.uk/20219/1/eRTR_SI_V10i2_Yovcheva_Buhalis_Gatzidis_63-66.pdf.

- [50] https://play.google.com/store/apps/details?id=fr.moblo&fbclid=IwAR2C1dJR-VblCQ8sBp0t_o04muH-yFlgGExGIS7u0veIWIESOnHuwb2GQr_s&pli=1.
- [51, 53] TRIVEDI & DUBEY. 2020. A Survey on Augmented Reality and its Applications in the field of Interior Design. https://www.researchgate.net/publication/341566479_A_Survey_on_Augmented_Reality_and_its_Application_in_the_Field_of_Interior_Design.
- [54] actiTIME. 2022. Waterfall Model: What Is It, When and How to Use It?. <https://www.actitime.com/project-management/what-is-waterfall-model#what-is-modified-waterfall-mod>.
- [55] SMARTIQHUB. 2021. What is Waterfall Model? Modified Waterfall Model. <https://www.smartiqhub.com/what-is-waterfall-model-modified-waterfall-model/>.
- [56, 59] SHARMA & SINGH WATERFALL MODEL. 2021. <https://www.toolsqa.com/software-testing/waterfall-model/#:~:text=The%20waterfall%20model%20is%20a,Production%2FImplementation%2C%20and%20Maintenance>.

HUMANA CORPUZ: 3D Simulation of the Human Anatomy

John Ryan Anunciacion

Alliana Marie Flora

Jerickzon Lumanlan

Seiya Watanabe

Engr. Ernie Lee E. Pineda, MIT (Technical Adviser)

The main objectives of this study is to establish a simulation based mobile application that has a feature such as a puzzle mode where students and casual users can play to enhance their knowledge on body parts associated with human anatomy and interactive mode where users can interact with the body parts at the same time providing them facts and definition of the topic. The methodology used in this study is modified waterfalls wherein the researchers will develop the mobile application through series of systematic planning and development where the researchers can improve the ongoing mobile application, they are producing based on ISO 25020. The outcome was that the researchers was able to determine that there is a significance on the mobile app they developed based on the reviews and answers of the respondent on their beta testing. The application was useful into providing relevant visual context that a textbook cannot provide, furthermore, the result of the development of the application was to be used by students that seek information and definition about human anatomy and the researchers was able to implement relevant information and content inside the mobile application.

INTRODUCTION

Technology development has a positive outcome into human lives specifically on the capabilities of improving innovation in the field of professional education of human anatomy. Through collaboration of humans and the existing technology, applications and software are produced to enhance the capabilities of humans to conduct research as well as establishing a formal platform into providing input on scientific knowledge and discovery. [1] Technology has been used for millennia in various fields, although application of technological advancement in human anatomy and the medical field in general is still in the developmental phase [2]. The use of and development of mobile applications is a new and quickly expanding sector. Mobile applications have a global positive influence. Using mobile applications in affluent countries are becoming more accessible, while people and societies in poorer countries are upgrading and creating new types of IT infrastructures. [3] Amid the COVID 19 Pandemic, technology is the field that serves the community of education and information about the crisis that has happened. Technology was used by the government and local government units to establish and create a platform informing the

general public about the ongoing relief program and provided information on how to avoid and make less chances of having viruses at the time. Which means the government relied on using emerging technologies to disseminate health care information as it is the fastest and most convenient way for the public to access. Infographics and community guidelines were distributed using digital technology to maximize its capabilities in providing useful information to the public. [4]

Meanwhile, branches of science are variously studied for a millennium, but most of its knowledge is engaged and provided in limited forms of qualitative books with the advent of providing the same understanding of science, but the problem is, it is being hindered by the platform used, as textbooks usually have limited form of providing accurate data and context, as it is generally limited into providing illustrations.

With the rapid and increasing growth of technology in the digital era. In line with this, a capstone study name Humana Corpuz is planned to be developed and the researchers aim to develop a mobile application that will provide and transcend a branch of science which is called "Human Anatomy" into an information and learning approach that will

have the capability of providing information and general knowledge associated with the topic of human anatomy.

Researchers are aiming into taking advantage of the existing platform of knowledge established on human anatomy and bridge it using a mobile application as a platform of providing users can access and way of having the information projected not just what the textbook provides but also provide a simulation like experience to have further understanding of human anatomy. Researchers are also aiming to take advantage of the puzzle-based type of approach and transcend it to the mobile application as a mode where users can enhance their understanding of the placement and structure of the human anatomy.

General objectives of the study

The primary objective of this study is to show the emergence of the simulation in practicing and improving the knowledge of users in Human Anatomy and their spatial and visual attention skills.

In line with this, the study aims to achieve the following specific objectives:

1. To gather related literature and studies relevant to the topic through research.
2. To identify the hardware and software needed to meet the requirement to develop the mobile application
3. To design the application using analysis tools.
4. To create and develop a mobile application.
5. To test and evaluate the mobile application's quality characteristics as specified in ISO / IEC 25010 using test cases.
6. To deploy the mobile application to the market.

Scope and limitations

The researchers will gather data and conduct research associated with human anatomy. They need to determine what is the current state of human anatomy as a branch of science and its background, specifically on how it is being defined in a societal context and educational field, COVID-19 plays a major part in this study because of the recent changes in the field of studying and information gathering. A major role of this study is to gather accurate information on how human anatomy is being discussed or learned, to produce an accurate

application that has the relevant needs of the users.

The researchers need to determine the specific hardware and software needed to meet the application's requirements based on ISO 25010. The software needed to produce the application needs to meet the requirement of the hardware specification.

The researchers need to design analysis tools to determine the strengths, weaknesses, opportunities, and possible threats to the study. In this way, the application can be studied further and the researchers can determine where to improve.

The researchers will develop a mobile application called Humana Corpuz that would be based on the data and research gathered, in this way, a relevant mobile application timely needed would be developed.

The researchers will develop a mobile application that has 2 main features. The first one is the Puzzle mode, where the users or the student can have the capability to enhance their knowledge of the body parts associated with human anatomy by drag and drop feature on the puzzle mode. The second main feature would be the view interactive mode where the users can access specific body parts and will be provided with information regarding specific body parts and users or students will have the capability of rotating the body parts to have deeper context on what it looks like.

The researchers would collaborate with IT associates to conduct alpha testing. To meet the current standard and requirement of ISO / IEC 25010. Beta testing would also be conducted with a specific group of people to also meet the user's needs. The researchers will use the Random sampling method since the target demographic for the respondent of this study are students that are taking human anatomy as their subject and program.

From high school to college students and general casual users who seek information regarding human anatomy. The statistical treatment used in this study would be the mean score as the significance of the relevance is based on the metrics or score the users and testers would provide.

After following through with guidelines and standards, the researchers will deploy the mobile application on the market through

Google Play Store, and will be available on Android devices.

SYSTEM DEVELOPMENT METHODOLOGY

This section shows the methodology used for the development of the application. There are also different processes involved in the development of the project, each of the phases is shown in the diagrams included in this section with their explanation of the processes to further explain the process done by the researchers into creating the mobile application.

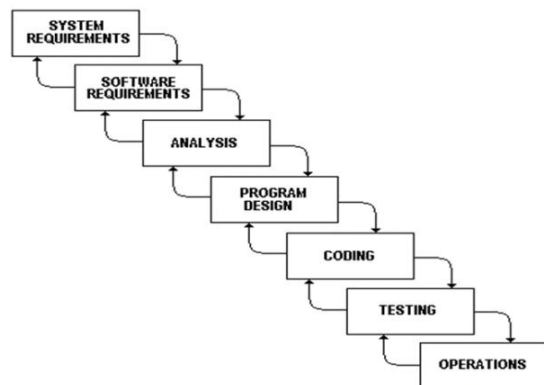


Figure 6: Modified Waterfall Model

The waterfall model is a sequential design process that is frequently used in software development processes. It depicts progress as flowing smoothly downwards (like a waterfall) through the phases of System Requirements, Software Requirements, Analysis, Program Design, Coding, Testing, and Operations. Multiple problems were encountered using the old format of Waterfall model, there are times where the objectives are redundant to certain aspects of system or application development. The researchers concluded to use modified waterfall as their primary methodology in developing the mobile application.

System Requirement

The researchers will gather information and data associated with the software development tools that will be used in order to check and meet the standard requirements of the software tools into the hardware specification of the computer that would be used in developing the mobile application.

Analysis

The researchers will proceed on gathering data, information, analytics, and other associated activities in order to find relevance and evidence in order to establish proper development of the application. The researchers have already gathered preliminary data on the topic from the internet and other studies. The researchers came up with the idea to use human anatomy as the fundamental concept for the mobile application. The researchers began by obtaining data from relevant studies and reliable articles on the internet that were used as a reference. The researchers then met with the adviser to determine specific needs needed to develop and conceptualize the project.

Program Design

The researchers planned what would be the flow and the design of the mobile application. The researchers want the application to be user friendly, so the app would only show the important aspect of the application such as what mode the user wants to do.

Coding

The researchers will create an analysis tools that would be used as a visual context of what would be the processes that will be implemented on the mobile application, specifically a flowchart would be designed (See Appendix E). The researchers will use Visual Studio in writing the codes and developing every functionality that was decided to be implemented on the mobile application.

Testing

The researcher will release a prototype of the mobile application to ensure that the program and animation inserted in the application are fully functional during the testing phase. The researchers will collaborate with alpha testers in order to check if the required standards will be met. The testing case used in this research will be based on the standards of ISO 20510. In addition, the researchers will conduct a survey on who will be beta users of the application, users will provide their feedback after they use the application. A beta testing form will be provided and will be answered and will be used as data in completing and enhancing the mobile application's standard.

Sampling Method

The researchers and their adviser came up with the decision to use a simple random sample for this study. The mobile application itself has a general information in terms of human anatomy which is a fundamental topic student takes on their programs, hence, using random sampling for this study would ensure high validity of randomization in order to have generalize outcome for the betterment of developing the application and reduce the chances of impacting uncertain variables. The method will be straightforward and will focus on students in high school and college. Furthermore, the researchers will conduct alpha and beta testing in order to take a brief look at the improvement and the current state of the development of the mobile application.

The following tables are interpretations of that would need to be met for the application to be successful based on the characteristics of ISO 25020 and the objectives that were set in the beginning of this study.

Alpha Testing Frequency Distribution

The researchers collaborated with alpha testers that will use and try the mobile applications and will check its quality based on the standard and characteristics of ISO 25010.

Table 1: Alpha Test Results Interpretation

Content	Verbal Interpretation
90.00% - 100.0%	Excellent
80.00% - 89.00%	Very Good
60.00% -79.00%	Good

Table 2: Beta Testing Frequency Distribution

The researchers will conduct beta testing through its respondent of students who are proven through research will use this type of application most of the time. A survey is also going to be provided in order to determine the current state of the mobile application in perspective of general users.

Content	Verbal Interpretation
4.01 - 5.00	Very Feasible
3.01 - 4.00	Feasible
3.01 - 4.00	Less Feasible
1.00 – 2.00	Inappropriate

Operations

The researchers will release the mobile application via Google Play Store and will be available on android mobile devices. The researchers were able to provide accurate data that are relevant to the outcome of the mobile application. The researchers are successful on developing the mobile application that was agreed to be a simulation based on human anatomy. The main feature of the application is Puzzle Interactive Mode and View Information Mode which are both implemented properly on the application. Puzzle Interaction is a mode where users can have the ability to challenge their knowledge on the positioning of the body parts through a mode of puzzle. View Information is another mode developed by the researchers, the users will have access to general information about the branches of human anatomy, it will also have a simulation like experience where each body part will be shown that are interactive and users can rotate and see its detailed look. The researchers are able to produce an application that was alpha and beta tested using ISO 25010, in addition, the researchers were able to meet the panelist recommendation on the application's standard and features.

Developer Testing

The researchers conducted different methods of testing throughout the development based on the scale and quality of ISO 25010. Based on the suggestion of the adviser of the researchers. They will conduct an alpha testing that would be tested by IT Experts or certified individuals. Beta testing would be also conducted through a form of survey consisting of a specific group of high school and college students who are taking science programs, 20 random students would be testing the usability of the application.

RESULTS AND OUTCOMES

This section discusses all the researchers' findings and discussions. Displaying all user requirements, from software to hardware, with data analysis grouped into tables, giving meaning to the data, explaining its significance, and connecting the data to a larger context.

The researchers were able to gather related studies and related application that was used to established and create the mobile

application such as related studies associated with the software and application that were used during covid-19 pandemic, software developmental tools used on the application was briefly studied as well in order to have a deeper context on how to develop the mobile application. Human anatomy was a significant contributing aspect of this study since it will revolve around this aspect or branch of science, therefore, its system and associated structure inside general science was studied by the researchers as well.

The researchers aimed into gathering enough information to meet the standard of the hardware specification requirements of the software development tools that would be needed in order to develop the mobile application.

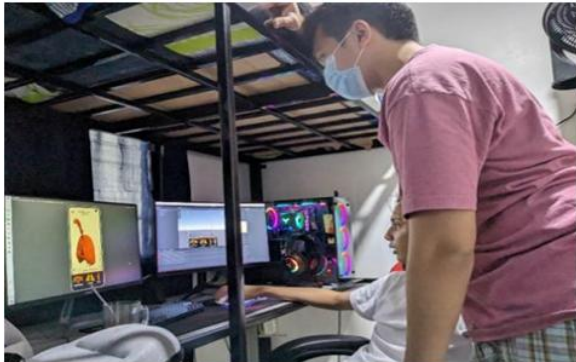


Figure 7

The researchers are on the developmental phase of the application. The researchers were able to create the main feature of the 3D objects being able to have a rotation, furthermore, the objectives set on the study such as information, interactive mode, & puzzle was implemented throughout the developmental phase.

The researchers were able to meet the design they created using system analysis tools. The researchers were able to develop the mobile application using the software developmental tools planned to be used on developing the mobile application.



Figure 10: Blender

This figure shows the Blender software. A 3D-building Software that the researchers used to create the object and other assets of the application. In this illustration the researchers are developing a 3d object for a body part that would be displayed on the mobile application. The researchers created 3D objects which is one of the fundamental functionalities of the mobile application. The first main feature of the mobile application is the view interaction mode where the users can Description of every parts of the human anatomy was displayed.

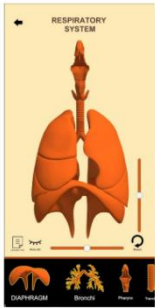


Figure 11: View



Figure 12: Description

The researchers were able to implement a puzzle interactive mode on the application which consist of body parts being drag and drop throughout the gameplay.



Figure 13: Puzzle



Figure 14: Trivia

The researchers were able to collaborate with the alpha testers to validate the mobile application’s quality based on ISO 25010. Beta testing was also conducted based on the responded of the study. Beta users were given a chance to test and provide feedback of what they have thought of the mobile application.

Table 3: Alpha Test Results

The researchers were able to meet the standard of ISO 25010 into the mobile application they developed.

Content	Results	Verbal Interpretation
1. Functional Sustainability	66.67%	Good
2. Usability	100%	Excellent
3. Portability	100%	Excellent
4. Reliability	100%	Excellent
Total	91.66%	

The alpha testing was provided with 91.66%, which means that the application was able to meet an excellent standard in terms of its usability. The lowest contributing factor to the alpha testers is that the application was not able to run on other operating system yet, the mobile application was designed to run on mobile application. It was provided by the alpha tester of a total of 66.67%, which means this is the lowest contributing factor on the mobile app and that is not supporting different operating system yet.

Meanwhile, the highest contributing factor on the mobile application passing the standard of ISO 25010, having a total test results of 100% under usability, portability, & reliability, which means the mobile application was able to run on android mobile devices without any hiccups based on the standard set on ISO 25010.

Beta Test Results

The researchers were able to conduct beta testing through a survey from the respondents which range from high school to college students and casual users in general. The users were able to use the mobile application based on the objectives that was set by the researchers.



Content	Results	Verbal Interpretation
1. Was the application useful?	4.5%	Very Feasible
2. How would you rate the information provided on the application?	3.8%	Feasible
3. How would you rate the puzzle feature?	4.5%	Very Feasible
4. Was the UI easy to use?	4.7%	Very Feasible
5. How would you rate the experience?	4.4%	Very Feasible
Total	4.38%	

The researchers were able to create an application that is relevant for its specific demographic and purpose. The beta testing was provided with 4.38%, which means the mobile application was able to meet a feasible standard for the users. The lowest contributing factor on the beta testing results is under information provided inside the application, gaining 3.8% from the respondent. It is still relatively high, considering the interpretation is still under decent mean score, meaning the information provided on the mobile application was feasible in nature.

The highest contributing factor on the scale is under user interface gaining 4.7% from the users, this indicates that the application was easy to use as what the researchers are intend on developing the application at the first place. Both usefulness and puzzle feature gained 4.5% which means there is significance and relevance on producing the study since users themselves are gaining what the application is intended to provide which is information associated with human anatomy. The experience of the users was feasible as it was provided with a mean score of 4.4% which means the experience using the application was easy. The user interface design is the sole accountable for having a friendly user. The researchers were able to upload the mobile application to the market through Google Play Store.

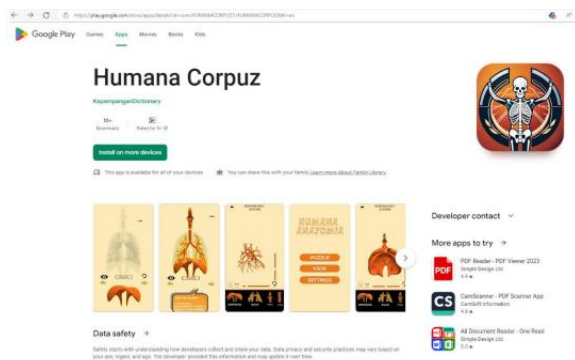


Figure 15

DISCUSSIONS

This section summarizes the study's findings, the implications formed from these findings, and the suggestions provided by the researchers based on the findings. This study was the tested performance of the application perceived and concluded by the researchers.

The essential objective of this study is to develop a mobile application that would provide information and knowledge associated with human anatomy. The developed application was aimed to hone the existing platform on the intervention of knowledge and information on emerging technology. The researchers mainly focused on developing an application that can be used on accessing information using a mobile application.

Section one and two mainly focused on gathering data and relevant studies associated with human anatomy. Existing problem and conflicts with traditional way of accessing information and knowledge was discussed thoroughly in order to establish the relevance and the purpose of developing the mobile application at the first place.

Section three was about providing context and interpretation on what is going to be the results of the studies. Software developmental tools was also discussed and explain in this chapter. Chapter four mainly focuses on providing the information of the results gathered throughout the development of the study. Lastly, chapter five focuses on providing the explanation of the results and brief summary of the findings provided on chapter four.

In the relevance of gathering literature review, studies, and application, the findings of this mobile application would focus on the gathered

results through alpha and beta testing that would be interpreted and briefly discussed.

Conclusions

The researchers developed a Mobile Application that has the functionality to provide information associated with the panel's Recommendation of human anatomy. The application was hone into the panel's suggestion of putting a puzzle feature where the users can match the said challenge. Adding puzzle feature has the capability provides new way of transcending scientific information through a form of a small game mode. Furthermore, the view mode functionality also a major part of this study in providing importance of the concept which is human anatomy. The users were able to use the app's feature on accessing information associated with human anatomy in a generalized and easier form.

In conclusion, based on the test cases of the app gathered, the researchers were successful in creating a application that is available in any android device with a Android 5.0 Lollipop to Android 6.0.0 Marshmallow operating System.

5.4 RECOMMENDATIONS

The researchers considered the following recommendations for future improvement of the developed

application "Humana Corpuz: A 3D Simulation of the Human Anatomy".

- Consider providing Augmented Reality
- Consider adding a feature of AI that could determine a body part into an information
- Consider compatibility on other platforms such as iOS & Windows.
- Consider adding different variations and branches of science in general such as Solar System, Biology, & Archeology.

REFERENCES

- [1] US Department of Education "Reimagining the Role of Technology in Education: 2017 National Education Technology Plan Update" (2017)
- [2] Institute of Medicine (US) Committee on Technological Innovation in Medicine; Gelijns AC, editor. Washington (DC): National Academies Press (US); 1990.
- [3] International Journal of Engineering and Technology 10(6):72-78
- [4] Socio-educational implications of technology use during COVID-19: A case study in General Santos City, Philippines (wiley.com)

- [5] Wiggins, B.E. (2016). An overview and study on the use of games, simulations, and gamification in higher education. *International Journal of Game-Based Learning*, 6(1), 18-29.
- [4] 1.2: What is Human Anatomy, What is Human Physiology - Medicine LibreTexts
- [5] Textbook of Human Anatomy - William James Hamilton - Google Books]
- [6] ERIC - EJ1263557 - Challenges and Opportunities for Higher Education Amid the COVID-19 Pandemic: The Philippine Context, Pedagogical Research, 2020
- [7] Human Anatomy - Kenneth S. Saladin - Google Books JMIR Medical Education - The Present and Future Applications of Technology in Adapting Medical Education Amidst the COVID-19 Pandemic
- [8] Javan R, Rao A, Jeun BS, Herur-Raman A, Singh N, Heidari P. From CT to 3D Printed Models, Serious Gaming, and Virtual Reality: Framework for Educational 3D Visualization of Complex Anatomical Spaces From Within-the Pterygopalatine Fossa. *J Digit Imaging*. 2020 Jun;33(3):776-791. doi: 10.1007/s10278-019-00315-y. PMID: 31916019; PMCID: PMC7256169.
- [9] <https://oaktrust.library.tamu.edu/bitstream/handle/1969.1/188424/LAMHE-FINALTHESIS2020.pdf?sequence=>
- [10] Moncada-Madrazo M, Rodriguez Valero C. Embryology, Uterus. [Updated 2022 Jul 25]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK547748/>
- [11] de La Barrera-Cantoni SJ, Lizarbe-Lezama ML, Rodriguez-Macedo JE, Carrillo-Levin TS, JaramilloOcharan MF, Toro-Huamanchumo CJ. Use of a 3D virtual app and academic performance in the study of the anatomy of the musculoskeletal system among Peruvian medical students. *Heliyon*. 2021 May 27;7(6): e07149. doi: 10.1016/j.heliyon.2021.e07149. PMID: 34141919; PMCID: PMC8187966.
- [12] Ryan GV, Callaghan S, Rafferty A, Higgins MF, Mangina E, McAuliffe F. Learning Outcomes of Immersive Technologies in Health Care Student Education: Systematic Review of the Literature. *J Med Internet Res*. 2022 Feb 1;24(2):e30082. doi: 10.2196/30082. PMID: 35103607; PMCID: PMC8848248.
- [13] Riel Miller, Wolfgang Michalski and Barrie Stevens "THE PROMISES AND PERILS OF 21st CENTURY TECHNOLOGY: AN OVERVIEW OF THE ISSUES"
- [14] International Encyclopedia of Social & Behavioral Sciences, 2001
- [15] Simul Gaming 2018 June; 49(3): 279-314
- [16] Ip G. Covid-19 Propelled Businesses into the Future. Ready or Not. *Wall Street Journal*
- [17] Santiago González Izard (University of Salamanca, Spain) and Juan Antonio Juanes Méndez (University of Salamanca, Spain): Information Technology Trends for a global and interdisciplinary Research Community
- [18] Franco Landriscina: "Simulation and Learning: A Model-Centered Approach".
- [19] Santiago González Izard and Juan Antonio Juanes Méndez: Information Technology Trends for a global and interdisciplinary Research Community
- [20] The Lancet. COVID-19: protecting health-care workers. *Lancet*. 2020; 395:922
- [21] Galit Botzer, Michal Yerushalmy: "MOBILE APPLICATION FOR MOBILE LEARNING"
- [22] Simulation Games with Embedded Puzzles (February 12, 2015
- [23] Excel as a Qualitative Data Analysis Tool - Daniel Z. Meyer, Leanne M. Avery, 2009 (sagepub.com)
- [24] he value of storyboards in the product design process | SpringerLink
- [25] The Multiple Meanings of a Flowchart | Information & Culture (utexaspressjournals.org)
- [26] An Overview of 3D Software Visualization | IEEE Journals & Magazine | IEEE Xplore
- [27] Future of developer testing | Proceedings of the FSE/SDP workshop on Future of software engineering research (acm.org)
- [28] Emergent Themes for Instructional Design: Alpha and Beta Test : Simulation in Healthcare (lww.com)]
- [29] JMIR Research Protocols - Development and Alpha Testing of QuitIT: An Interactive Video Game to Enhance Skills for Coping with Smoking Urges

iLine: A Web-Based Queuing Tracking Management System for PELCO II Customers

Carlo Alexis Arevalo
Jeff Kevin M. Bulanadi
Danielle Joseph C. Cunan
Ivan Kenneth P. Malabanan
Jerick P. Razon
Marion Chester A. Santiago
Lovely Ruth C. Valdez (Technical Adviser)

ABSTRACT

An automated queue management system with Online billing system is a tool that aids service providers in effectively managing their clients. The method can be controlled with smooth transactions while providing a hassle-free online payment without the need of going to the PELCO offices. The objective of this study is to provide a queue management automation system through Online Billing that can determine queue situation while showing information of which customer should be prioritized first. The average waiting time and various queuing algorithm approaches utilized in banks to serve customers are the main topics of this project. This queuing architecture model can use two separate queue control systems that have evolved to transition between various scheduling algorithms in accordance with the testing outcome, or the average waiting time. The focus of the project is for the website to offer a separate account for the admin, staff, and customer. The web-based system was developed and planned to use a modified waterfall technique. The project is put through two rounds of testing. The user interface of the project was altered based on the findings of research and testing, and alpha and beta testing utilizing ISO 25010 that assists in adjusting and working according to stated project objectives. The project has now been made available to iLine for internal use only.

INTRODUCTION

Electricity is the movement of electrical power or charge. Electricity is a necessary component of nature and one of the most commonly used types of energy.

Users of electricity rely on a secondary energy source created by turning primary energy sources like coal, natural gas, nuclear energy, solar energy, and wind energy into electrical power. Electricity is referred to be a "energy carrier" because it may be converted into other types of energy such as mechanical or heat energy. Although main energy sources can be renewable or nonrenewable, the electricity generated is neither.

The production of electrical power involves converting primary energy sources, such as coal, natural gas, nuclear, solar, or wind energy into a secondary energy source that is used by electricity consumers. The term "energy carrier" is attributed to electricity because it can be transformed into various other forms of energy, including mechanical and heat energy. It is important to note that

while primary energy sources may be renewable or nonrenewable, the electricity produced from them does not fall under either category.[1]

In developed nations, electricity is easily accessible and widely available. On the other hand, developing countries face a challenge in finding a dependable and steady power source. The Philippines, for instance, requires more assistance to establish sustainable electricity supply, especially in rural regions. A consistent energy source is a persistent issue for individuals striving to manage their daily routine and build a stable local economy [2].

The most prominent private-sector electric distribution utility company in the Philippines covers 36 cities and 75 municipalities, comprising Metro Manila. It offers its services to 6.5 million customers in a franchise area of 9,685 km², which constitutes the central regions of the country's industrial, commercial, and population centers. With an illustrious history of 115 years, this entity aspires to become the preferred end-to-end energy

solutions provider by presenting corporate solutions beyond power delivery and personalized remedies that meet the distinct electricity requirements of distinct industries [3].

A queuing system is a method with a service facility where units of some kind (generally referred to as "customers") arrive for service; whenever there are more units in the system than the service facility can handle concurrently, a queue (or waiting for line) forms [5].

Waiting for services is among the most unpleasant but unpreventable experiences in life. When staying in line at a bank, a retail establishment, a medical office, a hair salon, or an electric service provider's office, it directly affects how we perceive the quality of the services being provided—one of the main reasons customers choose to make purchases online rather than in-person.

We may be standing in line for some reason. The journey is thrilling. It can be both great and terrifying to wait. A generally positive, unpleasant, or uncomfortable waiting experience is available to organizations.

Customers become upset if someone successfully manages to sneak ahead of them in line. Queuing systems are often seen in businesses to serve clients equally and fairly, especially when items or services require thorough and customer-specific consulting. These systems apply to "invisible" queues, where people are not lined up one behind the other.

With the help of iLine, you can serve users more effectively and in the proper order, improving overall customer experience. The user will benefit from being able to direct customers to the appropriate line based on needs for service inside the PELCO II office customer service or payment inquiries. PELCO II's web application will enhance its queuing system.

Objectives of the study

The general objective of this study is to design, develop and evaluate iLine: A Web-based Queuing Tracking Management System for PELCO II Customers.

Specifically, the study aims to achieve the following:

1. Gather Information

- 1.1. Requirement Needed
- 1.2. Platform on implementing website
- 1.3. Gather related Websites for PELCO II
- 1.4. Information about another Electric Cooperative
- 1.5. Website Platform
2. Analysis
 - 2.1. Create background flow
 - 2.2. Estimate possible output
 - 2.3. Defined gathered information
 - 2.4. Identify process needed
3. To Create Design and Flow
 - 3.1. Designing Tools
 - 3.1.1. Flow Charts
 - 3.1.2. Use Case Diagram
 - 3.1.3. Entity Relationship Diagram
4. To Identify Hardware and Software Requirements
 - 4.1. Hardware Requirements
 - 4.1.1. Desktop/Laptop
 - 4.1.2. Phone
 - 4.2. Software Requirements
 - 4.2.1. Website type of Platform
 - 4.2.2. NOTEPAD++
 - 4.2.3. HTML5 +
 - 4.2.4. PHP
 - 4.2.5. JAVASCRIPT
 - 4.2.6. AJAX
 - 4.2.7. CSS
 - 4.2.8. MYSQL
 - 4.2.9. XAMPP
 - 4.2.10. HOSTING
 - 4.2.11. DOMAIN
5. Integration of system and Testing
 - 5.1. Integration and Testing ISO 25010
 - 5.1.1. Alpha Testing
 - 5.1.2. Beta Testing
 - 5.1.3. User Researcher Testing
6. To deploy iLine Queuing and Online Payment System

Scope and limitation of the study

The scope of this study is to design, develop, and evaluate iLine, a web-based queuing tracking management system for PELCO II customers. This study will gather information about PELCO II in Mabalacat and other electricity providers' queuing systems and online payment since the researchers provide a website for the client. The website will focus on queuing, online payment, and Dashboard, All users. And for the user overview will have

Queue Registration, Monitoring, My Account, and Online Payment via PayPal.

Researchers surveyed 30 PELCO II users under Appendix K and 3 Alpha Testers under Appendix J for this study. The research will cover the design and flow charts of the system, system requirements, and testing of the system's functionalities using ISO 25010 evaluation. Additionally, the study will deploy iLine queuing and online payment systems.

However, this study has some limitations. It only focuses on PELCO II customers, their physical queuing system, and online payment. It does not cover other non-PELCO II customers. The study only evaluates the system's functionalities based on ISO 25010 evaluation and does not cover other evaluation methods. Lastly, the study needs to cover the marketing and financial aspect of deploying iLine queuing and online payment systems.

The researchers interviewed PELCO II administrator to collect data. After gathering information from the client. The researchers conducted online research to find references for building a website. The researchers also studied the functionalities of other electric provider platforms, as the client suggested the need for a queuing system to speed up transactions. Once the researchers had gathered the required information, the researchers proceeded to identify the appropriate hardware and software, aligned with the requirement gathering and analysis methodology. The researchers used desktops to create the website and laptops to monitor progress. The software included Notepad++, HTML, PHP, JavaScript, AJAX, CSS, MYSQL, XAMPP, Hosting Platform, and Domain. The researchers also utilized charts such as Flowcharts, ERD, Use Case Diagrams, and Test Cases to guide the developer in creating an effective solution. The Flowchart served as a foundation for the website, ERD provided an overview of the entire system, and Test Case tested the functional suitability, reliability, performance efficiency, usability, security, compatibility, maintainability, and portability. Additionally, the System Designs contained all the necessary design elements for implementing the website, including three user levels: Admin, Customer, and Cashier.

The Admin Level of the website provides a summary overview for the admin to view the data contained in each page of the admin user level. This includes website settings to view, edit, and delete users' accounts, user management to manage all charges at the cashier and customer user levels, a list of categories to set if the customer lives in a residential or commercial building, access to the account of admin and staff, and the ability to set the per meter wage for the month. On the other hand, the Customer Level offers various functionalities such as queue registration or getting a queue number by inputting customer information, monitoring the queue line flow by clicking the next Queue, online payment via PayPal, point of sales to track sales, and receipt printing to provide a physical receipt to customers that paid electric bills online. Lastly, the Cashier Level provides functionalities such as customer information management, billing system monitoring, queue control, and monthly report tracking to help cashiers perform their tasks efficiently.

SYSTEM DEVELOPMENT METHODOLOGY

This section discusses the methods and techniques used to outline the flow and processes of the iLine Queuing Management System for Pelco II. By conducting interviews and observations of the current system, researchers were able to establish a foundation for the proposed system's development. This chapter also covers how researchers handle research data.

General Methodology Used

The research design model used by the developers was the Modified Waterfall Model. This model is an upgrade of the traditional waterfall model since it allows to return to a previous stage and address issues where the traditional model does not allow to go backward.

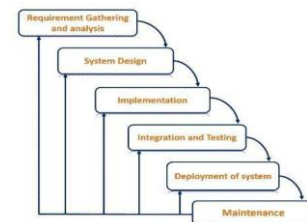


Figure 22: Modified Waterfall Model

Requirement Gathering and analysis

The Modified Waterfall technique is predicated on the idea that all project specifications can be acquired and comprehended in advance. The project manager goes above and beyond to comprehend the project sponsor's requirements fully. Written specifications detail every aspect of the project, including the costs, assumptions, hazards, dependencies, success indicators, and completion dates. Frequently, all of these standards are provided in a single document.

The researchers interviewed the admin of PELCO II Mabalacat City, which needed system growth and improvement. According to conversations with representatives of other PELCO II personnel, the iLine queuing management system and online billing is the one that requires the system to be developed and improved the most.

The researcher gathered examples of how the iLine queuing management system and online payment may be used to reduce the hassle of paying the customer's bills. Websites that are studies that are linked to this page can be found there. The webpage served as the researcher's starting point—the most crucial strategy for growing ILine from the online billing platform.

The researcher conducted a comprehensive online search to gather the necessary materials for creating an online billing platform and identified the essential components. Additionally, they decided to utilize the MySQL database platform due to its versatility in managing data.

They constructed and created a function and designs for the Website they were constructing using the information acquired. The platforms that have been determined necessary to create a Webpage.

- Hostinger (Hosting and Domain Plan)
- Online billing Platform (PayPal)
- HTML
- PHP
- JAVASCRIPT
- AJAX

- CSS
- MYSQL

The Following was utilized to create and implement the Webpage for iLine Queuing Management System and Online Payment. The researcher's cited data has been bookmarked for the backlog and documents.

System Design

Software designers who build scenarios, layouts, and data models address the study's backdrop difficulties technologically. Initially, a higher-level or logical design lays out the project's goals, scope, general traffic patterns for each component, and connecting points. The following are the charts used by the researchers:

Flow Charts

Process workflow is developed as a manual for the proper and functional operation of the website. This will operate as the direction for each action and provide the desired outcome. To develop a specific flowchart for each function, a Step is followed. Define the procedure that will be shown. At the top of the work surface, type its title. The parameters of the process should be discussed and decided upon: When or where does the process begin? What or when is the conclusion? The level of detail to be included in the diagram should be discussed and chosen. Make a list of all the things that happen. On a card or sticky note, write down each. Put the actions in the right order. Draw arrows to depict the process' flow once all activities have been considered and everyone has agreed that the order is correct. To determine whether other parties involved in the process (employees, admin, and customers) concur that the process is depicted accurately, go over the flowchart with them.


```

graph LR
    A[Login User Account] --> B{Login Successful}
    B -- No --> C[Check Login Credentials]
    B -- Yes --> D{Change Payment Status}
    D -- Yes --> E[Change Status to Paid]
    E --> D
    D -- No --> F[No Changes Needed]
  
```

```

graph TD
    Start([Login Cashier Account]) --> Login{Login Successful?}
    Login -- No --> Check[Check Login Credentials]
    Login -- Yes --> Dashboard[Dashboard]
    Dashboard --> ClientList{CRUD Client List}
    Dashboard --> ViewReport{View Report}
    ClientList -- Yes --> ClientDetail[CRUD Client Detail]
    ClientList -- No --> NoChanges[No Changes Needed]
    ClientDetail --> DatabaseCRUD[Database CRUD]
    NoChanges --> DatabaseCRUD
    ViewReport -- Yes --> DatabaseCRUD
    ViewReport -- No --> DisplayReport{Display Report?}
    DisplayReport -- Yes --> DatabaseCRUD
    DisplayReport -- No --> ErrorMessage[Error Message]
    DatabaseCRUD --> BillingList[CRUD Billing List]
    BillingList --> NewInfo{New Information CRUD?}
    NewInfo -- Yes --> ErrorMessage
    NewInfo -- No --> MyAccount[My Account]
  
```

```

graph TD
    Start([Login Admin Account]) --> Login{Login Successful?}
    Login -- No --> Check[Check Login Credentials]
    Login -- Yes --> Dashboard[Dashboard]
    Dashboard --> ChangeRate{Change Rate}
    Dashboard --> CRUDUserList[CRUD User List]
    ChangeRate -- Yes --> ChangeRateValue[Change Rate Value]
    ChangeRate -- No --> NoChangesNeeded[No Changes Needed]
    CRUDUserList --> ViewReport{View Report}
    ViewReport -- Yes --> DisplayReport[Display Report]
    ViewReport -- No --> ErrorMessage[Error Message]
    DisplayReport --> DatabaseCRUD[Database CRUD]
    DatabaseCRUD --> ChangeRate
    DatabaseCRUD --> CRUDUserList
  
```

```

graph TD
    A[Add Queue Details] --> B{Queue Created}
    B -- No --> C[Check Queue Connection]
    B -- Yes --> D{Cashier/Admin Change Status}
    D -- Yes --> E[Change Status to Next Queue]
    D -- No --> F[Pending]
  
```

Researchers used Entity Relationship Diagram to visually depict how information moves within a system or process. The data inputs, outputs, data repositories, and several sub-processes are all displayed.

```

graph TD
    billing_list[billing_list] --> system_info[system_info]
    billing_list --> category_list[category_list]
    billing_list --> question_list[question_list]
    billing_list --> cust_list[cust_list]
    billing_list --> items[items]
    system_info --> category_list
    system_info --> question_list
    system_info --> cust_list
    system_info --> items
    category_list --> question_list
    category_list --> cust_list
    category_list --> items
    question_list --> cust_list
    question_list --> items
    cust_list --> items
  
```

The diagram shows the following tables and their attributes:

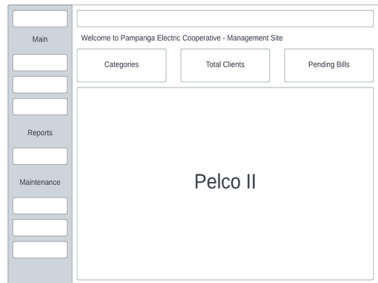
- billing_list**:
 - id int(30)
 - id_ref int(30)
 - id_ref int(30)
 - reading_date date
 - doc_date date
 - writing float(12,2)
 - primary key: id
 - foreign key: id_ref to id_ref in system_info
- system_info**:
 - id int(30)
 - id_ref int(30)
 - meta_text text
 - meta_text text
- category_list**:
 - id int(30)
 - name text
 - status tinyint(1)
 - delete_flag tinyint(1)
 - date_created datetime
 - date_updated datetime
- question_list**:
 - id int(30)
 - question_id int(30)
 - Transaction text
 - account_number text
 - barcoding text
 - customer_name text
 - status tinyint(1)
 - created_timestamp datetime
- cust_list**:
 - id int(30)
 - code varchar(100)
 - category_id int(30)
 - firstname text
 - middlename text
 - lastname text
 - contact text
 - address text
 - meta_code varchar(100)
 - first_reading float(12,2)
 - status tinyint(1)
 - password text
 - delete_flag tinyint(1)
 - date_created datetime
 - date_updated datetime
- items**:
 - id int(30)
 - firstname varchar(255)
 - middlename text
 - lastname varchar(255)
 - username text
 - password text
 - avatar text
 - last_login datetime
 - type tinyint(1)
 - date_created datetime
 - date_updated datetime

Due to the complexity of the systems, the researchers employed a standard use case diagram to develop a straightforward model that will illustrate the system's overall context. The data flow and system processes for the customer, administrator, cashier is presented in Appendix A.

Below are the guidelines directing the development of the iLine website platform's backend and frontend designs. These designs serve as the framework for the iLine website, enabling researchers to complete their projects and anticipate the system's output. This section also presents the results of analyzing data obtained from various sources. By carefully examining each piece of information, researchers arrive at the final product. Next, the Admin page, Customer page, and Cashier page's backend and front end must be developed. All necessary pages, functions, and contents were considered for a more comprehensive

understanding of the tasks that need to be prioritized. The design aims to provide user-friendly approaches for all levels of users.

Appendix D: (Website wireframe- Admin Panel)



Implementation

After completing the design, the technical implementation begins. This stage of the Waterfall process may be the quickest due to the comprehensive research and design. During this stage, the programmers created programs based on the project requirements, tested them, and implemented them. If significant changes are needed during this phase, it is important to return to the design phase.

Subsequently, to design the front and back end, the iLine Queuing management system and Online billing researchers had sessions to decide whether to proceed with the software requirements finalization and set up for the Online billing platform. The system operates by the intended structure's design regarding the necessary and optional data elements, features, and details that produce an effect and information. To finish this stage, the researcher had to do all duties required to finish the Online billing platform, align with the final implementation, and concentrate on the crucial features. To adhere to the study's primary goal, the researcher followed the guidelines of the scope and restrictions. The researchers used the necessary tools to accommodate the needs of each part of implementing the Online billing Platform. The following are the software and representation tools used to help the implementation step.

Software tools

Visual Basic Studio – a device used to hard code the programs for each page of the e-commerce platform and compile them. It is connected to the usage of JavaScript, CSS, HTML, and PHP. Each of these serves to illustrate and develop a procedure to adhere to each goal and range of the iLine platform.

Xampp – An External application that supports the PHP platform for an offline use of the platform.

Composer – This is used to compose additional components for libraries of the scripts and main sources of the programs. It supports the use of PHP and any particular languages in the programming industry.

Browser – This served as the output platform of the iLine website. This is the primary medium to use the iLine platform. Since the iLine platform is a web type application it would support domain access and can be accessible using a browser.

Backend and Frontend Requirements

Database Structure- The researcher identifies entities present to create functional database management of the website platform. Both the logical and physical data structures will be entered into the data specification language supported by your database management system when it comes time to build the actual database. To ensure you have the performance level and storage capacity, the database will need, you should estimate its size then.

Integration and Testing

A product must be tested to ensure that there is no flaw and all requirements have been completed, resulting in a positive user experience with the application before making it available. The test team used the personas, user case scenarios, design papers supplied by the product manager, and ISO

25010 evaluation to inform their test cases.

In the integration and testing department, the researchers developed the test cases and engaged with 3 IT professionals and 30 Pelco II Customers to examine the system and get comments to enhance the constructed website. The researchers created a testing table and real-time testing during the installation phase. Each of the objectives specified in section 1's objectives was completed using the testing table as a guide. At this point, a function or a procedure might change to fit the ideal and better workflow for the Online billing platform.

Deployment of System

The program's maintenance phase began when it was made available to clients or put into use on the market. When faults are found, and user modification requests are received, a team is formed to handle upgrades and the distribution of new software versions. After the researcher applied all the objectives and recommendations in the iLine website, with the testing and suggestions from the adviser, it was verified that there were no issues and the website was in line with the right processes and procedures. The researcher ran presentations and demonstrations for the iLine Queuing Management system and Online billing about the functionality and operation of their online billing; the Website researcher made the usage of a Web hosting and Domain.

Maintenance

After the researchers had gathered all of the comments from the Alpha Tester and PELCO II, the system underwent another modification based on PELCO II and the Alpha Tester recommendations for system implementation. As the Researchers already expect this stage of maintenance, one of the objectives of the researchers is to create a free IT service for minimal or design features of the application.

RESULT AND OUTCOMES

The testing and evaluation of the system conducted by the researchers are presented in this chapter, along with the findings and analysis. This part describes the test cases to be examined by Alpha Testers in the testing process to verify the stability of the iLine Queuing and Online Payment System.

Gathering and Analyzing the Information

According to the researcher's discussion and the findings of the relevant studies presented in Chapter 2, it has undergone extensive analysis to take a different course and produce a particular result.

iLine: The online billing and queue management systems provided some general information regarding management and its functions. From this vantage point, the researchers used this as their primary source of information while setting up the Online billing Website queuing. Website/Online; the following figure serves as a demonstration of the commercial information utilized.

The following details are used as a prerequisite for setting up an authenticated and non-scam online billing website on the internet.

Requirements

Table 1: Hardware and Software Requirements

Hardware Requirements	Software Requirements	Function
Desktop/Laptop	Windows 7, Windows 8, Windows 8.1, Windows 10 or later. 4GB RAM (minimum) Google Chrome version 105.0.5195.102	Operating System Memory Browser

Software, Product/Processes Screenshots

The requirements of the system were met. The researchers created the web-based iLine: Pelco II system following the data collection and analysis. The needed software is the following and are the elements that support to fulfill the

projects: Hostinger (Web Application), XAMPP (PHP emulator), Notepad++(IDE), and Browser (Output)

Objectives Testing and Results

Procedure testing was performed on the System to evaluate its functionality and how well each Website step worked. This would establish and pinpoint any systemic outcomes that might have been ignored.

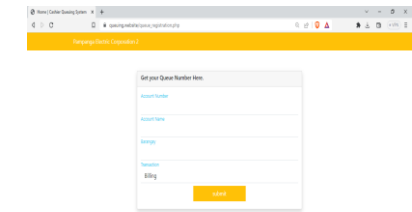


Figure 23: Queuing Registration

To get a queuing number for payment and customer service transactions.

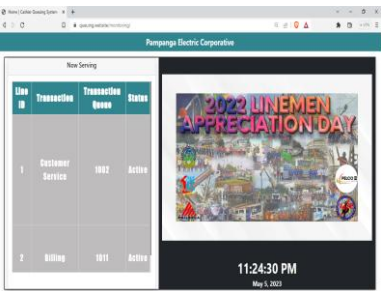


Figure 24: Live Monitoring

This is where the customer can monitor the queuing process; it includes the Line ID, kind of transaction, Transaction Queue, and Status of the customer; when it is active, the customer is processing its transaction; when it is pending, the customer is still at the queue line.

Admin Panel Results and Discussion

The information acquired will prevent all testing results from being feasible. The outcomes demonstrate the output of each phase of the system. The basis for completing the stages is the test case parameters result.

Admin User Process



Figure 25: Login page

The figure above shows the Login page of the Admin and Staff of Pelco II. To successfully create a session within the system, an admin or staff must validate a registered account to log in.



Figure 26: Admin Page

The website’s admin dashboard. Here on the dashboard, you can see numbers of categories, Total Clients and Pending bills. This dashboard is common to the admin panel because the overview of all processes performed by the admin can be seen here.

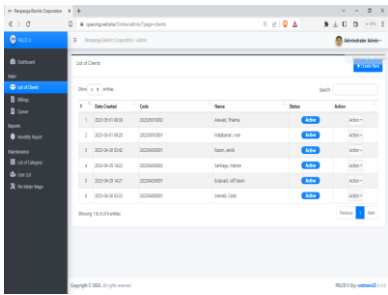


Figure 27: List of Clients Page

The figure above shows the website’s List of Client page. On the Client List page, you have

the ability to view a roster of users and modify their details, as well as include an invoice.

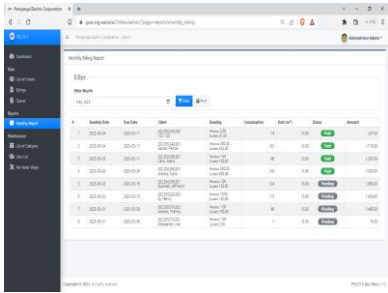


Figure 28: Transaction Report Page

The website's Transaction report page. Depending on the transaction date, the report displays sums for the selected period for transactions linked to your accounts. If the date of creation falls within the range of your chosen dates, bills, invoices, and credit notes will display.

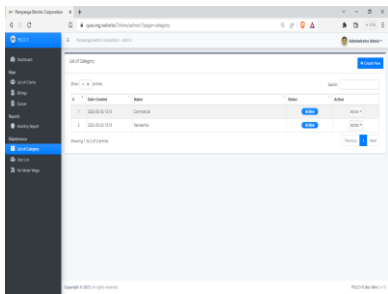


Figure 29: List of Category (Admin side only)

The figure above shows the List of a Category page, and it displays the users' Two (2) category, which is Residential or Commercial.

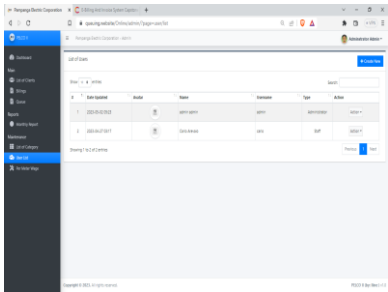


Figure 30: User List (Admin side only)

The figure above shows the user list on the admin side of the system; Admin users and Staff users are on the list.

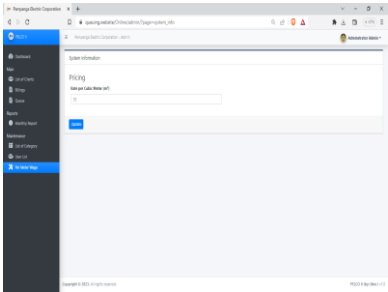


Figure 31: Per Meter Wage (Admin side only)

The figure above shows the Per meter wage, the amount of meter set for the consumer's bill.

Customer User Process

The information acquired will make it impossible to obtain all test results. The outcomes show the outcomes of each system phase.

It is the second most popular website since the customer panel acts as the front end, and the website's main objective is to develop a platform for market reasons.

Crucial panel for the website. This testing outcome leads to the result of the following features.

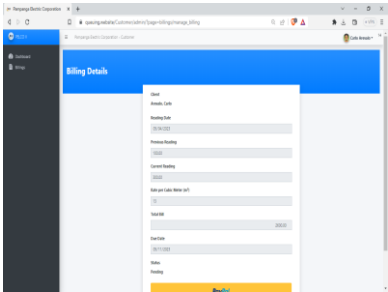


Figure 32: Customer Billing

The figure above shows the Billing Details of the customer.

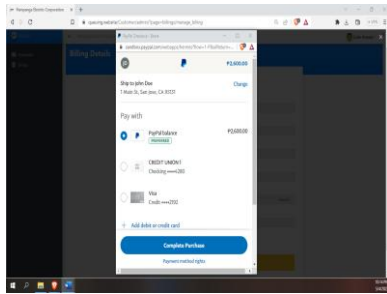


Figure 33: Transaction Form Modal 1

The figure above shows the transaction of the customer in the online billing via PayPal.

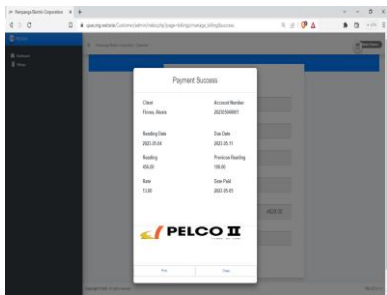


Figure 32: Transaction Details (Point of sale)

To the online billing, this is the receipt of the customer after paying the electric bill for the month.

Testing and Implementation

This percentage only shows that the system's three (3) major user levels were approved by the three (3) alpha testers. Queue, Billing, Online payment, and Monitoring systems have all been fully implemented. The testers also discovered that the system is fully functional and compatible with a variety of browsers, databases, operating systems (OS), mobile devices, networks, and additionally, the database infiltration is checked, and the tester was granted access to the hardware.

Table 1 Alpha (Appendix I Alpha tester ISO 25010)

Category	Score	Descriptive
Functionality	5	Strongly Satisfied
Reliability	5	Strongly Satisfied
Portability	5	Strongly Satisfied

Usability	5	Strongly Satisfied
Performance	5	Strongly Satisfied
Security	5	Strongly Satisfied
Compatibility	5	Very Strongly Satisfied
Maintainability	5	Strongly Satisfied
Mean	5	Strongly Satisfied

Overall system performance, interoperability, usability, portability, and compatibility Security scored 5 with a verbal interpretation of "Strongly Satisfied." This percentage only shows that the three (3) alpha testers accepted the system's three (3) major user levels. Systems for billing, payments, and notifications, among other features, were fully established. The testers also discovered that the system is completely functional and compatible with a variety of browsers, databases, operating systems (OS), mobile devices, networks, and additional software. The testers were also given access to the hardware and had the database penetration checked. the complete safety of the system.

Table 2 BETA (Appendix J Beta tester ISO 25010)

Category	Score	Descriptive
Functionality	4.5	Very Strongly Satisfied
Reliability	4.6	Very Strongly Satisfied
Portability	5	Very Strongly Satisfied
Usability	4.9	Very Strongly Satisfied
Performance	4.8	Very Strongly Satisfied
Security	4.9	Very Strongly Satisfied
Compatibility	4.8	Very Strongly Satisfied
Maintainability	5	Very Strongly Satisfied
Mean	4.8	Very Strongly Satisfied

The ISO 25010 was used by this research's creators to beta-test iLine and build it as a comprehensive integrated system. Throughout the testing procedure, this ISO uses a variety of categories. To determine whether a system actually satisfies system requirements and operates as intended, it is put through a sequence of tasks known as a system test case. Its objective is to confirm that different system components are operating as expected and to confirm that the system conforms with all relevant standards, guidelines, and client requirements. An international standard for software engineering called ISO/IEC 25010 is followed when testing a web application.

This demonstrated that the web application complied with all requirements and was suitable for its intended use. The competency, features, and functioning of the application were assessed by three users or Beta users. One of the most crucial features that a software should have been security because it protects both the program and its users. By doing this, the application's requirements for data and networking security are met. According to the beta test's overall Iso rating, which is "Strongly Satisfied" or 4.986111.

Table 3 Grand Mean

Category	Score	Descriptive
Functionality	4.7	Strongly Satisfied
Reliability	4.7	Strongly Satisfied
Portability	4.8	Strongly Satisfied
Usability	4.8	Strongly Satisfied
Performance	4.8	Strongly Satisfied
Security	4.7	Strongly Satisfied
Compatibility	5	Very Strongly Satisfied
Maintainability	4.8	Strongly Satisfied
Mean	4.8	Strongly Satisfied

Functionality of the system was given a "Strongly Satisfied" rating, indicating that it can effectively and efficiently adapt to many types of operating or usage contexts as well as hardware and software.

Furthermore, the dependability rating for the system was "Strongly Satisfied," indicating that it regularly makes it simpler to accomplish the aims and objectives outlined in each module or panel. The developed system received the highest overall rating among the numerous dependability sub-criteria since it was operational and usable when required. The portability criterion for the developed system obtained a "Strongly Satisfied " rating.

The system can adapt to various hardware, software, or other operational standards since it received the greatest total score among the five indications under the portability criteria.

The system's usability was rated as "Strongly Satisfied" as well. The accessibility sub-indicator under usability received the best score because it allows users more freedom in how they can complete a job in a certain use situation.

Users had consistent bandwidth access during system testing at least 10 to 15 Mbps Internet connection. When the system is operating, a higher bandwidth will provide it greater responsiveness, processing, and throughput. Additionally, the kind of resources needed to access the system will affect how well it performs.

The security rating of the system was likewise very high, with excellent ratings for the sub-factors of secrecy, accountability, and integrity. It offers several security login access features for all user types, which guarantees that only those with access rights may access the data. Additionally, it guards against unauthorized access to data modification and keeps auditable logs of all operations.

The system's compatibility function also obtained an overall "Very Strongly Satisfied" rating. It proves that the system efficiently completed the required tasks while utilizing shared resources and an environment with other things, all without negatively affecting resource use. The portability and compatibility of the system are related. It means that a different device connected to a network may

access the system, enabling usage and information sharing.

Testability obtained the highest mean score among the sub-indicators, and the Maintainability grade was "Strongly Satisfied." The technology enables user-selected changes to the settings without introducing errors or degrading the system's performance.

DISCUSSIONS

The Website was created using both personal knowledge and websites that were cited. The website's functionality was able to meet the needs of users at various levels (Admin, Staff, Customer). With this strategy of having many user levels, the researcher provided various points of reference to develop an approach in terms of the end result.

Through research and data gathering, a Queuing System with Online Payment Website was developed to meet the needs of three different user levels: Admin, Cashier, and Customer. This approach provided the developers with varying perspectives on user requirements, resulting in a more comprehensive final output.

Multiple trials and modifications were carried out on the iLine website to ensure compatibility and proper data validation structure for seamless implementation. Subsequently, the parameter mediums were processed digitally, and the hosting and domain were established to enable users to view the platform through their browsers. The iLine system functions based on its well-structured information flow and efficient workflow, providing users with a fulfilling experience while using the platform.

Conclusion

The researchers collected the necessary data for the system through a series of interviews and observations at iLine: PELCO II. The interview helped the researchers pinpoint the local issues that require fixing. The primary focus of the project is the "iLine" web-based system, including its development, design, and evaluation. The researchers' findings were as follows after they examined, tested, and

evaluated the website: The Iterative approach motivated the program's supporters while designing it. The diagrams used to allow the researchers to interpret the application flow; these diagrams served as a reference for the researchers during application development to describe the overall application flow.

Recommendations

The researchers considered the following recommendations for future improvement of the developed iLine.

- Improve the User Interface of the system.
- Improve the Online Payment Transaction

REFERENCES

- [1] "Use of electricity - U.S. Energy Information Administration (EIA)," Eia.gov. [Online]. Available: <https://www.eia.gov/energyexplained/electricity/use-of-electricity.php>. [Accessed: 21-Apr-2023].
- [2] K. Thelwell, "Improving electricity in the Philippines," The Borgen Project, 29-Sep-2020. [Online]. Available: <https://borgenproject.org/electricity-in-the-philippines/>. [Accessed: 21-Apr-2023].
- [3] "Manila electric company (meralco)," Pe2.org. [Online]. Available: <https://www.pe2.org/members/manila-electric-company-meralco>. [Accessed: 21-Apr-2023].
- [4-6] "Pelco II," Pelco2.com. [Online]. Available: <https://pelco2.com/content/LE7M6Ydx/aboutus>. [Accessed: 21-Apr-2023].
- [4] C. Armero and M. J. Bayarri, "Queues," in International Encyclopedia of the Social & Behavioral Sciences, Elsevier, 2001, pp. 12676-12680.
- [5] "Definition of KIOSK," Merriam-webster.com. [Online]. Available: <https://www.merriam-webster.com/dictionary/kiosk>. [Accessed: 23-Apr-2023].
- [6] [Online]. Available: <http://https://www.pinelabs.com/blog/online-payments-and-its-types-methods-and-meaning>. [Accessed: 23-Apr-2023].
- [7] "sneak," Thefreedictionary.com. [Online]. Available: <https://www.thefreedictionary.com/sneak>. [Accessed: 23-Apr-2023].
- [8] M. C. Y., "The Effect of Inventory Management on the Devaluation of Pharmaceutical] Products," In XV Multidisciplinary International Congress on Science and Technology,, pp. 135-146, 2020

iLTOGo: An Informative Land Transportation Guide Mobile App

Christian A. Cuenca
Axle James D. Dela Cruz
Arvin Andrew N. Ortiz
Joshua M. Santos
Mary Anne L. Tapnio
Warren T. Virgines
Lorenzo C. Macam, MIT (Technical Adviser)

ABSTRACT

In the Philippines most of the common problems that people are facing is the road violations, penalties and mostly accidents that causes fatalities along the road. The common mistakes of committing violations, penalties and accidents are from those people who are unknowledgeable about the traffic road rules and regulations like the basic rules by obeying traffic lights, traffic signs and other safety protocols in the road. These problems in the road can be prevented if drivers are obeying the rules and regulation in the road. As stated by the World Health Organization (WHO) Yearly 1.3 million died because of conflicts along the road that is how risky the road was if people are unknowledgeable in driving. This study aims to examine and provide a solution that would help to reduce the risk of accident and prevent committing penalties and violations while driving on the road which would mainly in the Philippines. In order to gather data the researcher conducted a survey and searching online that would be used to conduct the study for developing a mobile application called iLTOGo which is an Informative Land Transportation Guide Mobile App that can help and assist people to lessen the risk of accident and committing violations or penalties in the daily travel on the road. This study also indicates that most of the drivers in the Philippines are driving without licenses, which is a form of violation or penalty in the road.

INTRODUCTION

As stated by the World Health Organization (WHO) [1] Every year, around 1.3 million people are killed and millions more are wounded or disabled because of road traffic accidents, the most of which occur in low- and middle-income nations (LMICs), (World Health Organization, 2022). Possibly this will cause traffic law violations which are reckless driving, accidents in the roads, also death. This happens globally because of the lack of knowledge of drivers and riders about traffic and roads safety including the signs in the roads. Also, according to Muhammad M. R., [2] there are several factors that lead to road accidents. Some of these factors are linked to road geometry, while others are linked to driver conduct, (Muhammad M. R. et al., 2022). When investigating the causes of traffic accidents, one of the most important topics is driving behavior. Every year many accidents and violations are committed in every country in the world. Many people have been died because of failing to respect traffic and road signs,

which have resulted in fatalities or infractions. However, The International Association of Traffic and Safety Sciences (IATSS) [3] claim that there are few opportunities for comprehensive road safety education and driving instruction. As a result, poor driving skills and low normative awareness among road users contribute to accidents and worsen congestion. Particularly, the number of collisions involving young people (between late teens and early 20s) is rising.

As stated by Jagnoor J., [4] a variety of risky behaviors have been linked to teenage motorbike riders. These were most frequently associated with a lack of basic driving skills: a limited understanding and/or recognition of traffic rules (speeding, helmet use, use of mobile phones while driving, dangerous overtaking), an inability to stop a motorcycle in an emergency, difficulties with balancing the motorcycle, an inability to stop a motorcycle in a crisis, issues with balancing the motorcycle, an inability to navigate subpar road

infrastructure, and a lack of experience traveling great distances on a motorcycle.

Accidents and violations will be prevented when many of the drivers are reading and understanding all the rules and regulations in traffic road safety such as the traffic signs, traffic lights and other law if talks about on the road safety protocols. But some of the drivers and riders are lack of knowledge about this rule and that is why these mistakes cause fatalities along the roads. The reason why some of the drivers are committing violations because of the reason that rushing in the work or appointments and other activities, so drivers ignores to recognize the traffic laws and safety regulation on the road in the end this mistake can cause deaths, accidents, penalties, violations, and Philippines are one of the dense populations in the world specifically in manila. According to Ricky Publico, [5] The Philippines traffic laws aim to protect not only the public's safety on the roads but also an orderly flow of traffic and motorist discipline. They have laws that require wearing motorcycle helmets and seatbelts and ban people from driving when drunk and while using their phones.

According to the study of Asor, Jonardo R., [6] In Los Baños, Laguna, poor traffic flow has recently become a serious issue that has a significant impact on the neighborhood's economic development. The well-known district of Los Baos in Laguna has a lasting impression on visitors thanks to specialties, hotspots, and other tourist attractions. However, Los Banos is the region in the middle of the province through which all public and private vehicles entering and leaving Laguna travel. The district is approached by a variety of vehicle types and sizes, including ten-wheeler trucks, buses, motorcycles, and even tricycles.

According to Sunstar.com.ph [7] a recent campaign to raise awareness of road safety for local transportation organizations and students from various schools was organized by the Land Transportation Office (LTO) Angeles City District Office under the direction of Chief Transportation Regulatory Officer Aida Santiago. As part of the ongoing campaign to raise awareness of road safety, LTO Angeles City employees have already visited the City College of Angeles City, the Angeles City National Trade School, the Macdo-Henson

Tricycle Operators Drivers Association in Barangay Lourdes Northwest, and other schools.

According to Jeremy Laurence M. Banez, [8] It will take some time to obtain a driver's license in the Philippines, whether it is new or renewed, as there are a number of procedures to complete in accordance with government Land Transportation Office (LTO) regulations. Based on the LTO citizen's charter, each phase has a specific completion time. The LTO system is now set up to accept walk-ins as soon as they open. While some LTO branches are open to every customer, others have restrictions on which they would accommodate. Some LTO branches have received complaints that their services are subpar because clients take a long time to complete transactions like getting a driver's license, which frequently occurs on busy days.

According to Bejamin G. Quito, [9] to ensure that everyone operating a motor vehicle on Philippine streets and roads is knowledgeable about traffic safety, rules of the road, and professional driving etiquette, the Philippine Driver's License will be standardized. Through the deputization of schools and training facilities to deliver Road Safety Education to "would-be" drivers, the LTO will professionalize the operation of vehicles. Before taking the practical driving test, this instruction will be required. By doing away with the lecture before to the real driving test, this will hasten the issue of a driver's license. The process will still include the written test that comes before the practical driving test. In this manner, there won't be any drivers operating automobiles on the streets and highways of the Philippines who are unaware of the traffic laws and regulations. The idea includes incorporating Road Safety Education (RSE) into the K-12 curriculum to institutionalize traffic education across the nation. It is appropriate to include driving skills in the K-12 curriculum in grades 11-12 because the Land Transportation Office (LTO) has proposed raising the legal driving age from 16 to 17 years old. RSE can be included in the curriculum for children in Kindergarten through Grade 3. This will impart to our kids the importance of adhering to traffic safety regulations and producing responsible drivers.

General objectives

In general, the main objective of the study is to design and develop the mobile app iLTGo, an informative land transportation guide that would help drivers and riders to have knowledge to the roads in road and safety including traffic signs and road signs.

Specific objectives

The researcher compiles all the data on the subject and the specifications required for the mobile application, then moves on to designing the interface of the mobile application, testing it with an IT specialist and a rider, and finally putting it into use.

The study aims to provide and achieve the main goal and objectives to shown below:

1. To acquire information for application planning, the researchers conduct data collection through interviews and web searches.
2. To identify the hardware and software that the researchers would be use for the development of the applications:
 - a. Dart
 - b. Flutter
 - c. SQLite
 - d. Android Studio
3. To design the application using designs and analysis tools:
 - a. Story Board
 - b. Flowchart
 - c. Menu Tree
4. To create a mobile application with the following features:
 - a. LTO reviewer, penalties, and driving guidelines
 - b. AI scanner of traffic signs
 - c. LTO Locator
 - d. Trivia
5. To test the mobile application using ISO 25010 in terms of:
 - a. Functional Suitability
 - b. Usability
 - c. Compatibility
 - d. Portability.
6. To deploy a mobile application available on Google Play Store.

Scope and limitation

This application will be beneficial to everyone and will lead to everyone securely arriving at the various locations. It can also assist them in saving not just lives but also money by

preventing violations from occurring. This mobile application will also act as a guide for all drivers who are unfamiliar with road traffic signs and laws; it will assist drivers in thoroughly understanding those rules and signs on the road to be safe and aware.

First the researchers conduct face-to-face interviews to get to know the riders and motorists, whether they have an idea about the traffic rules and regulations and laws implemented by the LTO (Land Transportation Office), and how the iLTGo app can help them. After conducting an interview and web searchers the researchers would be developing an mobile application called iLTGo an Informative Land Transportation Guide Mobile App . Before developing the mobile application, the researchers first successfully collected data from online research publications, relevant applications, and collaborations

The researcher will test the mobile application to find and fix any flaws after it has been built and written, and the programmer will look for ways to improve the app. The study is available for criticism, and this testing will provide the researchers with feedback. This will help them to identify the advantages and disadvantages of the application. The researchers also use random purposive sampling. To determine whether the mobile app really helps both drivers and riders, the researchers first use an ISO25010 serving tool. Upon planning, creating and developing for the mobile application the researchers would be conducting a survey and web searchers for data collection. The researchers conducted face-to-face and online interviews with the participants using Google Forms for a total of 51 beta and 3 alpha testing.

The researchers would use a desktop pc powered by Microsoft operating system using the software's Dart, Flutter, SQLite and Android Studio. Dart serves as the programming language that has been use on developing the app. Flutter serves as the codebase of the mobile application by taking control the codebase plugins on developing a high quality application. SQLite serves as the database of the mobile application and the Android Studio that serves on building the application for mobile apps, this software's are

used upon creating and developing the mobile application iLTGo.

When it comes on designing the mobile application, the researchers would be using Menu Tree Diagram, Flowchart and Story Board upon developing the app. Both menu tree diagram and flowchart will describe the function and the scope of the app system and the story board which could be uses to indicate the key findings and conclusion on developing the app.

The mobile application iLTGo has a features this are the LTO Reviewer, Penalties and Driving guidelines ,Exam ,Trivia, LTO Branch Locator .LTO Reviewer has a preloaded reviewer of 100 questions including traffic signs reviewer and 60 out of the 100 review questions would be randomize appear on the Exams. LTO Reviewer has a dual language English and Tagalog Professional, Non Professional and Traffic signs reviewer that would depends on the user.

The mobile application has also a Penalties and Driving Guidelines that can be view by the users on the LTO Related Laws in the Homepage.On the Trivia Bar that can see on the Homepage this feature was also preloaded Trivia about the driving the trivia will be shown randomly. Lastly the LTO Branch locator in the homepage the users can view it by going on the bottom of the right screen by tapping the pin icon. The user would be directed on the google map, when the app is newly install on the smartphone the location icon would appear when the user go back in the homepage then go back again on the LTO Branch Locator icon. The user can locate a new branches of the LTO Branch, Emission Center and Driving School by tapping first the my button icon on the map then after tapping, the scroll button icon on the top would be shown the user can adjust it to maximize and minimize the range locator on locating a LTO Branch, Emission Center and Driving School. The user can locate by tapping the Arrow Icon in the right side of the scroll icon the arrow can tap once and twice only. After tapping the arrow icon it would start to locate a near LTO Branch, Emission Center and Driving School. The red pin would be shown of the map this red pins is the branches that the Google maps locate.

The users can view the address of the branch by tapping the tap me text that can be seen in the bottom, the address and the branches was recommended by google map. Some of the features of the app can perform online and offline and the app android requirement is android five and above. Some of the information that can be read and saw in the app was based on the rules and regulation of the LTMS Portal of the LTO.

To test the mobile application iLTGO using ISO 25010 in terms of Functional Suitability, the mobile application meets the Functional Completeness, Functional Correctness and Functional Appropriateness because the app has the features of LTO reviewer, penalties, and driving guidelines, AI scanner, Google Maps and Trivia that has been applied on the mobile app and all of the features are working properly which it meets the Functional Correctness of the app and lastly the ability of the app function to finish a specific task and objectives that meets the Functional Appropriateness of the app.

In terms of Usability the mobile application is easy to use it can allow user to achieve a specific goal, it is easy to operate and control, protecting users upon making errors, it has a satisfying user interface and it can manipulate data and so that the mobile application meets the ISO 25010 interms of Usability. In terms of the Compatibility of the app it can interact with one another app without causing any issues on the mobile phones this is the app Co-existence. Then in terms of Interoperability the app has the ability to exchange information and use that information that has been exchange that was the iLTGo app meets the ISO 25010 in terms of its Compatibility.

Lastly, The mobile apps Portability in terms of the app adaptability, installability and replacebility are meets the requirement the app can demonstrate independence, the app was flexible because it can be installed in any different android OS versions that has the minimum requirement of specification and lastly replaceability of the app which is the app can be accessed with more than one mobile devices and has the minimum required specification upon running the app. To deploy the mobile application the researchers have been uploaded it on Google Play Store, because

Google Play Store is one the number one platform upon uploading and creating an app.

SYSTEM DEVELOPMENT METHODOLOGY

This section uses the design of a mobile application and the analysis plan to explain how they work together. The project is implemented using systematic methods and techniques.

The researchers would use the Modified Waterfall to develop the mobile application because of the flexibility and the efficiency that suits the project development. The Modified Waterfall technique aims to create a flow that will make the application development process more effective. for the documentation and design. This approach tries to bring back the former steps of validating and verifying, and it also gives researchers permission to apply the Modified Waterfall approach more effectively throughout the phases of application development. These are the steps in the modified waterfall requirement gathering process, which entails design, coding, and testing.

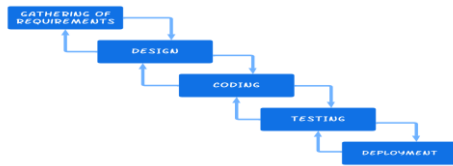


Figure 1: Modified Waterfall

Gathering of Requirements

For the gathering of requirements, the researchers would plan to develop a mobile application in order to gather requirements. To make the study more innovative and informative, the researcher brainstormed various types and styles. In order to support the data, the researchers hunt for innovative ways to gather a variety of information using internet platforms and do surveys. Researchers decided to create a smartphone application that will be ideal for motorbike riders after exchanging several suggestions. The study's primary focus being motorcycle riders, researchers spoke with a few motorcycle riders about the concept and asked pertinent questions regarding the subject. The replies provided the researchers with insight into the functionality and design of their mobile

application that would best serve the demands of the riders. At this point, in this phase, the researchers will be able to create a clear goal for the study.

Table 1. Hardware Specifications

Hardware	Description
120 GB SSD	Solid State Drive Capacity
16 GB RAM	Memory Capacity
Intel Core i3	Unit Processor
1360 x 768 Pixels	Screen Resolution

Software Specifications in the Development of the Application.

Table 2. Software Specifications

Software	Description
Android Studio	Used to build Android Application
DB Browser for SQLite	Used to create database
Flutter	Used to develop the frontend
Dart	Used for frontend logic

Tables 1 and 2 show all of the hardware and software specifications used in the development. The researchers created the application in this step based on the plan and design phases. Programming and database construction were carried out using a machine with a resolution of 1360x768 pixels, an Intel Core i3 processor, a 111 gigabyte solid state drive, and 16 gigabytes of RAM. The application was built with Android Studio, the database was built with SQLite Db Browser, the front end was built with Flutter, and the front end logic was built with Dart. By merging all of these hardware and software tools, "iLTGo: An Informative Land Transportation Guide" was established.

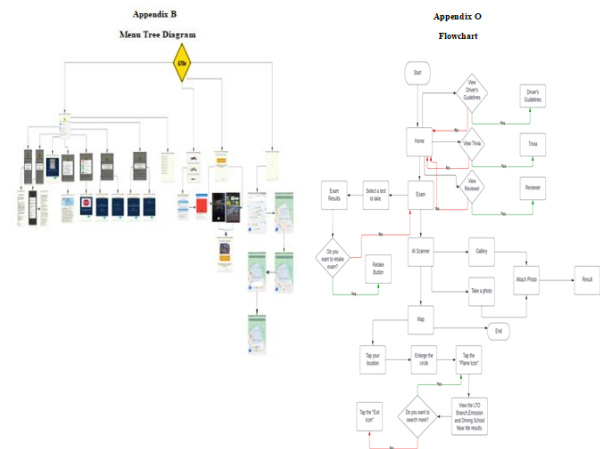
Design

After gathering ideas from brainstorming, the researcher created a diagram this is the Menu Tree Diagram (See in Appendix D) and Flowchart (See in Appendix O) on designing

the mobile application, because menu tree diagram would serve as to make it simple to understand the flow and how the system of the mobile application works. In the menu tree diagram the user will see the main page or homepage of the application where the user can select a tab in that can see in the bottom this are the Exam Menu, AI scanner and Map. In the exam menu user can take an exam based on what the user will choose to take after taking exam user can select submit exam to see the exam result. Next tab would be the AI scanner this feature of the app can be used to scan a traffic sign that was the user wants to know, user can access this feature by tapping the AI scanner tab then user can select photo or take a photo of the traffic signs on based on the user desire to choose.

Lastly the Map user can access this tab after tapping the pin icon on the bottom right after tapping the user would need to tap the current location to access then by adjusting the radius of the circular shape on the map after that user can now tap the airplane icon to start locating a near LTO branches, emission centers and driving schools. Admin of the mobile application can update the app base on the future recommendations and suggestions of the users. In the storyboard shows the raw development of the mobile application, in the hamburger icon user can see the about and the two choices user manual and report a bug. In the next screenshot shows the raw development of the Non-Professional Driver's License reviewer, where user can view 1 out of 100 reviewer.

Next screenshot is the exam page which shows the development of the exam page by choosing 1 out of the 3 choices alongside with the exam result after user finish the exam. Next would be the AI scanner page that shows the simple design of the development of this feature by the choosing take picture or gallery. Lastly the Map user would see the process of how to locate branches of LTO this was the simple design that the developer was planning to create and develop into the mobile application iLTGo the storyboard will serve as the step by step process of the development of the app from raw design and simple ideas upon planning and creating the mobile application.



Storyboard



Coding

After visualizing the concept and what will be used in the mobile application, the developer began to use. The researchers used SQLite to store all the data, Flutter because it has a lot of pre-built widgets that can be quickly customized and used to develop this application, Dart to create this application, and Android studio to implement the mobile application.

This is where the developer tests the applications' features, if all are working towards them in functions. The LTO Reviewer, Penalties and Driving Guidelines, Exam, Trivia, and LTO Branch Locator are among the features of the mobile app iLTGo.

Testing

After it has been developed and programmed, the researcher will test the mobile application to identify and correct any bugs, and the programmer will seek for methods to improve the app. In order to identify the benefits and drawbacks of the application, the study is open for critique, and this testing will give the researchers feedback.

The researchers use Random purposive sampling. The researchers initially conduct an ISO25010 serving tool to ascertain whether the mobile application truly benefits both drivers and riders. The researchers conducted face-to-face and online interviews with the participants using Google Forms for a total of 51 beta and 3 alpha testing. The Alpha test respondents were John Wilfred Duran, a BS in Information Technology and a Major in Programming graduate of Quezon City Polytechnic University; Jay Christian Cortez, a BS in Information Technology graduate of Utah Valley University; and Brian Orbino, a BS in Information Technology graduate of Sultan Kudarat State University.

During the distribution and administration of the questionnaire, a brief explanation of how the respondent will fill out the checklist based on the functionality of the mobile application was provided. The researchers used the mother tongue language for communication. The questionnaire was administered both in-person and online via Google form from October 1 until November 30, 2022. Within less than 10 minutes of using the mobile application, the respondents completed the beta questionnaire that the researchers disseminated, gathered, and administered.

After disseminating, gathering, and administering the collecting questionnaire the researcher use the Mean Scale for the purpose of calculating a collection of numbers central value and for determining the data's central tendency. The formula for finding the mean for a set of given observations is $\text{Mean} = (\text{Sum of Observations}) / (\text{Total Numbers of Observations})$
 $\bar{x} = \Sigma fx / \Sigma f$ where, $\bar{x}$ = the average value of the provided data collection, f = the frequency of every class, and x is the midpoint of each class's interval.

Table 1 : Rating Scale for Beta And Alpha Test Survey

Scale	Mean Range	Response	Verbal Interpretation
5	4.21-5.00	Strongly agree	Excellent
4	3.41-4.20	Agree	Very Satisfactory
3	2.61-3.40	Neither agree nor disagree	Satisfactory
2	1.81-2.60	Disagree	Need Improvement
1	1.00-1.80	Strongly disagree	Poor

The researcher then used the Likert scale to assess respondents' sentiments by asking how strongly they agreed or disagreed with a specific question or statement. Eventually, the verbal interpretation was used by the researchers to assess how positive the interview for the mobile application performed. To know about the feedback regarding the mobile application, total all the respondents' feedback to determine whether the mobile application is entirely beneficial to the riders and drivers. Verbal interpretation shows how satisfied each the user is with their response, ranging from Poor, Needs Improvement, Satisfactory, Very Satisfactory, and Excellent.

Deployment

After the process and testing phase, the technical adviser, panelist, and the mobile application are effective, develop and improve. Now the developer is ready to deploy the mobile application in Google Play Store so that anyone can easily access it.

RESULTS AND OUTCOMES

This section presented the findings and outcomes based on the study's objectives, and it is crucial that the research output be organized and presentable. The discussions and conclusions are based on the goals of the study, as well as the completion of the analysis and testing of the development of the application known as the iLTGO: An Informative Land Transportation Guide Mobile App.

Before developing the mobile application, the researchers first successfully collected data from online research publications, relevant applications, and collaborations. This gave them a wealth of knowledge, insights, and ideas. The information obtained from online

libraries, research journals, and related applications will be included in the application's content to make it simple for riders and drivers to understand the traffic laws and regulations here in the Philippines.

Second software technologies and system needs were found by the researchers. The evaluated available hardware that is compatible for installation and configuration has complied with the system software requirements, allowing the researchers to create the iLTGO app. The researchers used SQLite to store all the data, Flutter because it has a lot of pre-built widgets that can be quickly customized and used to develop this application, Dart to create this application, and Android studio to implement the mobile application.

Third, to develop visually appealing and eye-catching icons for the mobile application, the researchers utilized a narrative board to outline its appearance and layout. This helped them turn the story board into a functional application that would catch users' interest.

Fourth the researcher used the software developed tools to translate the design into working system .The researcher successfully developed and created iLTGo An informative Land Transportation Guide Mobile App an app that would able to assist the drivers and riders in knowing, understanding, and being aware of road signs and traffic signs in order to avoid infractions and accidents. This mobile application will also act as guide for all drivers who are unfamiliar with road traffic signs and laws it will assist drivers in thoroughly understanding those rules and signs on the road to be safe and aware.

Fifth, utilizing the ISO25010 Software Product Quality Standards to evaluate the user's thoughts and ideas regarding the program in terms of Functional portability, Usability, Compatibility, and Portability.

After the mobile application was created and coding was completed, the researcher conducted testing to look at what are the ways to improve the mobile application.

The study is open to critique to see what the weaknesses and strengths of the application and this testing will serve as feedback to the researchers. The testing of the mobile application is using the ISO 25010 in terms of Functional Sustainability, Usability,

Compatibility and Portability. After the testing was conducted from the expert and users the researchers will see that it has a failure in terms of the features, the programmer code again to settle the detect of the mobile application is ready to be used and put through another test .

The mobile application has passed the test in Functional Sustainability represents the extent to which a system provides functions that meet stated and implied needs.

The mobile application has also passed the test in Usability. It is cover under which a system can be used by helping to achieve goals in a specified context of use completely, efficiently, and competently.

The mobile application has also passed the test in Compatibility. The ability of a product, system, or component to communicate with other products, systems, or components and/or carry out its necessary functions while utilizing the same hardware or hardware environment known as compatibility.

And lastly, the mobile application has also passed the test in Portability (See in Appendix I) Portability describes how well system, product, or component can be moved from one to another. The survey was done through in-person interviews and Google forms. The information received from the Alpha and Beta is listed below.



Figure 3:iLTGo Main Menu

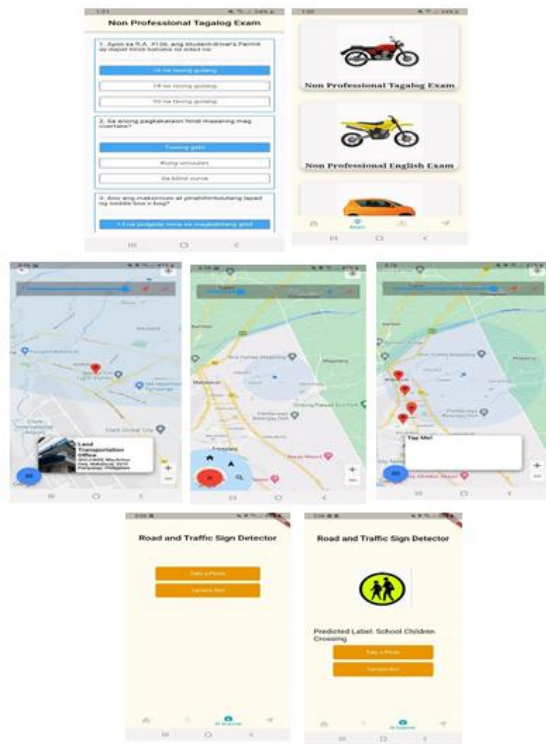


Figure 4: iLTGo Features

Table 1: Rating Scale for Alpha and Beta Test

Criteria	Mean Range	Response	Verbal Interpretation
Functional Suitability	5	Strongly Agree	Excellent
Usability	4.83	Strongly Agree	Excellent
Compatibility	5	Strongly Agree	Excellent
Portability.	4.88	Strongly Agree	Excellent
Total Result		4.92	Excellent

Alpha test

This Alpha test table would be the basis about how Alpha users satisfy about the mobile application in terms of Functionality Suitability, Usability, Compatibility and Portability of the app.

Functional Suitability got a total result weighted mean of 5 with a verbal interpretation “Excellent”. This means that alpha users are very satisfied in the mobile application in terms of functional completeness which is the features of the app; functional correctness that

the app features are working properly and lastly the functional appropriateness which is the functions are able to finish task and objectives. Functional Suitability got a total weighted mean of 5 because the mobile applications meet the alpha users satisfactory in the app. The entire alpha user answered strongly agrees which resulted a total weighted mean of 5 and a verbal interpretation excellent that the alpha users are satisfied.

The Usability of the mobile application based on the alpha test survey Usability of the app got a total overall result weighted mean of 4.83 and a verbal interpretation “Excellent”. This means that alpha users are satisfied in the mobile application in terms of appropriateness recognisability which is for the alpha users the app is easy to use, learnability that alpha user satisfied because the app is allowing to achieve a specific goal, operability that the alpha users are satisfied on the app is easy to operate or control, user error protection which the alpha users are satisfied in the app protection on making errors, user interface aesthetics that the alpha users are satisfied on the app user interface, and lastly the accessibility which allow the users to allow the users and manipulate data. The total weighted mean of 4.83 and a verbal interpretation excellent defines that the alpha users are satisfied in the mobile application usability.

Table 11 : Summary over all of alpha Test

Scale	Mean Range	Response	Verbal Interpretation
5	4.21- 5.00	Strongly agree	Excellent
4	3.41-4.20	Agree	Very Satisfactory
3	2.61-3.40	Neither agree nor disagree	Satisfactory
2	1.81-2.60	Disagree	Need Improvement
1	1.00-1.80	Strongly disagree	Poor

The mobile application compatibility survey result for the alpha users got an overall total weighted mean of 5 with a verbal interpretation of “Excellent”. This result means that all of the alpha users are very satisfied in the mobile application usability in terms of its co-existence which is the app is can interact with other apps on devices without causing any issues in phones the alpha users answered strongly

agree which means that alpha users are satisfied. In the Interoperability of the app the alpha users are satisfied that it can exchange information and used that information that has been exchange and alpha users answered strongly agree and got a weighted mean of 5 and verbal interpretation excellent resulting that the mobile application compatibility meets the alpha users satisfactory.

In the Portability survey of the mobile application for the alpha users has got a total overall weighted mean of 4.88 and a verbal interpretation "Excellent". The overall weighted mean 4.88 was got because in terms of the mobile application adaptability one of the alpha users is answered agree so the computed total weighted mean is 4.66 for the adaptability; in total overall result is 4.88. This means that alpha users are strongly agree and satisfied in the mobile applications adaptability which is alpha users saw that the app can demonstrate software independence, Installability that the alpha users saw that the app can be installed in any different android OS version with the minimum requirement specification and lastly the replaceability that the alpha users saw that the app can be accessed with more than one devices. The 4.88 weighted mean and the verbal interpretation defining that the mobile applications portability meets the satisfactory of the alpha users.

The total respondents for alpha test for the functional suitability the mean range is 5 means strongly agree for the function of the mobile application and for the usability test obtain a mean range of 4.83 means strongly agree for the usability test, in term of usability test and the capability test got a mean range of 5 they strongly agree for the capability test and lastly the portability test and have a mean range of 4.88 they strongly agree for the portability of the mobile application.

Beta test

In the Functionality Suitability survey of the mobile application in beta users has got an overall total weighted mean of 4.66 with a verbal interpretation "Excellent". This means that the beta users are satisfied in the mobile application in terms of its functional completeness which is the app features satisfy the beta users because 49 of the beta users answered strongly agree and 4 are agree.

Functional correctness which is the features of the app is works properly the beta users satisfied, functional appropriateness which is the application functions able to finish task and objective. The overall result weighted mean of the mobile application functionality suitability is 4.66 with a verbal interpretation excellent this is defining that beta users are satisfied in the app functionality suitability.

The usability of the mobile application survey for beta users got an overall total weighted mean of 4.51 with a verbal interpretation "Excellent". Excellent defines that the beta users are satisfied with the mobile application in terms of Appropriateness recognizability which is the app is easy to use because most of the beta users agree with it, Learnability the beta users satisfied on the apps ability to allow user to achieve specified goals of learning, Operability is that the app is easy to operate or control and the beta users are answered strongly agree and agree, user error protection that does the app protecting users on making errors the beta users are satisfy, User interface aesthetic most beta user agree because of the user interface is satisfying, lastly the Accessibility which the application allows users to access and manipulate data. The overall total weighted mean 4.51 with verbal interpretation excellent is a result that the mobile application usability meets the satisfactory of the beta users.

In the compatibility of the mobile application survey for the beta users the overall total result weighted mean is 4.61 with a verbal interpretation "Excellent". The beta users satisfied in terms of the apps co-existence which is the app can interact with other apps without causing any issues on the phone and the beta users answered 36 are strongly agree and 18 are agree with a total weighted mean 4.75 a verbal interpretation excellent this means the beta users are satisfied on the app co-existence. Interoperability of the app the beta user's answers strongly agree and agree with a weighted mean of 4.61 a verbal interpretation excellent showing that the app compatibility satisfied the beta users.

In terms of the portability of the mobile application the overall total result on the survey for beta users got a weighted mean 4.58 and a verbal interpretation "Excellent". The

weighted mean 4.58 and verbal interpretation is defining that all of the beta users are satisfied in the mobile application in terms of its adaptability that can app demonstrate independence the beta users answer strongly agree and agree, installability is the app can be installed on different android OS version with the minimum requirement in specification and lastly the replaceability that the application can be accessed with more than one devices that can be run 31 beta users answered strongly agree and 22 are agree. This result in the survey for the portability of the app is showing that all of the beta users are very satisfied on the mobile application in terms of its portability.

Table 12 : Summary Over All of Beta Test

Criteria	Mean Range	Response	Verbal Interpretation
Functional Suitability	4.66	Strongly Agree	Excellent
Usability	4.51	Strongly Agree	Excellent
Compatibility	4.61	Strongly Agree	Excellent
Portability.	4.58	Strongly Agree	Excellent
Total Result		4.59	Excellent

The total respondents for beta test for the functional suitability the mean range is 4.66 they strongly agree for the function of the mobile application and for the usability test got a mean range of 4.51 they strongly agree for the usability test, in term of usability test and the capability test got a mean range of 4.61 they strongly agree for the capability test and lastly the portability test and have a mean range of 4.58 they strongly agree for the portability of the mobile application.

Comparison of Alpha and Beta Test

The majority of respondents said that the mobile application is fully functioning when comparing the functional suitability of beta and alpha. Additionally, some respondents' responses that they concurred with showed that the mobile application is functionally appropriate. The respondents indicated an answered strongly agreed and agreed with the results of the usability test because the mobile application has a learning material and for the user friendly of the mobile application specially the design of it, the compatibility test results for the mobile application for the alpha and

beta testers were both strongly agreed and agreed because of the features that the mobile application have example of IA scanner and the Google maps that's locate the emission center, driving school and LTO branches, lastly the portability test results for the beta and alpha testers were also strongly agreed and agreed with the portability test because the mobile application meets the respondents smart phone requirements and completely installed the mobile application properly.

DISCUSSIONS

This section presented the discussion and conclusions based on the study's objectives, finished analysis, testing, and evaluation of the created app. It also included the developers' suggestions for how to make the app even better for upcoming researchers.

The researchers successfully collected data from online research articles, pertinent applications, and collaborations before constructing the mobile application. This provided them with a variety of information, thoughts, and ideas. The content of the application will comprise material acquired from online libraries, research journals, and related applications to make it easier for riders and drivers to understand the traffic laws and regulations in the Philippines.

The researchers discovered software technologies and system requirements. The reviewed available hardware that is compatible for installation and configuration has met the system software requirements, allowing the researchers to construct the iLTGO program. The researchers used SQLite to store all of the data, Flutter because it contains a lot of pre-built widgets that can be rapidly changed and used to make this application, Dart to design this application, and Android studio to implement the mobile application. The researchers used a story board to outline the style and layout of the mobile application in order to create visually appealing and eye-catching icons. This aided them in turning the story board into a useful application that would pique the interest of consumers.

The researcher used software developed tools to translate the design into a working system. The researcher successfully developed and created iLTGo An informative Land

Transportation Guide Mobile App, an app that would help drivers and riders know, understand, and be aware of road signs and traffic signs in order to avoid infractions and accidents.

The study is open to critique to see what the weaknesses and strengths of the application and this testing will serve as feedback to the researchers. The testing of the mobile application is using the ISO 25010 in terms of Functional Sustainability, Usability, Compatibility and Portability. After the testing was conducted from the expert and users the researchers will see that it has a failure in terms of the features, the programmer code again to settle the defect of the mobile application is ready to be used and put through another test

The majority of respondents said that the mobile application is fully functioning when comparing the functional suitability of beta and alpha. Additionally, some respondents' responses that they concurred with showed that the mobile application is functionally appropriate. The respondents indicated an answered strongly agreed and agreed with the results of the usability test because the mobile application has a learning material and for the user friendly of the mobile application specially the design of it, the compatibility test results for the mobile application for the alpha and beta testers were both strongly agreed and agreed because of the features that the mobile application have example of IA scanner and the Google maps that's locate the emission center, driving school and LTO branches, lastly the portability test results for the beta and alpha testers were also strongly agreed and agreed with the portability test because the mobile application meets the respondents smart phone requirements and completely installed the mobile application properly.

Conclusion

iLTGo is a mobile application that can help riders and drivers recognize, comprehend, and be mindful of traffic and road signs. This application will also be a source of information for those motorists who are unfamiliar with traffic regulations and signs. By minimizing violations, it can also help drivers and riders save money in addition to lives. The iLTGo mobile app is an informative land

transportation guide that caters to all motorists and riders that find it difficult to understand all of the traffic signs and regulations in the Philippines. According to L. Batongbakal Jr., the minimum age to apply for a license is 16 or 18 if you're a foreigner. All drivers and riders that followed the LTO rules would benefit from the app. The mobile application iLTGo was developed using Dart, Flutter, SQLite, and Android Studio. When creating the app, researchers would use a menu tree diagram and a story board. The LTO Reviewer, Penalties and Driving Guidelines, Exam, Trivia, and LTO Branch Locator are features of iLTGo app. On the exams, a random selection of 60 out of the 100 review questions would be presented.

The users of the mobile application can view the Penalties and Driving Guidelines on the LTO Related Laws page. On the exam bar, users can take a test that is offered in both English and Tagalog. When the user returns to the homepage and clicks the LTO Branch Locator symbol a second time after installing the app, the location indicator will show up. The app's functions can be used both online and offline, and Android version five or higher is required. Users can view the address of the branch by tapping the tap me text that is visible at the bottom. Google Maps recommends the address and the branches. In terms of functionality, usability, compatibility, and portability, the mobile application iLTGo an Informative Land Transportation Guide Mobile App has been thoroughly developed. The mobile application was released to the Google Play Store after requirement gathering, designing, coding, testing, and after the researchers had finished their ideas and recommendations. With the summary of findings and complete evidences the researches conclude that the overall objective of the study was achieved.

Recommendations

The researcher has a plan for the future features of the mobile application iLTGo, which stands for Informative Land Transportation Guide Mobile App. One of the changes the researchers want to make to the mobile app's design is the font. They also want to apply a different font to the app's logo and user interfaces to make them easier for users to read. Secondly, the researchers want to

introduce a dark mode for users that wanted to use the app in a dark theme.

The researchers want to incorporate dark mode to make the other users compatible while using the mobile app because some of the users are compatible with excessive light and the other users are compatible with dark themes. In order to make the mobile software usable for additional users, the researcher would also like to provide dual language features. Lastly, the researcher would like to develop a virtual driving school where users may utilize this function as a driving instruction manual by practicing on a virtual driving automobile to become knowledgeable with the traffic laws that can be applied in real life.

REFERENCES:

- [1] World Health Organization. (2022). *Powered two- and three-wheeler safety: A road safety manual for decision-makers and practitioners* (2nd ed.). <https://apps.who.int/iris/bitstream/handle/10665/363455/9789240060562-eng.pdf?sequence=1>
- [2] Rahman, M. M., Islam, M. K., Al-Shayeb, A., & Arifuzzaman, M. (2022). Towards sustainable road safety in Saudi Arabia: Exploring traffic accident causes associated with driving behavior using a Bayesian belief network. *Sustainability*, 14*(10), Article 6315. <https://doi.org/10.3390/su14106315>
- [3] Kitamura, Y. (2018). Traffic problems in Southeast Asia featuring the case of Cambodia's traffic accidents involving motorcycles. *IATSS Research*, 42*(4), 163–170. <https://doi.org/10.1016/j.iatssr.2018.12.001>
- [4] Publico, R. (2023, November 21). 6 traffic laws in the Philippines that keep our roads safe. *Moneymax*. <https://www.moneymax.ph/car-insurance/articles/driving-laws>
- [5] Sunnexdesk. (2019, June 6). LTO Angeles City conducts road safety awareness drive. *SunStar Pampanga*. <https://www.sunstar.com.ph/article/1808835/pampanga/local-news/lto-angeles-city-conducts-road-safety-awareness-drive>
- [6] Bañez, J. L. M. (2022). *[Title not available]*. Bulacan State University. <https://bulsu-ovprde.com/wp-content/uploads/2022/10/Jeremy-Laurence-M.-Banez.pdf>
- [7] Quito, B. (2016). Road safety and traffic education (RoSTed): The institutionalization, certification, and standardization of road safety and traffic education in the Philippines. *ResearchGate*. https://www.researchgate.net/publication/297715282_Road_Safety_and_Traffic_Education_RoSTed_The_Institutionalization_Certification_and_Standardization_of_Road_Safety_and_Traffic_Education_in_the_Philippines
- [8] Batongbakal Jr., L. E. (2024, March 27). *How to renew driver's license in the Philippines: 2025 guide*. FilipiKnow. <https://filipiknow.net/drivers-license-renewal/comment-page-5/>
- [9] [Author unknown]. (2022). *An interpretation of Dart programming language*. ResearchGate. https://www.researchgate.net/publication/358661479_AN_INTERPRETATION_OF_DART_PROGRAMMING_LANGUAGE
- [10] Synytsia, M. (2024, December 23). *Pros and cons of Flutter app development*. AltexSoft. <https://www.altexsoft.com/blog/engineering/pros-and-cons-of-flutter-app-development/>
- [11] GeeksforGeeks. (2025, July 11). *Introduction to SQLite*. <https://www.geeksforgeeks.org/introduction-to-sqlite/>
- [12] Mathur, N. (n.d.). *What is Android Studio and how does it differ from other IDEs?*. Packt. <https://hub.packtpub.com/android-studio-how-does-it-differ-from-other-ides/>
- [13] Walsh-Kelly, C. M. (2015, August 26). *Flow chart/process flow diagram*. UNC School of Medicine. <https://www.med.unc.edu/neurosurgery/wp-content/uploads/sites/460/2018/10/Flow-chart-Process-Flow.pdf>
- [14] Sherman, A. (n.d.). *Create a storyboard: A guide by Storyboard That*. Storyboard That. <https://www.storyboardthat.com/articles/e/what-is-a-storyboard>
- [15] Arora, V. (2021, February). *What is a tree menu?*. Planet Crust. https://www.planetcrust.com/what-is-a-tree-menu?utm_campaign=blog
- [16] Peters, E., & Aggrey, G. K. (2020). An ISO 25010 based quality model for ERP systems. *Advances in Science, Technology and Engineering Systems Journal*, 5(2), 578–583. https://www.astesj.com/publications/ASTESJ_050272.pdf
- [17] Aydinan, J. B. (2020). Knowledge and level of compliance of tricycle drivers on traffic rules and regulations: A case of the tricycle city of the Philippines. *International Journal of English Literature and Social Sciences*, 8(1), 1–20. https://ijels.com/upload_document/issue_files/30IJELS-104202034-Knowledge.pdf
- [18] Boensma, E. C. M. (2019). The use of gamification and virtual reality in e-learning tools used in preparation for driving exams: A comparative study [Master's thesis, University of Twente]. https://essay.utwente.nl/78930/1/Boensma_MA_BMS.pdf
- [19] Lu, J. L., Herbosa, T. J., & Lu, S. F. (n.d.). *Analysis of transport and vehicular crash cases using the Online National Electronic Injury Surveillance System (ONEISS) from 2010 to 2019*. Retrieved from https://www.researchgate.net/publication/334997137_Self_Adaptation_in_Mobile_Apps_a_Systematic_Literature_Study
- [20] Sester, M. (2020). Analysis of mobility data – A focus on mobile mapping systems. *Icon*, 68–74. <https://doi.org/10.1080/01426397.2020.1737612>
- [21] LTO Driver Exam Reviewer. (n.d.). [Mobile app]. Ephesus Computer Technologies. <https://play.google.com/store/apps/details?id=com.ephesuscomputertechnologies.ltodriverexamreviewer>
- [22] LTO Theoretical Driving Filipi. (n.d.). [Mobile app]. TDC Driving School. <https://play.google.com/store/apps/details?id=tdc.com.dst&pli=1>
- [23] LTO Reviewer. (n.d.). [Mobile app]. <https://play.google.com/store/apps/details?id=com.ltodriverexam>
- [24] LTO Driver's License Exam. (n.d.). [Mobile app]. PiusWorks. <https://play.google.com/store/apps/details?id=com.piusworks.ltoexam>
- [25] LTO PH. (n.d.). [Mobile app]. DevJXTN. <https://play.google.com/store/apps/details?id=com.devjxtn.ltoph&hl=en>

InTheMap: An Android Mobile App that Locates Nearby Resorts

Kristine D. Dayrit
Carol D. De Jesus
Nico D. Dungca
Mark Ryan C. Naguit
John Michael G. Ramos
Lorenzo C. Macam, MIT (Technical Adviser)

ABSTRACT

The primary purpose of this project to develop a mobile application Im the map that locate nearby resort in first district in Pampanga that can assist everyone, this application helps you to find a private resort and to show and locate a resort here in 1st district of Pampanga. Modified Waterfall method was used in the development of the mobile application. Use Case Diagram was utilized to illustrate the user's interaction and represents the relationship between the admin, conductor and the users. The researchers used flutter, dart and firebase to developed the "ImTheMap: An Android Mobile App That Locates Nearby Resorts. This study uses a mobile app and provide information on the well-liked private resorts a location that people frequently or regularly visit for enjoyment pleasure, especially one that offers accomodation for tourist relax and have fun.

INTRODUCTION

According to research conducted by Mabalacat City College students, there are a lot of problems when it comes to finding resorts around the world. Possibly this will be the cause for the tourists and growers. This happens globally because of the lack of advertising resorts like no social media advertisement. Today's generation, we are using different technologies wherever location. Even the children are using technologies. It is clear that we have to do something in our time concerning global warming yet before we can actually change the world, we must first understand our world.

According to Heidegger, technology itself is not good or bad, but the problem is, that technological thinking (calculative thinking) has become the only form of thinking. Heidegger saw that the essence of technology nowadays is enframing – Ge-stell, which means that everything in nature is 'standing-reserve' (Bestand). Enframing (as apparatus) is one way of uncovering, which for Heidegger meant truth. Truth can appear in many ways and the danger is that this truth of representational-calculative thinking becomes the only truth. We claim that the calculative way of thinking must be changed and we posit that Gelassenheit (slow thinking, releasement, letting-go) is the remedy. It does not mean some kind of mysticism or irrationality. The notion of

Gelassenheit includes the idea of to let learn. We as teachers and educators have to learn how to think outside of the technological 'Ge-stell' and start thinking and acting in radically new ways. Like Arne Naes and Michael Zimmerman, we connect the overcoming of technological 'Ge-stell' with so called deep ecology. We have to 'learn to think' and act within the deep ecology. We call for an educational ecological imperative. Every teacher and educationalist have to think what they can do (not as private person but as professionals) in order to prevent the coming eco-catastrophe.

It is now entirely clear that we must do something about the global warming and climate crises. Yet before we can change our situation, we must first understand our situation. According to Heidegger, and also in line with Deep Ecology, our understanding of technology plays a central role in fighting the climate crisis. Technology itself is not good or bad. The problem is that technological thinking (calculative thinking) has become the only form of thinking. One reason for this is our failure to understand the essence of technology in modern times. In Antique Aristotelian thought, Techne (the bringing forth of something) was the essence of technology. Heidegger saw the essence of technology in modern times as Ge-stell (frame, framing, enframing, construct, exposition, universal imposition).

Beherrschbarkeit (controllability) and Machenschaft (machination) can be seen as predecessors to Ge-stell. Ge-stell is a kind of thinking that conceives both nature and humans as a 'standing-reserve' (Bestand). Ge-stell reduces the whole world to a manageable reserve, which can be put to use with the help of calculative thinking. A river is a reserve for a power station; a forest is a reserve for a paper factory.

The aim of this paper is to reflect on how or to what extent – if any – teachers and educational scientists could step outside of this technological Ge-stell. First, the calculative way of thinking must be changed, and we posit that Gelassenheit (slow thinking, releasement, letting go) is the remedy. Gelassenheit is thinking that lets things 'be in their being', letting the world to be. Gelassenheit is the opposite of Ge-stell and is an active way to be in the world. It does not imply some kind of mysticism or irrationality. The notion of Gelassenheit includes the idea of to let learn. This letting learn is more difficult than learning itself, because the task of letting learn involves learning to think. (Heidegger, 2019).

There are several technologies have but the mobile devices are majority for people. With mobile devices, there are lots of applications are using especially finding resorts in the Philippines. Some apps show navigations, maps and other things, but none of those apps shows the specific information of resort, offline use of applications and exact location of resort. That is why the researchers created "ImTheMap: An Android Mobile App that Locates Nearby Resort", a smartphone application that can assist the tourist to find resort. This application is useful program because the user can use whether there has an internet connection or not.

This focuses only on 1st District of Pampanga because most Filipino people like to travel and take vacation. Although navigation apps and some testing apps are ubiquitous. All tourist and gowers are considered but the coverage of the resorts is 1st District of Pampanga only. This study demonstrates what are the information, prices, show the different images of specific resort or in other word is the gallery of resort, the exact location of resort and the user will use online and offline mode.

ImTheMap is a great tool for the tourists specially the different owners of the specific resort, because even if there has advertisement of tarpaulin, flyers, and so on. Using this application software, they will advertise the resort using social media and it will serve as a locator for the user.

Objective of the study

In general, the main objective of the study is to develop a mobile app entitled "ImTheMap: An Android Mobile App That Locates Nearby Resorts" that will find the different resorts in 1st District of Pampanga, as well as the information, activities, events, embedded map or location, online offline view, direct contact and email of resort's owner, embedded gallery of resort and the manual of application on how to use it.

In line with this, this study aims to achieve the following specific objectives:

1. To identify the different resorts in District 1 of Pampanga
2. To design a mobile app using:
 - a. Android Studio
 - b. Android SDK
 - c. Java JDK
 - d. HTML5, CSS 3 and Javascript
 - e. Intel core i3, Ryzen 3, 4gb ram, 500gb HDD [Hard Disk Drive] or SSD [Solid State Drive]
3. To develop a mobile app that will show the Resorts in District 1 of Pampanga with the following features
 - a. Different resorts covered in 1st District of Pampanga including the information.
 - b. Embedded map or location and gallery of the application
 - c. Offline and online mode
 - d. The application was fit on the different android devices or what we called dynamic app.
4. To test the mobile application using ISO 25010 in terms of:
 - a. Functional Suitability
 - b. Reliability
 - c. Performance Efficiency
 - d. Usability
 - e. Security
 - f. Compatibility
 - g. Maintainability
 - h. Portability.

5. To deploy a mobile application on Google Play Store App.

Scope and delimitation

The Study aims to develop a ImTheMap: An Android Mobile App That Locates Nearby Resorts for 1st District of Pampanga that will provide comfortable way of searching a Resort based on the user in their contemporary position. This application is to show divergent information and policies, background, promos, pays for that resort and the location of the Resort.

The application is free of charge on play store mobile application or other services. The application is delimited to searching Resorts for 1st District of Pampanga. The application for ImTheMap: An Android Mobile App That Locates Nearby Resorts does not provide support for booking and on-line reservation system. It only serves as a locator and provides a list of resorts for 1st District of Pampanga.

SOFTWARE DEVELOPMENT METHODOLOGY

This section is used to demonstrate the analysis plan and the design of a mobile application, the implementation of the project is being done by the following the methodical practices and techniques.

The researchers used the Modified Waterfall to develop the mobile application because of the flexibility and the efficiency that suits the project development. The Modified Waterfall method and its purpose is to make a flow that the development of the application will be more efficient in Developing. Designing and for the documentation. This method aims to restore the previous phases on validating and verifying, it also authorizes the researchers to work more efficiently in the use of the Modified Waterfall method through the application development phases. These are the gathering process of requirements using Modified Waterfall which is design, coding, and testing.

Modified Waterfall

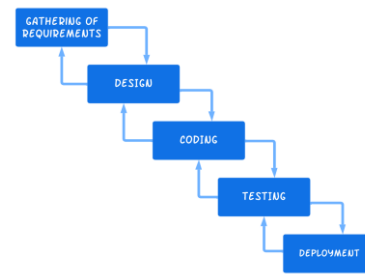


Figure 2. Application Methodology

Gathering of Requirements

For the gathering of requirements, the project leader plans for developing a mobile application. The researcher brainstormed about different types and styles so that the study will be more useful and creative. The researchers look for creative ways and a variety of information through online platforms and conduct surveys to support the data. Through a lot of ideas researchers agreed to come up with the idea of a mobile application that will be suitable for the tourists, because the tourists are the main concern of the study researchers interview few tourists about the idea of the study and the questions are relevant about the subject, through the answer the research had ideas on what are the useful design and features of their mobile application based on the needs of the tourist and gowers, In this phase the researchers will be able to create a clear goal for the study.

Design

After the gathering of ideas, the documents and prototype of the ImTheMap: An Android Mobile App That Locates Nearby Resorts for 1st District of Pampanga were constructed based on the requirement that had been gathered. The researchers planned the system's features during this phase as well. The information obtained from the collected data was also used to define the design of the different features of the suggested mobile application.

After the gathering of ideas from brainstorming, the researchers began to visualize the possible ways to create the mobile application, starting to look for the good software to use that will be suitable for the study. The researcher visualizes the use of HTML5, CSS3,

JAVASCRIPT, Java JDK and Android Studio to the mobile application, the HTML5, CSS3 and JAVASCRIPT as the programming language that will be suitable for mobile application together with the Java JDK to make a good result and an android studio for the coding of data, and lastly visual table of contents for the structure and flow of the features in the mobile application, this software are convenient and accessible ways to create mobile applications.

Coding

After visualizing the concept and what will be used in the mobile application, the developer began to use html, CSS, JavaScript and android studio to create the application. The html, CSS, JavaScript together as the main foundation of the mobile application since this is the programming language that is used and it supports the application's core to develop, while the android studio will be the main platform for the coding, this is where the developer tests the applications features if all are working towards in functions.

Testing

After the mobile application was created and coding was completed, the researcher conducted testing to look at what are the ways to improve the mobile application. The study is open for critique to see what the weaknesses and strengths of the application and this testing will serve as feedback to the researchers. The testing of the mobile application is using the ISO 25010 in terms of: Functional Suitability, Reliability, Performance Efficiency, Usability, Security, Compatibility, Maintainability and Portability, (See in Appendix C). After the testing was conducted from the expert the researchers will see that it has a failure in terms of the features, the researchers code again to settle the defect of the mobile application, after the adjustment and improvement the mobile application is not in the good condition to use.

Before deployment, the researchers used ISO 25010 testing cases to assess the mobile application's functional suitability, reliability, performance efficiency, usability, security, compatibility, maintainability, and portability. The mobile application has passed the test in Functionality Suitability, (See in Appendix B). Functionality Suitability represents the extent

to which a system provides functions that meet stated and implied needs.

The mobile application also passed the test in Reliability, (See in Appendix C). Reliability is a set of characteristics that support on a software's ability to maintain its level of performance under specified conditions for a specified period of time.

The mobile application has also passed the test in Performance Efficiency, (See in Appendix C). Under specified conditions, Performance Efficiency is a set of attributes that hold on the relationship between the level of performance of the software and the number of resources used.

The mobile application has also passed the test in Usability, It is the cover under which a system can be used by helping to achieve goals in a specified context of use completely, efficiently, and competent.

The mobile application has also passed the test in Security. Security is the stage to which a product or system protects information and data so that people or other products or systems have the appropriate level of data access for their types and levels of authorization.

The mobile application has also passed the test in Compatibility, Compatibility is the ability of a product, system, or component to exchange information with other products, systems, or components and/or perform its required functions while sharing the same hardware or software environment.

The mobile application has also passed the test in Maintainability. The ability of a product or system to be modified to improve, correct, or adapt to changes in the environment as well as requirements is referred to as maintainability.

And lastly, the mobile application has also passed the test in Portability, (See in Appendix C). Portability describes how well a system, product, or component can be transferred from one environment to another.

Deployment

After the process and testing phase, the technical adviser, panelist, and the mobile application are effective, develop and improve. Now the developers are ready to deploy the mobile application in Google Play Store so that anyone can easily access it.

RESULT AND OUTCOMES

This section deals with the Requirements Software, Product/ Processes Screen Shots Development and Testing Results Prototype.

Based on the gathered data, the researchers arrived with the following findings:

The common methods used by the 1st District of Pampanga to locate the resort are the following (1) flyers (2) Tarpaulin, (3) Magazine.

The main problems they encountered with the common methods used in locating resort in the 1st District of Pampanga are not familiar in the place, too far in the city, and the resort in hidden in the remote areas.

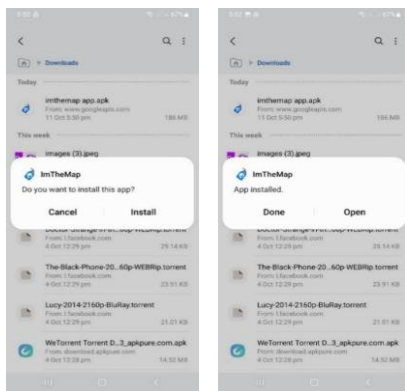
The best solution to minimize the problems encountered as indicated in the survey is to develop ImTheMap: An Android Mobile Apps That Locates Nearby Resorts.

The features that should be adopted in mobile application as recommended by the respondents are: easily view all resort on a single map view, display contact information, menu, resort hours and services, and latest information about their resort and activities.

Screenshots

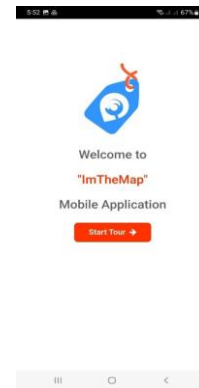
In this section the developers have formulated the features of the system that is to be used to cater the problems that the study has determined. Additionally, the application's actual design and screenshots are shown.

User Manual



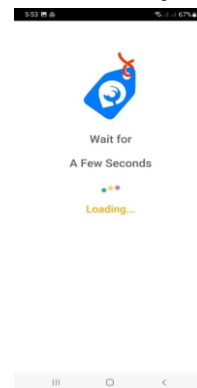
Screenshot 1 Installation Screen

Screenshot 1 is the Installation Screen. In this module ImTheMap, it is the interface where the application installing process. It is the process on how to install the application on android devices. After you download the application.



Screenshot 2 Welcome Screen

In screenshot 2 which is the splash screen, when you download the ImTheMap application that is the front page that you will see. It is the splash screen where apps opened this will appear and can be seen by the user.



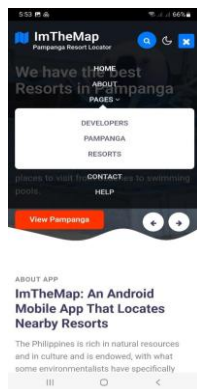
Screenshot 3 Loading Screen

The screenshot 3 after the user download the application on playstore and run-on android device. The loading screen, when the user clicks the “Start Tour” button, the screen shows the loading screen.



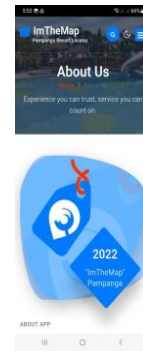
Screenshot 4 Home Page

The screenshot 4 is the Home Page of the app. This is the application's main user interface, through which one can view several overviews of Pampanga's first district. The different towns were Angeles, Mabalacat and Magalang, in the upper part with carousel is automatic show in the different details and buttons of the application. In the very upper right part, you will find the search box, the moon icon where the user changes the theme in light and dark mode. The logo of ImTheMap has a use of going to homepage.



Screenshot 5 Menu Bar

In screenshot 5 or the Menu Bar of the application in which the user will know the different button links of the application including the HOME, ABOUT, PAGES (Developers, Pampanga, Resorts), CONTACT and HELP MENU.



Screenshot 6 About Page

Screenshot 6 is the About Page, this page will show the information of the application, Pampanga, different credits of the application including their functions to know the beauty of the place.



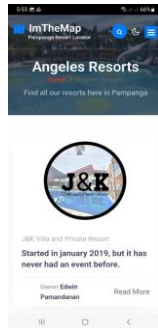
Screenshot 7 Developers Page

In screenshot 7 is the Developers Page, this page will show the owners of the application including their details and information they have or what they called "The Developers. The page will show the different person who are created the app.



Screenshot 8 Detailed View for Pampanga

Screenshot 8 is the detailed view for Pampanga. Starting in the homepage of the application, when the user clicks the Pampanga Button at the Menu bar it will show the history, and show with different information.



Screenshot 9 Different Resorts on Angeles Pampanga

In Screenshot 9 is the different resorts on Angeles Pampanga. When the user goes with Resorts Page, it will give the different lists of Angeles Resorts in 1st District of Pampanga. This page are shows the resorts of the District.



Screenshot 10 Different Resorts on Mabalacat Pampanga

In Screenshot 10 is the different resorts on Mabalacat Pampanga. When the user clicks to the next page below with Resorts Page, it will give the different lists of Mabalacat Resorts in 1st District of Pampanga.



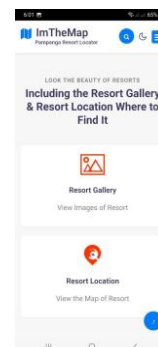
Screenshot 11 Different Resorts on Magalang Pampanga

In Screenshot 9 is the different resorts on Magalang Pampanga. When the user clicks to the next page below with Resorts Page, it will give the different lists of Mabalacat Resorts in 1st District of Pampanga.



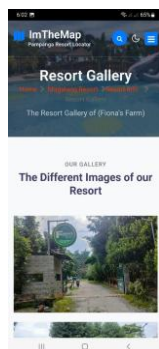
Screenshot 12 Detailed View of Resort

In Screenshot 12 is the detailed view of resort. Within this module the application will show the user the details about the owner, open and closing time, entrance fee, pay of cottages, activities that the resort offer, and its contact details of the resort.



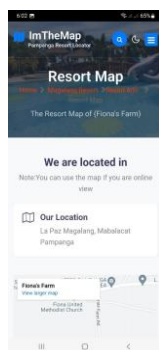
Screenshot 13 Resort Gallery & Location Button

In Screenshot 13 is the Resort Gallery & Location Button. In this module it shows different buttons including the resort gallery and location of resort and the upper icon in the right side has its function to automatic go to top of the page.



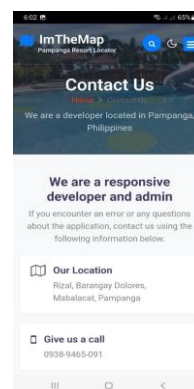
Screenshot 14 Resort Gallery

Screenshot 14 is the Resort Gallery of specific resort. In this module it shows different images in a specific resort that the user chooses to identify the different views of the resort. Whether the user is offline, the gallery of the resort is functional.



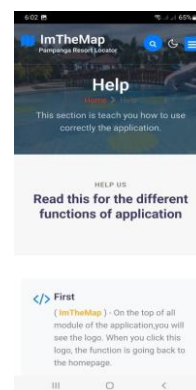
Screenshot 15 Resort Location/Map

Screenshot 15 is the Resort Location or Map. Within his module it shows that the map of a town or the resort itself in online mode, the user will find easily the location of the resort. If the user has not internet, the Map is error and not displayed.



Screenshot 16 Contact Us

In Screenshot 16 is the Contact Us. This page of the application will show the Contact Us where you can know the developers of the application, ask suggestions and the questions needed for the user.



Screenshot 17 Application Manual

In screenshot 17 is the Application Manual. This module shows if the user chooses the last part of the navigator button the user will show the manual or tutorial on how to use the application. you will saw the Application Manual in offline mode.

DISCUSSIONS

This section deals with the summary of findings, conclusions, and recommendations of the researchers based on the results and discussions gathered.

The researchers aimed to develop a ImTheMap: An Android Mobile Apps That Locates Nearby

Resorts for 1st District of Pampanga to promote the different resorts and tourist spots in the province. Specifically, it sought to answer the following specific problems. First, what are the present systems used in locating resort information for the 1st District of Pampanga? Second, what are the problems encountered with the present system used? Third, what system can be proposed to minimize problem encountered? Fourth, what features can be included in the design in proposed system?

The researchers chose to use Descriptive Developmental method pair with Agile Methodology as software development tool.

The researchers chose 1st District of Pampanga as the place where the study would be conducted. The target respondents were the people of 1st District in Pampanga. The district is made up of the municipality of Magalang, the neighboring city of Mabalacat, and the autonomous city of Angeles.

Conclusions

Based on the previous findings, the researchers concluded that:

The resorts located in the 1st District of Pampanga are using traditional methods of disseminating the resort's information.

There are problems encountered by the guests of the resorts using the present method in the locating the different resort in the 1st District of Pampanga.

A mobile resort-locating application is the first choice to minimize the existing problems encountered.

There are features that can be adopted in the development of mobile resort-locating application that would address the problems encountered.

Recommendations

Based on the foregoing findings and conclusions, the researchers offer the following recommendations:

The ImTheMap: An Android Mobile Apps That Locates Nearby Resorts will be uploaded to

Google play in order to be accessible to the users.

The application should comply to the standards of Google Play for the application to be uploaded.

The developers opted to develop android version of the ImTheMap: An Android Mobile Apps That Locates Nearby Resorts and envision to develop the application for other platforms.

The developers would initiate the upgrade of the ImTheMap: An Android Mobile Apps That Locates Nearby Resorts for additional features.

REFERENCES

Books

- [1] Abante, M. (2018). Web Application Programming Language (Revised Edition)
- [2] Farrell, Joyce (2018). Java Programming Concepts and Applications
- [3] Jemma Development (2019). HTML CSS and XHTML
- [4] Niederst, J. (2018). Learning Web Design (2nd Edition)
- [5] Malik. D. S. (2018). Java Programming from Problem Analysis to Program Design

Unpublished

- [6] De Guzman, Macaranas, Urayan, Poserio, Dumlaog & Hilot, (2018).
- [7] E-Turista Mobile Application for Pangasinan, Unpublished thesis, Philippine College of Science and Technology
- [8] Macalanda, Publico, Bacani, Permison, Quinagon, Austria & Concon, (2019).
- [9] Online Resto Bar Locator for Dagupan City, Unpublished thesis, Philippine College of Science and Technology
- [10] Castillo, Ballesteros, Centino, Padillon, Bautista, Hugo, Perez & Ico, (2019).
- [11] Insightlopedia: Matters of Life Mobile Application, Unpublished thesis, Philippine College of Science and Technology

Internet Sources

- [12] TripAdvisor [On-line]. Available at <https://itunes.apple.com/us/app/tripadvisor-hotels-flights/id284876795?mt=8> [2018, March 23]
- [13] MTrip [On-line]. Available at <https://www.mtrip.com/en/about/> [2018, September 01]

ITOUR: 3D Web Campus Guide of Don Honorio Ventura State University and Mabalacat City College

Rojie C. Bengco
Jondel A. Fiesta
Aira Nicole R. Gamulo
Edwin Ocampo
Jhan Kyle P. Waje
Agustin Edmin S. Yuzon (Technical Adviser)

ABSTRACT

Virtual tours are one of the trends that have emerged today. Different virtual tours are available on every platform based on their intended use. The addition of 3D graphics in this day and age has given birth to more innovative and interactive tours. The purpose of this study was to develop a 3D web campus guide that will inform the students by showcasing the 3D model of Mabalacat City College and Don Honorio Ventura State University along with the necessary information such as tuition fees, the admissions process, available courses, available facilities, and scholarship programs. The 3D web application uses a first-person perspective for a more realistic experience. The researchers used ISO 25010 for the alpha and beta tests. Five alpha testers were asked to evaluate the system, and thirty beta testers consisted of students aged 18–25 years old. The alpha testers evaluated the system with positive results, proving it works appropriately. The tester's results showed a positive result for all the categories of ISO 25010. In conclusion, the researchers were capable enough to meet study's overall objectives and met the expected outcome of the alpha and beta test results.

INTRODUCTION

Incoming or new students encounter a dilemma that always exists when looking for a new school to go into, which is how to scope out the university the student wants to attend so that the student will feel safe and confident. A single university is big enough for a student to have prior knowledge of the things that are available and accessible.

A college or university typically has several buildings to accommodate the learning activities of thousands of students from various faculties and departments. The large campus area sometimes makes visitors need to be aware of all the buildings. The university parties frequently held a campus tour activity to demonstrate the environment, facilities, and achievements to visitors or newcomers who came to the campus for the first time [1]. According to the article by De la Cruz [6], several programs or websites offer international virtual tours for students. Examples are CampusTours, which currently accommodates 1,800 schools in the United States and other countries such as the United Kingdom, Canada, China, and France. The other example is YouVisit, which offers virtual tours for more than 600 U.S. schools. These examples possess

the ability to provide a virtual environment for the students to have an easy way of navigating and the proper detailed distribution of the information that they need.

According to the study by Cyril [3], the difficulties encountered by new students and guests at Pangasinan State University in manually locating buildings and rooms are as follows: a tiring and time-consuming manual process and uncertainty in providing instructions and an exact location. In this regard, Campos developed a PSU Lingayen Virtual Mapping Walk-Through system, which features a 3D view and walk-through. In the recent study of Calingasan et al. [22], entitled "Into the Campus: Creating an AndroidBased Interactive Virtual Tour of La Verdad Christian College—Apalit Using Unity 3D," Calingasan advocated for 3D and virtual technologies by creating a 3D model of the school.

The study aims to help incoming students and their parents understand what they need to know before and after enrolling at La Verdad Christian College. The purpose of iTour is to help new students and visitors have proper knowledge before entering the campus. With the help of technological advancements, a new way for a campus tour was created by utilizing

three-dimensional (3D) technology and allowing users to explore the campus independently using self-guided devices.

Background of the study

The locale of the study is the Don Honorio Ventura State University (DHVSU) in Bacolor, San Fernando, Pampanga, and Mabalacat City College (MCC) in Barangay Dolores, Mabalacat City, Pampanga. Don Honorio Ventura State University (DHVSU) started when an Augustinian friar, Fr. Juan P. Zita, dreamed of helping the young people of Bacolor. Aided by an equally benevolent civic leader, Don Felino Gil, the school was officially founded on November 4, 1861. [7]

Mabalacat City College, known before as Mabalacat College, was established during the administration of former Mabalacat Mayor Marino P. Morales in September 2008. In 2013, the Mabalacat City College extension was built in Brgy. Dapdap, Mabalacat City. [18]

Many issues need to be considered in choosing the right university—especially as a student with no prior knowledge about the university you want to attend. It is a requirement for the student to know different things, for example, how big the institution is, the entry requirements for the chosen course, and the available social facilities such as a gymnasium, library, etc. These issues need real-time interaction between the student and the university because not all information can be found on the internet. [5]

The problem the researchers perceive is the average attendance requirement the students must fulfill. According to Trends in College Pricing and Student Aid, students must address transportation and personal expenses. Some students must go to their respective universities to scope out all the available offers that the institution can provide. The worst-case scenario is for those who are far away but know that the university does not suit them. [31]

iTour will be the tool students will use to gain easier access to the universities they wish to attend. The application will provide the right and exact information the students will need to decide on their college journey. Starting from the tuition fees, available courses, available facilities, admission process, and scholarships. With the application's ability to guide, students

can now scope out certain universities without leaving their homes.

Objectives of the study

The general objective of iTour: 3D Web Campus Guide of Don Honorio Ventura State University and Mabalacat City College is to develop a virtual guide for the new and incoming students of the included universities.

In line with this, the study aims to achieve the following specific objectives:

1. To gather the following information by sending formal letters and interviews to the included universities:
 - 1.1. Available Courses;
 - 1.2. Tuition Fee;
 - 1.3. Admission Process;
 - 1.4. Scholarship Programs; and
 - 1.5. Campus Layout.
2. To design the system using a storyboard and Use Case Diagram.
3. To identify software requirements for making the 3D layout and the system:
 - 3.1. Blender;
 - 3.2. Unity; and
 - 3.3. Adobe Photoshop.
4. To create a 3D web application with the following features:
 - 4.1. First-person perspective view;
 - 4.2. Minimap that will zoom in on the large scale of the whole campus; and
 - 4.3. Waypoints.
5. To test the application using the following ISO/IEC 25010:
 - 5.1. Functionality;
 - 5.2. Compatibility;
 - 5.3. Usability;
 - 5.4. Security; and
 - 5.5. Portability.
6. To deploy the web application through a hosting service platform.

Scope and limitations

The study, titled "iTour: 3D Web Campus Guide of Don Honorio Ventura State University and Mabalacat City College," aims to provide information and serve as a reference tool for incoming college students. The researchers created a criterion to decide which schools to include in the project. According to finduniversity.ph [19], the province of Pampanga has a total of 49 college universities, but based on the rankings given by the website [19] there are 23 universities within the region

of Central Luzon. One of those universities from the Province of Pampanga is the Don Honorio Ventura State University from Bacolor, Pampanga, which ranks 16th with a weighted ranking of 47.5%. In addition, according to iorbitnews.com [13], the Don Honorio Ventura State University garnered a 50.49% passing rate in the August 2019 Mechanical Engineer Licensure Examination with 122 passers. Mabalacat City College in Barangay Dolores, Mabalacat according to sunstar.com [20], based on the Local Pulse School Rankings released on January 1, 2020, Mabalacat City College (MCC) ranked fourth in the Best Customs Administration Schools in the Philippines for the 2019 category. Furthermore, according to sunstar.com [20], during the inauguration of Mabalacat City's re-elected Mayor Crisostomo Garbo in his first 100 days, he will transform the Mabalacat City College into a university. As a result, the researchers decided to include Mabalacat City College – Dolores Campus to advertise and endorse the college to potential students. To accomplish the necessary information, the researchers began the data gathering by sending a letter to the included college university to have a formal transaction with the researchers. After the letter had been approved, the researchers interviewed the administrators about what information they could provide to the researchers. Also, the requested confidential location of the school facility was not provided by the 3D tour

The researchers used the following software programs to develop and design the iTour; Blender 3D for recreating the whole campus because it has the capability of satisfying the requirements that the project needed; Adobe Photoshop for providing extra features and details for the 3D models if needed; the project's whole back-end coding will be carried out inside of Unity utilizing the C# language. Application Package Kit (apk) is also created inside Unity 3D.

The researchers came up with the following features: a first-person perspective mode, a minimap that the users can use while exploring the campus, and when it has interacted, the whole map layout will be displayed at the center of the screen. The larger map's objective

is to highlight the university's landmarks for easy access when exploring.

Waypoints, which can indicate the location of the facilities or buildings. Moreover, the researchers decided not to create a free-roaming camera feature to make the user fly freely across the campus because this will remove the experience of having the feeling while exploring the campus.

The researchers created a WebGL version of the system. The domain used is a website called itch.io. It is an open marketplace for indie developers to share their work. The researchers made the iTour WebGL available on itch.io for computers and mobile devices.

For the android users, researchers created an application package kit (apk) for android users. The researchers created a separate file for android users because mobile phones do not handle Unity WebGL. Unity WebGL may function on advanced gadgets, according to Unity Documentation [26], but current devices are insufficiently powerful and lack sufficient memory to support content. Furthermore, the system cannot be used offline if the user uses the web version

SYSTEM DEVELOPMENT METHODOLOGY

This chapter discusses the methodology of the research and how the application was developed using the development tools and techniques used by the researchers, from data gathering to program testing, and how the application was implemented to meet the objectives.

3.1 General Method used

The researchers of this study chose the system development life cycle (SDLC) method in designing and implementing iTour. The modified waterfall model, which is a descendant of the traditional waterfall model, guarantees the quality, dependability, and maintainability of the created custom software by offering a systematic flow of iterative development stages. The modified waterfall model, which is a descendant of the traditional waterfall model, guarantees the quality, dependability, and maintainability of the created custom software by offering a systematic flow of iterative development stages. [23]

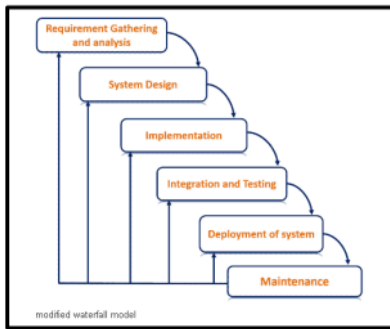


Figure 5: Modified Waterfall Model

(Source: <https://www.thestudygenius.com/what-is-waterfall-model/>)

Requirement Gathering and Analysis

The first phase began with the gathering and analysis of requirements.

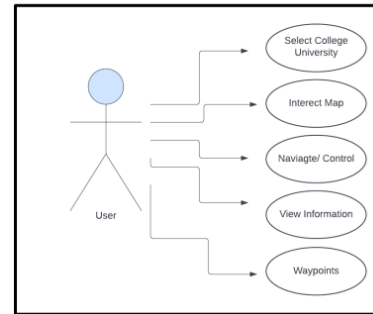
Researchers began by analyzing what information incoming students require to help them decide which college is best for them. Moreover, researchers list down all the information needed, such as tuition fees, courses available, the admission process, available facilities, scholarship programs, and campus layout. Researchers prepared a letter that was addressed to the president of the included college university and sent it. After the letter was approved, researchers spoke to the administrators of every college and university and agreed on what information the administrators could only provide and what information was restricted to the researchers.

System Design

System Design is the second phase of the modified waterfall model. Researchers researched related systems that could use and apply to the system. Researchers used two designing tools which are: Use Case Diagram and Storyboard. To show the relationship involving the user and the system, using the Use Case Diagram. (See Appendix B for the Use Case Diagram). Storyboard, to show how the system user interface flows and how the user will navigate. (See Appendix C for the Story Board)

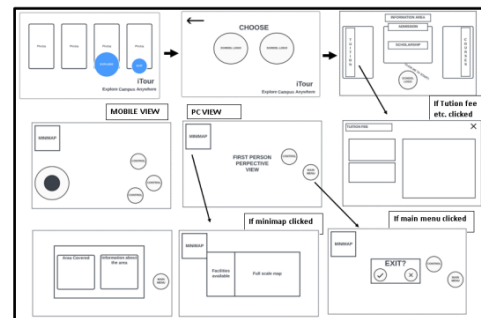
Appendix B

Use Case Diagram



Appendix C

Story Board



Implementation

The third phase is implementation. The researchers looked for suitable software that could help complete the project, such as Blender 3D, Unity 3D, and Photoshop. The creation of the 3D models was done using Blender 3D to portray the expected 3D environment of the included institutions. The help of Photoshop is for the texture designs of the 3D models that were built inside Blender 3D. Researchers were then transferred inside Unity 3D, which uses the C# language to create scripts that will enable all of our featured functions such as first-person perspective, a minimap, and waypoints.

Integration and Testing

The researchers conducted test cases using random sampling, a form of probability sampling, to select a subset of individuals from a population. [12]. The test cases were done in the form of ISO 25010, which focuses on the functionality, compatibility, usability, and security of the web application. For functionality, test all the features and objectives of the system. In terms of

compatibility, researchers assure that every device works on the system. Usability: test if the system is easy to learn and operate.

In terms of security, if the system is protected and able to prevent unauthorized access and modification to computer programs, Portability: test if the system is working well in one environment compared to another.

Deployment of System

Deployment of the system wherein the researchers created a WebGL version of the system and published it inside a website called itch.io for the users to use both laptops and computers. Itch.io is an open marketplace for indie developers to share their work. Researchers also created an Android version for mobile users using Unity 3D and uploaded it to the Google Play Store.

Maintenance

The last phase of the Modified Waterfall Model is Maintenance. The researchers provided maintenance functionality to fix bugs or issues in the system for better versions of the system. Researchers will also provide regular maintenance and support for the system.

RESULTS AND OUTCOMES

This section explains how the objective of the study is met, which is to provide a 3D web campus guide for Don Honorio Ventura State University and Mabalacat City College. Also included in this chapter is a discussion of the requirements gathering and analysis, design and implementation, and testing results.

Requirements Gathering and Analysis

The researchers discussed what information incoming students would require to help them decide where to enroll. Therefore, researchers agreed to collect the following information: available courses, tuition fees, the admissions process, scholarship programs, and campus layout. In line with this, with the use of formal letters, the parties involved, including the college and university, agreed to provide the data needed by the researchers.

(See Appendix A for the letters that were approved.)

The researchers found out what hardware and software were needed to make the system's features work.

Table 1. Hardware and Software requirements

Hardware Requirements	Software Requirements	Function
Android Phone	Android OS 10 (Minimum)	Mobile Operating System
	4GB RAM (minimum)	Memory
	8GB RAM (suggested)	
	8GB (minimum)	Internal Memory
	16 GB (suggested)	
Desktop/Laptop	Intel i3 (Minimum)	Desktop Processor
	8 GB RAM (minimum)	Memory
	16 GB RAM (suggested)	
	Google Chrome	Browser
	Mozilla Firefox	Browser
	Opera	Browser
	Safari	Browser
	Microsoft Edge	Browser

Design and Implementation

The researchers planned every feature and flow of the system aimed to provide by creating diagrams such as Storyboard and Use Case Diagram. With the help of these diagrams, researchers were able to gain a better understanding of designing the web application. In designing the web application, researchers used Blender 3D, Unity 3D, and Photoshop.



Figure 6: Information Area

Figure 8 shows the page that holds the information that will be beneficial for the students. The information area has buttons that hold specific information that the users can view, starting from the tuition fee, available courses, scholarships, and the admission process.

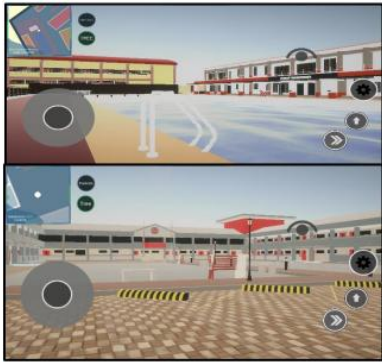


Figure 7: First-person perspective view

The figure above shows the first-person perspective view of the system, wherein the user can feel like the character. Using basic movements like walking, jumping, and running so user can roam around the campus.



Figure 8: Minimap and Full-Scale Map

Figure 9 shows the minimap and full-scale map; the first image is the minimap, which is shown in the screen's upper left corner. The minimap will follow the character or the user wherever they go. If the user clicked the minimap it will now show the full-scale map of the whole campus, the user can see all the facilities or buildings available on the campus as well as the names that are on the left side of the map.

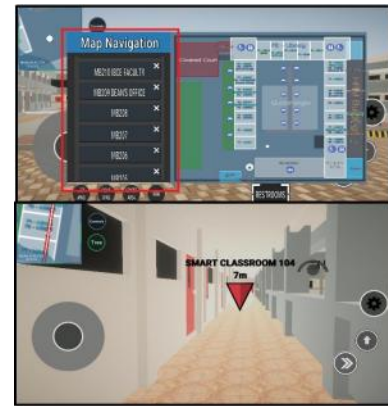


Figure 9: Waypoints

This illustration depicts the waypoints. In the full-scale map, the user will see the list of rooms and buildings on the campus on the left side of the map. To use the waypoints, the user will click on the rooms or buildings the user wants. To undo or remove the waypoints, the user needs to click again on the building chosen.

Testing Results

For the evaluation of the system, the researchers conducted alpha and beta tests. Three (3) practitioners in the field of Information Technology with experience in creating Web and Android-based applications. The system was tested based on ISO 25010 categories, namely Functionality, Compatibility, Usability, Security, and Portability.

Alpha Test Result

The alpha testers that were selected are Mr. Edward Allen B. Manaloto, who is currently working at Malabanas Integrated High School in Angeles City, and Mr. Ralph B. Cadalzo, a Doctor in Information Technology at La Consolacion University Philippines. The other practitioner is Mr. Jovie A. Fiesta, who is a System Engineer for GuardAll.

The following chart shows the alpha test result of the system:

In the functionality category, three (3) out of three (3) practitioners answered yes with a total percentage of 100% for the questions that concern the system's functionality, which shows that the iTour has passed all the conditions and features.

Under the compatibility category, questions regarding the compatibility of the system with both desktop browsers and Android versions were asked. Three (3) out of three (3) practitioners answered yes, for a total percentage of 100%. The results show that the iTour is working properly in both desktop browsers and the Android version.

In the usability category, the practitioners had a majority agreement that the system elements such as labels, 3D objects, icons, and images were effectively used based on the intended purpose. The alpha testers also concluded that the system can be used easily by the user without using a manual and that the interfaces were easy to use and simple to learn. Lastly, a total percentage of 100% was also given to the system in terms of its good performance in providing the basic or expected functions of the system.

In the security category, the practitioners—three (3) of them—said yes, with a total percentage of 100%. which indicate that the system doesn't allow the users to edit the values in the initial configurations that are given by the developers. (See Appendix G Table 5 for Alpha Testing of iTour under Security)

Finally, in the portability category, there are questions about the system's ability to run and execute within an Android version of Android 10 and above, which received a total of 100% from practitioners. The same goes with the question about the system's ability to run and execute inside a desktop with an Intel® Core™ i3 (I3) processor and above, which also gathered a total percentage of 100% from the practitioners. That proves that iTour is running smoothly with the given system requirements.

Beta Test Result

The beta testing was conducted by thirty (30) respondents ranging in age from 18 to 25 years old, using random sampling, wherein 33% of them are considered current and new college students, while 67% are halfway through their studies and are graduating. The respondents were asked what type of device they were using, and it shows that seventeen (17) of the respondents are using both Android and PC, for a total percentage of 57%, while thirteen (13) of them are only using Android devices, for a total percentage of 43%. This concludes that most of the respondents are between the ages

of 21 and 25 years old, and most of them are using both PC and Android.

In the functionality category, the respondents were asked about the basic functionality of the system. All of the respondents answered yes to functionality, which shows that they are able to use the features of the system.

Under the compatibility category, the respondents were asked what type of browser users are using when testing the system on computers. The data shows that twelve (12) out of thirty (30) users used Google Chrome at a total percentage of 46%, while Four (4) respondents show that they are using other browsers, such as Opera, Vivaldi, and Microsoft Edge, for a combined percentage of 11%. While 14 (fourteen) respondents said "not applicable" because they only used Android phones, the overall percentage was 43%. For the second question, twenty-seven (27) of the respondents answered yes, for a total percentage of 90%, while three (3) answered no, for a total percentage of 10%. This concludes that most of the respondents are using the Android version of iTour, which is able to run properly while other applications are running.

In the usability category, the respondents were asked about the overall design suitability of the system. Respondents were given a chance to choose more than one answer. Six (6) respondents only answered with a total design percentage of 20%. Five (5) respondents answered two (2) designs total percentage of 17%. There are only two (2) respondents that answered three designs with a total percentage of 7%, and seventeen (17) respondents answered four designs with a total percentage of 56%. The total number of overall respondents is thirty (30). Twenty-two (22) of those thirty (30) respondents answered Labels with a total percentage of 25%; 28% answered Images with a total number of twenty-four (24) out of thirty (30) respondents; twenty-two (22) of those thirty (30) respondents answered 3D objects with a total percentage of 25%; and nineteen (19) of those thirty (30) respondents answered Instructions with a total percentage of 22%.

The respondents were asked if the interface is easy to use and simple to learn. Two (2) respondents answered no with a total percentage of 7%, while twenty-eight (28)

answered yes with a total percentage of 93%. Respondents were also asked if the system could be used without consulting a manual; three (3) of them said no, accounting for 10% of the total, while twenty-seven (27) said yes, accounting for 90% of the total. According to the usability results, respondents prefer the image features of the iTour, as well as the label and 3D objects. Also, results show the iTour is simple to use and learn. The Security, which two (2) of the respondents answered no total percentage of 7%, while twenty-eight (28) answered yes with a total percentage of 93%. That concludes that iTour doesn't allow the respondents to make changes to the system.

Under the Portability category, the respondents were asked if the phone can easily install the application. Twenty-five (25) of them answered yes, for a total percentage of 83%, while five (5) of the respondents answered no, for a total percentage of 17%. Researchers also asked what Android version people were using and if the system worked or not. Out of the twenty-five (25) respondents who answered yes, ten (10) were using Android 10 with a total percentage of 33%, seven (7) were using Android 11, with a total percentage of 23%, and two (2) were using Android 12 with a total percentage of 7%. The rest, 37%, or eleven (11) respondents, answered "not applicable" because some of them did not know the Android version and the majority of them did not work on the phone. Four (4) of the respondents, or 14%, are using Android 8, an outdated version that is incapable of handling the system. One (1) respondent each for Android 12 and Android 10, with a total of 6%. The remaining 80%, or 24 of the respondents, answered N/A, or not applicable.

As a summary, the iTour's Android version is running properly with Android 10 and up.

DISCUSSION

This section consists of the summary of findings, conclusions, and recommendations based on the results of the study of iTour: 3D Web Campus Guide of Don Honorio Ventura State University and Mabalacat City College.

To achieve the whole system and functionality of iTour, the researchers first gathered all the basic information about the school that can help incoming college students. Users can

access this information in the information area, where they will see the tuition fees, admission process, courses offered, and scholarship programs with the corresponding buttons. With the use of a storyboard and use case diagram, we can identify the interaction between the system and the user and design the interface. Different software was used in the creation of the system's assets. Blender focuses on providing access to creating 3D objects that are already inside the system. Photoshop serves as the main tool for creating and designing texture materials and providing details on the user interface of the system.

The assets that were created were then transferred to Unity 3D, which utilizes the C# programming language to handle all the coding that is needed to create the main functionalities of the system. A first-person perspective view is one of the features of iTour, wherein the user can feel like they are in the character and can do basic movements. The minimap may be used, and if interacted with, it will show the full-scale map of the campus. The map also features the facilities' labels. Waypoints are markers that allow users to identify the location of a specific facility by pressing a button, which displays a marker inside the user interface and guides the user in navigating a specific area.

Conclusions

The researchers used test cases to test the system's functionalities. Based on the final results, the software works properly. To provide easy access to a campus tour, the researchers came up with this study. The system can be accessed through 2 platforms, which are the PC for the web application of the system and the Android phone for the application package kit. The web application can be found on the website of itch.io, while the mobile version is downloadable from inside the Google Play store. The system will offer two different universities, Mabalacat City College and Don Honorio Ventura State University. Choosing either one of them will lead the user to the information page that has different data regarding the university's tuition fee, available courses and scholarships, and the admission process. After skimming through the information provided, the user can then explore the 3D scene provided by the developers. To

help the users in terms of navigating around the campus, the developers provided some functions such as waypoint markers that display the exact location of a certain area. To use this function, the user will need to interact with the minimap that will display the full-scale map of the campus alongside the buttons that can display the markers that will locate an area for the user. Aside from waypoints, there are also faint information areas that are placed in different places inside the 3D universities. The main purpose of these "faint areas" is to somehow provide brief information regarding the area coverage of that specific area and a short description that will describe the activities that exist in that area. The users have the abilities of a normal person, who can jump, walk, look around, and sprint around the area. The developers provided buttons so that the user can navigate inside the user interface easily, such as buttons that will go back to the main menu, buttons that will make the user leave the 3D scene, and a button that can kill the application when the user is done using it.

Recommendation:

The researchers recommend the following:

1. Interior designs of the rooms.
2. Interaction with the door, in which the user can open and close the door to view the interior design.
3. More details and information about the university, such as some trivia, achievements, and others, are needed to persuade students to enroll.
4. Shifting perspectives, such as from first-person to third-person.

REFERENCES

- [1] "3D Virtual Tours | 3D Virtual House Tour | Karen Cannon, Realtors," Karen Cannon. <https://karencannon.com/3d-virtual-tours/> (accessed Apr. 10, 2022).
- [2] "7 Reasons Why 3D Modeling Is Important | Aristek Systems." [Online]. Available: <https://aristeksystems.com/blog/7-reasons-why-3d-modeling-isimportant/>
- [3] A. Cyril, A. Ordinario, F. The effect of advertising on the enrollment of senior highschool and college students at LPU-Laguna AY is discussed by Santis and Fernandez in The Journal of Business and Accountancy, vol. 3, no. 1 (online)(2018). Accessible at: [https://lpulaguna.edu.ph/wp-content/uploads/2018/10/2.-THE EFFECT OF ADVERTISEMENT ON ENROLLMENT OF LPU-Laguna seniors in high school and colleges.pdf](https://lpulaguna.edu.ph/wp-content/uploads/2018/10/2.-THE-EFFECT-OF-ADVERTISEMENT-ON-ENROLLMENT-OF-LPU-Laguna-seniors-in-high-school-and-colleges.pdf)
- [4] A. S. Karim, S. Sutedi, and M. Agarina, "Prototype Development of Android-Based Thesis Information System at Institute Informatics and Business (IIB) Darmajaya Bandar Lampung," Proceeding International Conference on Information Technology and Business, no. 0, pp. 122–132, Dec. 2019, Accessed: Oct. 30, 2022. [Online]. Available: <https://jurnal.darmajaya.ac.id/index.php/icitb/article/view/2084>
- [5] "Choosing the right course at university or college," nidirect, 15-Aug-2022. [Online]. Available: <https://www.nidirect.gov.uk/articles/choosing-right-courseuniversity-or-college>. [Accessed: 15-Jan-2023].
- [6] D. D. L. Cruz, "How to Choose Colleges With Virtual Tours," The New York Times, Apr. 30, 2020. [Online]. Available: <https://www.nytimes.com/2020/04/30/well/family/coronavirus-virtual-collegetours.html>
- [7] "Don Honorio Ventura State University - History," dhvsu.edu.ph. <https://dhvsu.edu.ph/index.php/dhvsu/history>
- [8] Y. Li and G. Liu Li, "Application of Roaming Visualization of the Anhui Museum Using 3D Animation Technology," Advances in Intelligent Systems and Computing, vol. 144, no. 7, July 2019, pp. 2036–2040, doi: 10.1007/978-3-030-25128-4_266.
- [9] H. Chun, "A Study on the Impact of 3D Printing and Artificial Intelligence on Education and Learning Process," Scientific Programming, vol. 2021, p. e2247346, Nov. 2021, doi: 10.1155/2021/2247346.
- [10] I. Buyuksalih, S. Bayburt, G. Buyuksalih, A. P. Baskaraca, A., and H. Karim ISPRS vol. 1, article by A. Rahman, "3D ADVANTAGES AND DISADVANTAGES OF MODELLING AND VISUALIZATION BASED ON THE UNITY GAME ENGINE AND CHALLENGES," IV-4/W4, November, pp. 161–1662017.
- [11] J. Laguador, Asia Pacific Journal of Maritime Education, "Behavioral, Environmental, and Personal Preferences of Maritime Students and the Influences on Them College Degree Program," Jan. 2019, accessed: Apr. 10, 2022. [Online]. Available:<https://www.academia.edu/45056511/Behavioral-Environmental-and-Personal-Factors-that-Affect-Maritime-Students-Preferences-in-Choosing-College-Degree-Program>
- [12] J. P. Naiman, "AstroBlend: An astrophysical visualization package for Blender," Astronomy and Computing, vol. 15, pp. 50–60, Apr. 2016, doi: 10.1016/j.ascom.2016.02.002.
- [13] J. Smith, "What is Photoshop," Agitraining.com, 2018. <https://www.agitraining.com/adobe/photoshop/classes/what-is-photoshop>
- [14] D. Clerissi, F. Ricca, M. Leotta, and P. In Advances in Computers, Tonella, "Approaches End-to-End Web Testing Tools," pp. 193-237, 2016, doi: 10.1016/bs.adcom.2015.11.007.
- [15] M. Ouza, M. Ulrich, and Bin Yang, "A simple radar simulation tool for 3D objects based on blender," 2017 18th International Radar Symposium (IRS), Jun. 2017, doi: 10.23919/irs.2017.8008254.

- [16] M. Z. Lubis et al., "Interactive Building modeling in Google Earthand GIS: a 3D Urban Planning Tool (Tunjuk Island, Indonesia)," *Journal of Applied Geospatial Information*, vol. 1, no. 2, pp. 44–48, 2017, Accessed: Oct. 02, 2022. [Online]. Available: <https://www.neliti.com/publications/195547/interactive-modelling-of-buildings-in-google-earth-and-gis-a-3d-tool-for-urban-planning>
- [17] M. V. Kontseva, H. V. Krimets, and S. A. Kontsevoi, "3D MODELING OF NITRIC ACID PRODUCTION," *KPI Science News*, vol. 0, no. 3, pp. 80–86, Aug. 2019, doi: 10.20535/kpi-sn.2019.3.175926.
- [18] "Mabalacat City College," mcc.edu.ph. <https://mcc.edu.ph/about-mcc/mcc-history> (accessed Jan. 15, 2023).
- [19] N. Mathur, "What is Android Studio and how it differs from other IDEs," *Packt Hub*, May 30, 2018. <https://hub.packtpub.com/android-studio-how-does-it-differ-from-other-ides/>
- [20] N. Rudhumbu, A. Tirumalai, and B. Kumari, The International Journal of Learning and Development published an article titled "Factors that Influence Undergraduate Students' Choice of a University: A Case of Both University in Botswana" in its vol. 10,5296/ijld.v7i2.10577, 7, no. 2, page 27, May 2017.
- [21] "Pampanga Universities Ranking," www.finduniversity.ph. <https://www.finduniversity.ph/philippine-universities-ranking/prov61-pampanga/> (accessed Nov. 05, 2022).
- [22] R. G. Navales, "Mabalacat City mayor vows to continue healthcare programs," *SUNSTAR*, Jul. 02, 2022. <https://www.sunstar.com.ph/article/1933631/pampanga/local-news/mabalacatcity-mayor-vows-to-continue-healthcare-programs> (accessed Nov. 05, 2022).
- [23] R. Fransson, "Comparing Progressive Web Applications with Native Android Applications," 2017.
- [24] Ronmar E. Calingasan et al., "INTO THE CAMPUS: Using Unity 3D, create a mobile-based interactive virtual tour of La Verdad Christian College in Apalit," *Innovatus*, vol. 2, no. 1, pp. 1–1, 2019, Accessed: Oct. 15, 2022. [Online]. Available: <https://ejournals.ph/article.php?id=14075>
- [25] "The Modified Waterfall Model," www.dhs.pa.gov. [https://www.dhs.pa.gov/providers/Providers/Documents/Business%20and%20Tech%20Standards/Business%20Domain/Modified%20Water%20Fall%20Method%20\(MWF\)%20Model.doc](https://www.dhs.pa.gov/providers/Providers/Documents/Business%20and%20Tech%20Standards/Business%20Domain/Modified%20Water%20Fall%20Method%20(MWF)%20Model.doc) (accessed Oct. 05, 2022).
- [26] T. Dovramadjiev, *SPECIALISED ARCHITECTURAL FEATURES IN BLENDER 3D*, vol. VI, 2016.
- [27] T. in C. P. and S. A. CollegeData, "How much does college cost?," *CollegeData*, 22-Nov-2022. [Online]. Available: <https://www.collegedata.com/resources/payyour-way/whats-the-price-tag-for-a-college-education>. [Accessed: 15-Jan-2023].
- [28] T. Thisarticle, A. Ly, B. Dagang, and C. De Mesa, "Factors Influencing Choice of a Business School in a City of Southern Philippines," *Research Journal of Social Sciences*, vol. 10, no. 2, pp. 1–7, 2017, [Online]. Available: <http://www.aensiweb.net/AENSIWEB/rjss/rjss/2017/July/1-7.pdf>
- [29] U. Technologies, "Unity - Manual: WebGL browser compatibility," [docs.unity3d.com](https://docs.unity3d.com/Manual/webglbrowsercompatibility.html). <https://docs.unity3d.com/Manual/webglbrowsercompatibility.html> (accessed Oct. 29, 2022).
- [30] "VIRTUAL INSANITY," *HuffPost*, Aug. 06, 2012. https://www.huffpost.com/entry/-campus-virtual-tours_n_1747542 (accessed Oct. 02, 2022).
- [31] "Why 3D and AR are the Future of Display Advertising," www.threekit.com. <https://www.threekit.com/blog/3d-and-ar-are-the-future-of-display-advertising>
- [32] X. Jing, "Design and Implementation of 3D Virtual Digital Campus - Based on Unity3D," *IEEE Xplore*, Mar. 01, 2016. <https://ieeexplore.ieee.org/abstract/document/7488531> (accessed Nov. 05, 2022).

Library Management System with QR Code for Jose C. Feliciano College Foundation Library

Denmark Austria
Lawrence Ballesteros
Arron C. Canlas
Joshua Miguel V. Galindo
Franklin S. Rivera
Christopher S. Roque Jr.
Marilou B. Cabuñag (Technical Adviser)

ABSTRACT

In our current culture, technology plays a significant role particularly in the sector of education. A library management system with a QR code is an innovative solution to improve the efficiency of library operations. It is a computer-based system that automates the circulation of library materials such as books, magazines, journals, and other resources. It can also be used to track and manage the library, including borrowing and returning of materials. QR codes are two-dimensional barcodes that can store a variety of data, including contact information. By incorporating QR codes into a library management system, the library can quickly and easily access information about materials and services. QR codes can also be used to quickly check out and return library materials, reducing time spent at the circulation desk. This can help library operations and improve student and user's satisfaction. In addition, QR codes can be used to facilitate communication between the head librarian and the staffs. Libraries can use QR codes to provide information about library services, upcoming events, and new resources. Libraries can also send messages such as overdue book notices or reminders about upcoming due dates. Using a library management system with QR codes can help libraries improve efficiency, reduce costs, and provide better customer service.

INTRODUCTION

Many school libraries still manage their collections/operations manually using pencil and paper. A library management system is necessary to keep up with the digital age; In some countries, library management systems have existed over the last decades, but library schools have continued to use the outdated approach. By switching from the outdated technique to an automated library system, school libraries would operate more effectively and with less paperwork [9].

The QR (Quick-Response) Code is used in the form of black and white squares that can be read by a variety of devices, including smartphones [11]. Additionally, the goal of a library management system is to assist the library to function more effectively and at a lower cost. Since the system is fully automated, it would make it easier to complete every required task to run a library. The QR code would be an essential element, especially when it comes to tracking users' actions inside the library such as books returns, issues and

in tracking library books usage [5]. The system would handle the duties of cataloging books, indexing, recording circulation, and stock check. This type of system would reduce the requirements for manual labor and the chance for errors. In addition, the library management system can help reduce the costs of operation. Moreover, with the help of an automated system, every issue would be solved [21]. QR code has been widely used by students in universities and colleges, including other bigger schools in the Philippines. Moreover, QR codes are two-dimensional matrix barcodes that have grown in popularity for web and mobile phones, and they have been used for educational purposes; it would be extremely useful in libraries [34].

This Library Management System was already implemented in the Quezon City Public Library. The traditional manual library system of Quezon City Public Library was directly replaced with a computerized library system. The researchers then have observed that the manual library system of Quezon City Public

Library has many problems. Thus, they decided to create a digital library system for easy transactions and to avoid data loss. The researchers have successfully developed a computerized library system, which is not only extremely useful but also secure, accessible, accurate, and user-friendly [33].

In the current research, the researchers believed that with the Library Management System with QR Code for Jose C. Feliciano College Foundation Library, the school would benefit because of the efficiency and accuracy of this system than the manual method. In addition, the admin and staff library would be able to easily track students' attendance time in and time out, including the borrowing and returning of books using QR Code. Furthermore, the students can also search for a book if it is available or not.

General Objectives

The general objective is to develop a "Library Management System with QR Code for Jose C. Feliciano College Foundation library."

Specific Objectives:

1. To gather data through interviews within the locale; employ online interviews
2. To design the system using these tools:
 - Use Case Diagram
 - Visual Table of Content
 - Entity-Relationship Diagram
 - Data Flow Diagram
3. To create a web application that has the following features:
 - To create an account for admin and staff
 - Manage all the reports on the dashboard page
 - Create student accounts using admin and staff accounts
 - Update the information of students and staff using the account of admin
 - To scan the students QR Code for their time in and time
 - Track the borrowing and returning book
 - Main page for searching books for student
 - Transaction of student
 - Penalties and Fines on the student
 - Notification due date via email
 - System can overwrite the due dates of book categories
 - The system will archive the book five years above

4. To create a QR code-based library management system for "Jose C. Feliciano College Foundation Library."

5. To test the system on the "Jose C. Feliciano College Foundation Library locale," using ISO25010.

6. To implement the system on the locale Jose C. Feliciano College Foundation Library.

Scope and limitation

The researchers would focus on the effect of the Library Management System with QR code for Jose C. Feliciano College Foundation Library and how it would be efficient to use an automated library system in their library school. This system can create an account for students by the admin and staff of the library; after creating the student account, the system will send a notification via email with the QR code of the students. In addition, the admin and staff can create and view, update and delete students' information, including the "Book Catalog" and "Book Categories."

This system can automatically archive the book if the book has been five years or above on the library system. Furthermore, the student has access to a web page (searching books); after searching for a book, the student could borrow it from the library. In the process of borrowing and returning a book, the admin and staff should scan the student's QR code and the book they will borrow and return. Moreover, if the student returned the book passed the due dates, damaged, or lost the book, the student, must settle the issue before re-activating their account. The admin and staff can track the borrowed and returned books and student attendance.

The researchers identified the software and hardware requirements to develop and employ the system. The researchers used Visual Studio Code, HTML5, CSS, Bootstrap, jQuery, PHP, MySQL Database, Apache, Database Server, and XAMPP for software development. Router/Internet, Desktop Computer, Laptop, Mobile Phone, QR/Barcode Scanner for the hardware. Different design and analytical tools were used, such as a Use Case Diagram, Visual Table of Contents, Entity-Relationship Diagram, and Data Flow Diagram.

The system cannot have a Log in Page for students. In addition, only the students at Jose

C. Feliciano College Foundation can borrow the books in their library. The system cannot be prompted to resend an email because of overdue books for return. It would only send one email reminder to the students before the due dates of the borrowed books.

SYSTEM DEVELOPMENT METHODOLOGY

The Modified Waterfall Model allowed a return to a previous phase for verification or validation, ideally confined to connecting steps. The Modified Waterfall model was first introduced in the work of Steve McConnell in 1996. The Modified Waterfall model was comprised of phases similar to the original model but allowed the various stages to overlap and divide the project into smaller projects. This modified Waterfall model was designed as a response to the limitations of the original Waterfall model.

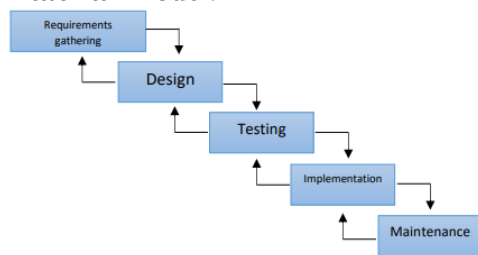


Figure 1: Modified Waterfall Model
(Source:

https://www.researchgate.net/figure/Modified-WaterfallModel_fig1_332095882)

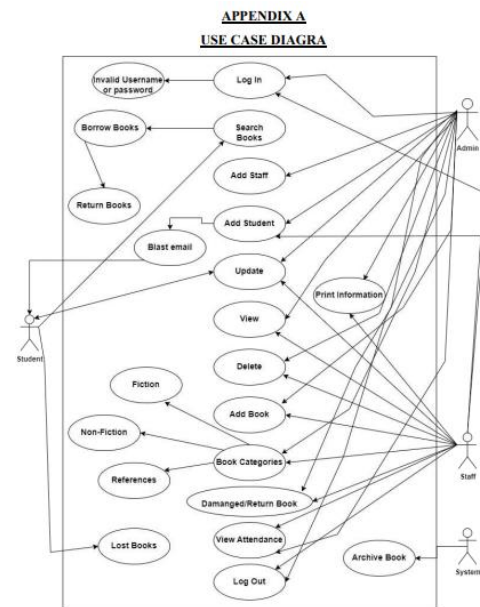
Requirements Gathering

The researchers started brainstorming and conceptualizing how the system would work after collecting all the researchers' initial ideas. The researchers set a schedule to interview the locale to gain ideas as well as the rules and regulations of the target locale. During the interview, two members have asked the library staff if the researchers could see the book history and use it for reference in creating the system. Moreover, when the system was ready for testing, the researchers would go back to the locale to test the system. The researchers also conducted survey questionnaires based on ISO25010 to selected students who often used the library together with the library staff and librarian to gather information after testing the

system. Furthermore, the researchers conduct face-to-face and online surveys after testing the system. The gathered information collected was used to improve the system.

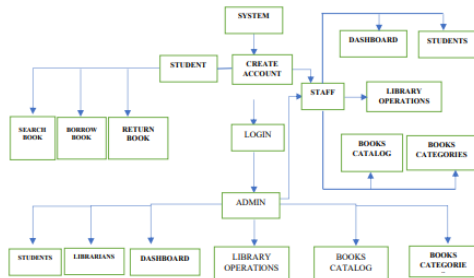
Design

The proponents used Use Case Diagram (UCD) to identify the possible use case (see Appendix A). The head librarian and the staff would create the student's accounts and they would be responsible for inputting the student number or scanning the QR code of the students who were borrowing or returning books. In addition, employees would notify the students of the due date when they need to return the books. Furthermore, students could search for books through the system's student page.



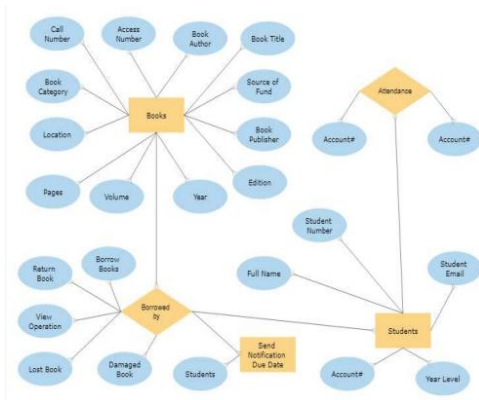
The Visual Table of Content (VTOC) will identify the functions and their relationships (see in Appendix B). The application would start at the home page. The students must request for their profile creation from any of the library staff. Also, after creating their profiles, the staff would need to print the student's credentials or take a picture of their QR code. Post which, the library admin/staff could update students' information, including book catalog, and book categories.

APPENDIX B VISUAL TABLE OF CONTENT



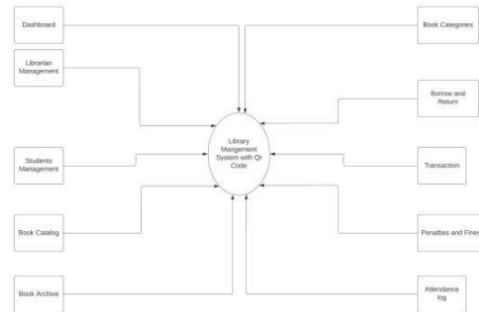
The Entity Relationship Diagram (ERD) will determine how the different concepts were connected in the database (as shown in Appendix C). This analysis tool would record and collect all the information and actions of the users. The user has the most relationships in this diagram because it was the entity most involved in multiple functionalities.

APPENDIX C ENTITY RELATIONSHIP DIAGRAM

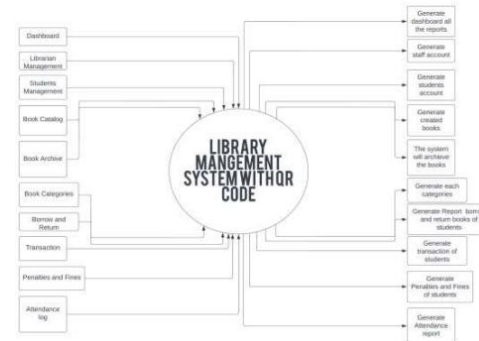


The Data Flow Diagram (DFD) would give an overview of where the data was inputted by the users and where the presented information by the system would go. The DFD (in Appendix D) would be simplified up to level 0-2. Some arrows (or data flows) on the system bundled up the other data.

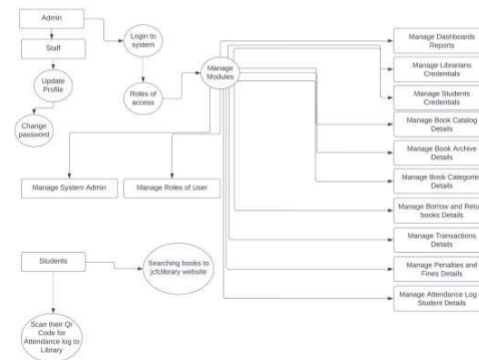
APPENDIX D Data Flow Diagram level 0



APPENDIX E Data Flow Diagram level 1



APPENDIX F Data Flow Diagram level 2



Testing

In this phase, the researchers have three alpha testers who were IT experts and 30 respondents at the locale for beta testing. The respondents would determine the efficiency and defects of the initial system design. The

researchers conducted alpha test online and beta testing at the locale and used random sampling to select the respondents. The librarian and library staff were also used as respondents and answered the survey questionnaire after testing the system. In addition, the researchers used a test case based on ISO25010.

Implementation

This phase included a fully enhanced and well-improved QR-code management system for library use of the Jose C. Feliciano College Foundation and was expected to be used in the future and it would be beneficial to the school.

Maintenance

The testing phase was the stage where we identified the system's errors and defects from both the alpha and beta testing respectively. The researchers listed all the errors in the system and after which, the process of fixing those system errors has started. Furthermore, the researchers retested the system to make it sure the identified defects in the system were successfully fixed.

RESULTS AND OUTCOMES

The researchers used the information gathered from Jose C. Feliciano College Foundation Library to accomplish the study's system requirements and specific objectives. Library Management System with QR Code for Jose C. Feliciano College Foundation Library was now accessible online; the researchers conducted the beta testing on the locale and after the respondents have tested the system, they answered the survey questionnaires based on ISO25010. The library admin and staff could monitor who visited the library. Also, they can track who borrowed and returned the book. The system could also send an email notification when the due date of return is nearing. In addition, if the student returned the book passed the due date, or the book was damaged, or lost, their account would be suspended. To reactivate their account, they must first settle the issue with the library admin/staff. Library admin and staff could add student accounts; once they were added to the system, the system will notify the students thru their email address that they were already registered to the system along with their QR Code. In addition, the admin and staff can add

Book Catalog, and Book Categories; system can automatically archive the book if the book has been five years or above on the library system. Furthermore, the student has access to a web page where they can search for books for reference or to borrow. Both the library admin and staff could print or download the reports in the system.

User Manual

The admin needs to put username and password to access the sign-in page (see in Appendix H).

APPENDIX H ADMIN LOG IN PAGE



The admin needs to put username and password to access the sign-in page (see in Appendix I).

APPENDIX I STAFF LOG IN PAGE



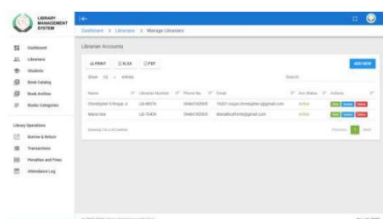
After the sign in page, the admin or staff would have access to the dashboard. The function of this dashboard is to record all the inputted data in the system (see in Appendix J).

APPENDIX J DASHBOARD



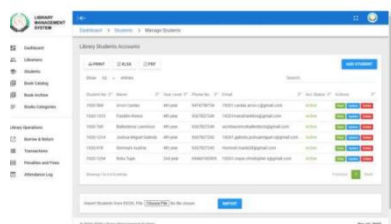
The librarian inventory was where the admin would create the account of library staff/s. That was where the admin can also manage the same staff information such as to update or delete information and accounts. Also, they can print or download those credentials (see in Appendix K).

APPENDIX K LIBRARIANS



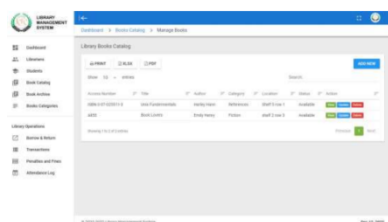
The student inventory was where the admin or library staff could create student accounts in the system. Post account creation, the system would send an email notification to the student informing them of the successful registration along with their QR Code. Admin can manage student credentials such as view, update or delete accounts. Also, they can print or download student credentials (see in Appendix L).

APPENDIX L STUDENTS



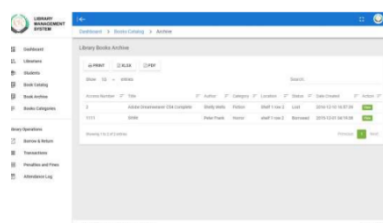
The book catalog inventory was where the library admin or staff can add books information. Admin can view the catalogued books, update information about those books or delete them from the system. They can print or download the book catalog (see in Appendix M).

APPENDIX M BOOK CATALOG



The system automatically archived books if they have been in the library system for five years or more (see in Appendix N).

APPENDIX N BOOK ARCHIVE



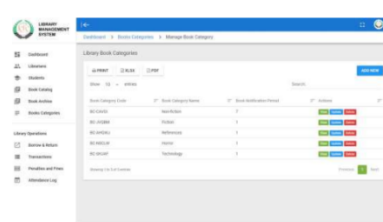
The book search function would help students to search for the books that they need to read or borrow. The search results would include the book's description, location, and author. When the students click the "View Book" they can also see the cover page of that book (see in Appendix O).

APPENDIX O BOOK SEARCH



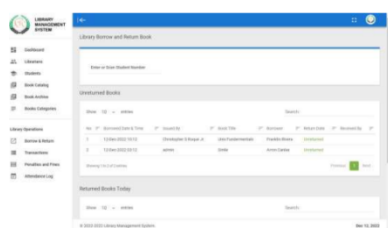
The "Book Categories" inventory would show how books were categorized based on the length of time that they can be borrowed. Non-fiction book can be borrowed for seven (7) days, while fiction and references can be borrowed for one (1) day. Furthermore, the admin can add more categories along with their allowable days for borrowing. The categories can be printed or downloaded (see in Appendix P).

APPENDIX P BOOK CATEGORIES



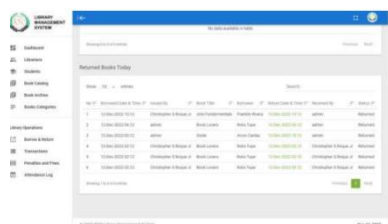
The borrow and return book functions would allow the library admin or staff to input the student number of the borrower, or to scan their QR code; after that step, the staff would press the “Enter” key to access the next process which is to input the name of book or to scan the QR code of the book to be borrowed; that completed the process and the student can take the book that they borrowed out of the library. Upon returning the book, the same process will be followed albeit for the opposite purpose (see in Appendix Q).

APPENDIX Q BORROW & RETURN



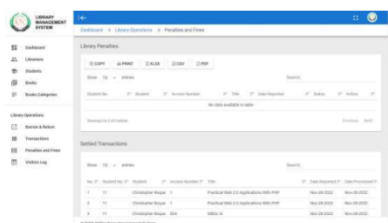
The transaction inventory’s function would be to track all the records of borrowed and returned books including their conditions (damaged) and status (lost) (see in Appendix R).

APPENDIX R TRANSACTIONS



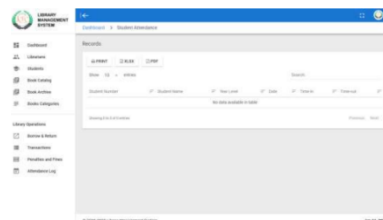
The function is also available to suspend any student credential who has returned books that were damaged, or books that were reported lost, including books that were returned late. To reactivate the account, the students must settle or agree to pay for the damaged and lost book (see in Appendix S).

APPENDIX S PENALTIES AND FINES



The system function to record the time in and time out of the students by scanning their QR Codes was also available (see in Appendix T).

APPENDIX T ATTENDANCE LOG



Alpha Testing

The researchers conducted an integrated end-to-end alpha testing to determine if it worked based on its function. Invited were three (3) IT experts, namely Mr. Ryan Arquiza, an IT specialist, Mr. Michael Valencia, an MIS specialist, and Mr. Lester S. Lacson, an MIS/IT specialist. All alpha testers answered the survey questionnaire based on ISO25010.

Table 3: Summary Results of Alpha Test.

CRITERIA	MEAN (%)
Functional Suitability	99.07%
Compatibility	100%
Usability	100%
Portability	100%
Total Average	99.76%

The Functional Suitability criteria has a cumulative mean of 99.07%. The per criterion results are as follows: Functional Completeness got 35 (YES) and one (NO); Functional Correctness got 15 (YES) and zero (NO); Functional Appropriateness got six (YES) and zero (NO) from the respondents. The Compatibility criteria has a cumulative mean of 100%. The per criterion results are as follows: Coexistence got three (YES) and zero (NO); Interoperability got three (YES) and zero (NO). The Usability criteria has a cumulative mean of 100%. The per criterion results are as follows: Appropriateness Recognizability got six (YES) and zero (NO); Learnability got nine (YES) and zero (NO); Operability got nine (YES) and zero (NO); User Error Protection got three (YES) and zero (NO); User Interface Aesthetic got nine (YES) and zero (NO); Accessibility got nine (YES) and zero (NO). The Portability criteria

has a cumulative mean of 100%. The per criterion results are as follows: Adaptability got six (YES) and zero (NO); Installability got three (YES) and zero (NO). The Total Average result from all criteria in Functional Suitability, Compatibility, Usability and Portability was 99.76%.

Beta Testing:

The researchers conducted beta testing at the Jose C. Feliciano College Foundation located at Dau Exit, NLEX, Mabalacat Pampanga. The total count of respondents was thirty (30) from different levels of the school's hierarchy: the head librarian (1) and library staff (1) also participated in the beta testing, including (28) students who frequently visit the library.

Table 4: Summary Results of Beta Test.

CRITERIA	MEAN (%)
Functional Suitability	99.91%
Compatibility	100%
Usability	97.78%
Portability	98.33%
Total Average	99%

The Functional Suitability criteria has a cumulative mean of 99.91%. The per criterion results are as follows: Functional Completeness got 359 (YES) and one (NO); Functional Correctness got 150 (YES) and zero (NO); Functional Appropriateness got 60 (YES) and zero (NO). The Compatibility criteria has a cumulative mean of 100%. The per criterion results are as follows: Coexistence got 30 (YES) and zero (NO); Interoperability got 30 (YES) and zero (NO). The Usability criteria has a cumulative mean of 97.78%. The per criterion results are as follows: Appropriateness Recognizability got 58 (YES) and two (NO); Learnability got 90 (YES) and zero (NO); Operability got 87 (YES) and three (NO); User Error Protection got 28 (YES) and two (NO); User Interface Aesthetic got 90 (YES) and zero (NO); Accessibility got 89 (YES) and one (NO).

The Portability criteria has a cumulative mean of 98.33%. The per criterion results are as follows: Adaptability got 58 (YES) and two (NO); Installability got 30 (YES) and zero (NO). The Total Average result from all criteria in Functional Suitability, Compatibility, Usability and Portability was 99%.

DISCUSSIONS

The automated system, Library Management System with QR Code for Jose C. Feliciano College Foundation Library, allowed the librarian and staff in the library to lessen their workloads. Thus, with the help of this system, the library faculty could easily track records of students who visit the library, including streamlining the process of borrowing books. In addition, by scanning the QR Code of the student, this automated system would record their time in and time out. Based on the results of the beta testing, the respondents were satisfied with the results of the system.

The researchers designed a working web system using different diagrams to better understand what the system would look like and how the data were processed depending on the users accessing the system.

The researchers conducted a test case based on ISO25010, each criterion was met and each functioned appropriately on the website. During the alpha test, defects were detected after tallying the results and those were addressed after the researchers re-coded and re-tested the system. The beta test results showed that improvement when the results returned that the users were satisfied with the system's outcomes.

According to the data gathered from the survey, the evaluators were satisfied with the system's functionality and efficiency in terms of its usability and purpose of changing the manual process into an automated system. The features of the system were all helpful in the library management per the evaluation's results.

Recommendations

The following are recommendations to further improve the Library Management System with QR code for Jose C. Feliciano College Foundation Library:

- Register card permission for students
- Student log-in page
- Receipt number
- Send another email to students who were yet to return the borrowed books / past the due date

The researchers would like to recommend to future researchers if they would like to improve this system to add other features that could help the users. They may also add new ideas that could improve this system. The

proponents would be grateful if this system could help them in the future.

REFERENCES

- [1] Singh, Adarsh N. ;, "https://www.semanticscholar.org/paper/Smart-Library-Management-System-using-QR-code-Singh/3308f013a47b5654b551dde7cc0497e78c0788d8," Smart Library Management System using QR code, 2019.
- [2] H. Supriyono, M. R. Fitriyan and M. , "Developing a QR Code-based Library Management System with Case Study of Private School in Surakarta City Indonesia," Third International Conference on Informatics and Computing, pp. 1-6, 2018.
- [3] M. . D. Khalif , "DESIGNING AND TESTING LIBRARY MANAGEMENT SYSTEM USING QR CODE BASED ON ANDROID WITH CLIENT SERVER CONCEPT," <http://eprints.uty.ac.id/5676/?fbclid=IwAR10gEi7Cw9NbZcsm3ZgEehW0YAhDmrpBeaYiknVo7unkGiWmh8F6thX4Jk>, 2020.
- [4] D. Bagal and P. Saindane, "Library - A Face Recognition and QR Code Technology based Smart Library System," 2019 International Conference on Communication and Electronics Systems, 2019.
- [5] I. Das and D. Das, "QR CODE AND IT'S EFFECTUALITY TOWARDS LIBRARY SERVICES," https://www.proquest.com/openview/3b1d6df758b2fbc1d0d4e3034ca332e9/1?pq-origsite=gscholar&cbl=54903&fbclid=IwAR1CReunm1L-IAMYBZHGNNDTVMFmeSTgdFZUSNXxGHss_MOWFw6CE1DoGUY, 2021.
- [6] I. Das and D. Das, "QR Code And Its Effectiveness in Library Services," https://www.researchgate.net/publication/352089171_QR_Code_And_Its_Effectiveness_in_Library_Services, 2021.
- [7] T. K. Dasa, T. S. Kumbarb and R. A, "Use of QR codes for enhancing access to library resources and services: a case study of IIT Gandhinagar library," http://op.niscair.res.in/index.php/ALIS/article/view/31482?fbclid=IwAR0Z2Xyd2EUQFtNLgllv4NcwspXk7DhyWO22lI32eWBSw2wzy_poPKTwokQ, vol. 67, pp. 156-163, 2020.
- [8] V. H and M. Patil, "QR CODE AS A DELIVERY TOOL FOR MARKETING LIBRARY PRODUCTS AND ITS SERVICES: A STUDY," International Journal of Information Movement, vol. 2, no. 3, pp. 124-129, 2017.
- [9] S. A. Kharat, B. . M. Panage and S. Nagarkar, "Use of QR code and Layar app for academic library services," https://www.emerald.com/insight/content/doi/10.1108/LHTN-12-2016-0060/full/html?journalCode=lhtn&fbclid=IwAR1C_Lio4RkRc6vhcIDY1rpYpNmyceLXaQ8j4YS42xaUn8H-j9EYR5qglgQ, vol. 34, no. 3, 2017.
- [10] A. Ateka and T. Kwanya, "Using QR codes to Promote Information Services and Products in Academic Libraries in Kenya," <http://repository.tukenya.ac.ke/handle/123456789/1767?fbclid=IwAR31b59ftRDKphlI6PKNH9EiK0dpr36voLQ6RFHXVXEh4Qj00HCTV7jdXZs>, 2019.
- [11] L. Parabhoi, N. Bhattachariya and R. Dhar, Use of QR Code in Library, Studera Press, 2017.
- [12] V. B. Gopale, "QR Code and Useful Applications in Libraries," International Journal of Library and Information Studies, vol. 9, 2019.
- [13] V. K. VERMA and M. RANJAN, "Application of QR Codes in Library Services: Beyond Q," <https://digital.library.unt.edu/ark:/67531/metadc1393771/m1/1/>, 2018.
- [14] I. M. Shettar, "Find, Point and Scan: QR Codes for Libraries," https://www.researchgate.net/publication/317399841_Find_Point_and_Scan_QR_Codes_for_Libraries, pp. pp 144-151, 2017.
- [15] N. Chaware, "QR Code in Library," https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3829363&fbclid=IwAR09H7WUA0-FRD_IuMri-hlWfB8KzY1nUz7CYqfWR892O58Zf1NEQXoxNvs, 2017.
- [16] A. Dani and R. N. Patil, "QR Code based Library Management System," Journal of Emerging Technologies and Innovative Research, vol. 7, no. 6, pp. 1876-1883, 2020.
- [17] M. M. Din, R. M. Anwar and A. . F. Fazla, "Asset tagging for library system - does QR relevant?," International Conference on Applied and Practical Sciences ICAPS, 2021.
- [18] H. YU, "QR Code based Library Management System mobile," https://books.google.com.ph/books?hl=en&lr=&id=bS4NEAAQBAJ&oi=fnd&pg=PA58&dq=QR%20Code%20based%20Library%20Management%20System%20mobile&ots=hzViv_AiEK&sig=2H7geJjr6mBbD GkPI-1kr4x3mE&redir_esc=y&fbclid=IwAR1QrQ2YiQs9vzCSDYOfLg-FMkRHWnuI9ZFvD82sQmgIo5INaz, 2020.
- [19] R. Tripathi and S. K. Dwivedi, "QR Code and RFID Agile Tags Provide Secure Data Extraction," THE American Journal of Humanities and Social Sciences Research, vol. 4, no. 6, pp. 70-77, 2021.
- [20] T. A. Babs, . I. R. Mathew, A. S. Johns and B. P. Babu, "Automation of Library Management System," International Research Journal of Engineering and Technology, vol. 07, no. 08, 2020.
- [31] D. K. Matsyaiswara, "DESIGNING AND TESTING LIBRARY MANAGEMENT SYSTEM USING QR CODE BASED ON ANDROID WITH CLIENT SERVER CONCEPT," http://eprints.uty.ac.id/5676/?fbclid=IwAR2XUCx2iAV1qzkaSg0rGS8ecyQOKda_xnlwSttOFMaXQhtdfpOxSIDgHqY, 2020.
- [32] E. A. C. J. P. J. V. M. G. L. Daryl Tampipi, "Library Management System for Quezon City Public Library," Ascendens Asia Singapore – Bestlink College of the Philippines Journal of Multidisciplinary Research, vol. 2, 2020.
- [34] J. A. B. J. T. M. K. S. P. E. R. Y. M. N. J. B. S. F. Amber Jade A. Baetiong, "National University Library System: A Mobile and Web ... - IEEE Xplore," <https://ieeexplore.ieee.org/abstract/document/8666313>, 2018.
- [35] HORSFALLK, "The human side of library automation," The Electronic Library.

MCC-HSU: Web-Based Mabalacat City College Health Services Appointment and Inventory with Report Generation System

Joebenenson A. Dalas
Clarissa T. Kabigting
Monica Rose D. Manalang
Ara Mae A. Mercado
John Patrick C. Pineda
Maria Regine M. Serrano
Engr. Robbert M. Bamba, MEECE (Technical Adviser)

ABSTRACT

Information is analyzed data in the development of the concept, whereas a system is a collection of finite elements linked together to achieve goals. Most information systems are composed of smaller systems known as subsystems, which all work together to ensure the efficacy of the larger systems. During clinical operations, information such as patient records, treatment records, inventory stocks, and data from other sources accumulates. The goal was to develop a web-based system for the MCC-HSU. Researchers used the Modified Waterfall Methodology as an internal process, with little emphasis on the end user or client involved in a project. Its primary goal has always been to help internal teams move through project phases more efficiently, which benefits the software industry. Through the details that could use in the objectives of the study, researchers conducted a survey. The total average result of the beta test which is the 30 respondents, is 4.73 with a verbal description of "Excellent". While the alpha test, the respondents are the 3 I.T. experts. The total average result of the alpha test is 4.58, with a verbal description of "Excellent". It means the system has been approved and well met the needs of the students, personnel, and IT experts. Clinic personnel also conducted the evaluation and gives an opinion to make the system more usable for the clinic's daily operation. The system can support daily clinic operations and perform the task correctly based on user feedback.

INTRODUCTION

Over the years, a wide range of literature has revealed the roles that Information Systems (IS) play in healthcare services. Information systems are defined using two terms: information and strategy. Information is analyzed data in the development of the concept, whereas a system is a collection of finite elements linked together to achieve goals. Most information systems are composed of smaller systems known as subsystems, which all work together to ensure the efficacy of the larger systems [1].

Significant improvements in clinical workflow, administration, and revenue enhancement are some of the benefits that outweigh the challenges of information systems in healthcare industries. Another critical factor to consider is clinical information access; digital access to medical records allows clinic staff to save time and a tremendous amount of resources. Therefore, IS provides comprehensive, trustworthy, and understandable information

on timely and efficient patient medical record management [2].

Finally, the need for effective information systems (IS) in healthcare services is regarded as critical because it depicts organizational performance, which aids in predicting the future of potential challenges and providing appropriate solutions that information systems can build with streamlined operations toward the enhancement of proper administration and control over unexpected threats.

CMS (Content Management System) is a system that connects patient information systems that collect and store demographic, financial, and medical data from ancillary services such as registration, billing, lab, radiology, pathology, pharmacy, and transcription. The CMS network links these systems, databases, interfaces, physician order entry, electronic communication systems, and clinical workstations [3].

During clinical operations, information such as patient records, treatment records, inventory stocks, and data from other sources

accumulates. Healthcare practitioners need help to manually transfer patient information from one file to another and from one healthcare practitioner to another as the complexity of healthcare services grows. As a result, more primary data storage and retrieval is required, as well as more accurate and timely reports, updates, and error-prone manual calculations.

MCC-HSU: The Mabalacat City College Health Services Unit Appointment and Inventory with Report Generation System was developed to improve the services and workflow of all HSU activity. Using this system, the HSU's inventory, report generation, and transaction recording will be improved and well-structured. In every school, a clinic operates through the complete primary education curriculum. The school clinic provides services to anyone on campus who requires immediate medical attention in order to recover faster [4]. Technology has become the new way of life; it is almost a requirement that people put technology in everything they do to become much more manageable. With HSU, automating all the records would be much simpler, and less work would be done, targeting the idea of "time convenience." The probability of the system's success is high, as it aims to be the foundation of the whole school clinic itself. Mabalacat City College Health Service Unit System, as a replacement for the manual paper-based records processing can store confidential files of every person in Mabalacat City College.

Background of the Study

The web-based application's goal is to manage HSU personnel's workload. Due to the modern world, we all know that people nowadays take advantage of technology. Utilizing technology work can be facilitated and sped up. Information Systems (IS) are defined using two terms: information and strategy. Most information systems are composed of smaller systems known as subsystems, which all work together to ensure the efficacy of larger systems. All people, businesses, and industries use technology in today's world. Many advantages/benefits-based application include giving health service unit solutions to issues like file management, report generation, and monitoring medicines and supplies inventory.

The target users of the web-based system are the employees and students at Mabalacat City College (MCC). Mabalacat City College (MCC) formerly name as Mabalacat College (MC) is a Pampanga public higher education institution. It was established in 2007 by Municipal Ordinance No. 2. MCC established a satellite campus in Barangay Dapdap in 2016 to increase access to education for the area's underprivileged residents. All processes in the school Health Services Unit, which Mrs. Florient G. Non leads, are carried out by hand. Significant problems arise, such as data retrieval, record keeping, data redundancy, and medicine inventory. According to Ms. Ayn Bernadette C. Galang (Nurse I), human error is a most common problem with a manual system. The current system is very prone to data redundancy in a scenario where the team enters the data. The other staff unknowingly enter the same data. As of now, data retrieval is essential to the clinic staff; they consume two to three weeks to retrieve data manually, and most of the time, some of the data need to be included because they need a structured way of making backup files.

CMS (Content Management System) is a system that connects patient information systems that collect and store demographic, financial, and medical data from ancillary services such as registration, billing, lab, radiology, pathology, pharmacy, and transcription. The CMS network connects these systems, databases, interfaces, physician order entry, electronic communication systems, and clinical workstations. The Mabalacat City College Health Services Unit System, which replaces manual paper-based records processing, can store confidential files for all Mabalacat City College students and employees.

SYSTEM DEVELOPMENT METHODOLOGY

A system development methodology is a tool used to organize the developing systems in a systematic and most effective way. It includes frameworks for describing the activities involved in defining, building, and implementing a system. The framework that the researchers used and the execution in every phase will be discussed.

Researchers used the waterfall methodology as an internal process, placing little emphasis on the end user or client involved in a project. Its primary goal has always been to assist internal teams in moving more efficiently through project phases, which can benefit the software world.

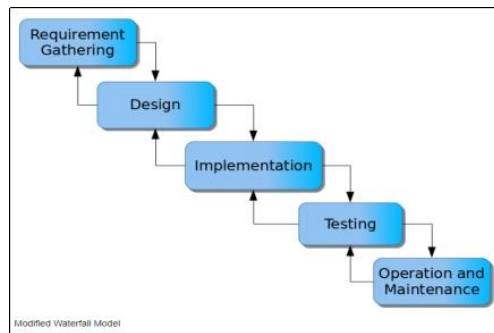


Figure 23. Modified Waterfall Methodology (https://www.researchgate.net/figure/Modified-Waterfall-Model_fig1_332095882)

The waterfall model, also known as the Linear-Sequential Life Cycle Model, is another name for the waterfall model. This refers to the entire software being structured in a systematic manner, and it is also known as the Strict Waterfall Model because the model is strictly followed like a waterfall in the valley.

Requirement and Analysis

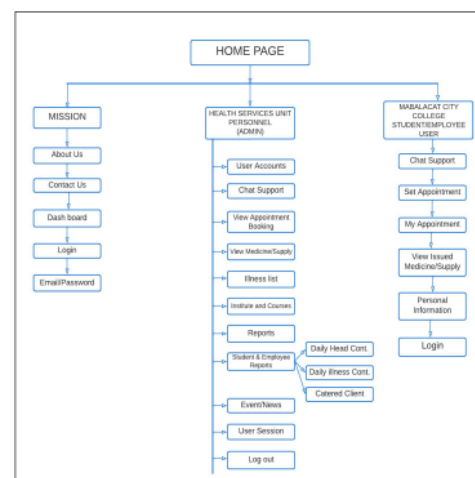
The researchers held several meetings for idea development and brainstorming followed by related literature review and studies gathered from the internet and previous classified research relevant to the developed system in acquiring additional knowledge. Based on the information provided, the researchers compiled a list of all the issues and devised a procedure for improving the system's required features. To improve the project's functionalities, the researchers sought additional information from their technical adviser and Health Services Unit staff information inputs. In short, in order for researchers to fully comprehend the required output functionalities, the researchers outlined the study's benefits, goals, risks, and concerns, which aided them in determining and concluding their web research.

System Design

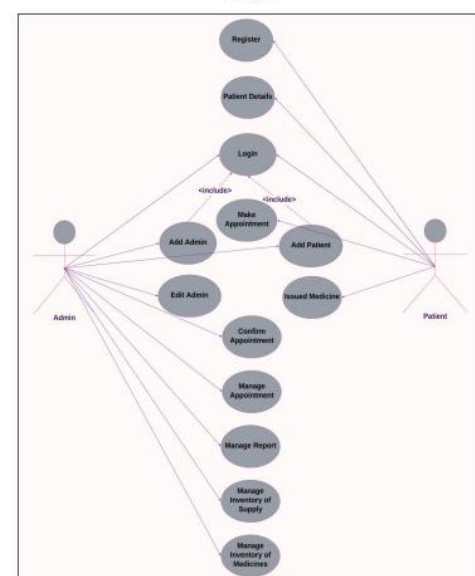
During this phase, a quick design, also known as a preliminary design, is created, which gives

the user a brief overview of the system flow and user system interaction, assisting the researchers in designing and developing the system. The researchers needed to analyze all of their requirements after completing all of the criteria for creating a design for their project, but it had to be a complete design. This can provide researchers with an advantage as well as a rough idea of how their system will function and look. The tools created during the design phase include the Website map (see Appendix D), Use Case (see Appendix E), and Entity Relationship Diagram (ERD) (see Appendix F).

APPENDIX D
Website Map



APPENDIX E
Use Case





Implementation

This phase is where the researcher's stage is inspected and adapted. The developer explained the minimum specification and demonstrated it to the target users, the students and employees at Mabalacat City College, particularly those in the Health Services Unit. At this time, the target users analyzed the system to identify the requirements they missed or issues with the initial conditions. The developer, target users, and researchers worked through these issues during the iteration, evolving the codes that can have the guidelines for accomplishing and finishing throughout.

Some requirements must be met during this stage and at each meeting. It is also critical to go over the system documentation to see if any changes or progress have been made. To complete the capstone project, the researchers must meet the technical adviser's and instructor's specifications.

The researchers used Laravel to develop the system as shown in figure 24. It is a free and open-source PHP web framework created by Taylor Otwell. It is intended to develop web applications following the model-view-architectural controller pattern and based on Symphony. The developer uses CSS and Html5

are used for the Graphical User Interface (GUI) with the help of Bootstrap for the front-end design. Visual Studio helps create programs to aid in the creation of the game. The researcher's stage is inspected and modified during this phase. The developer explained and demonstrated the minimum specification to the target users, students and employees at Mabalacat City College, particularly those in the Health Services Unit. At this point, the target users analyzed the system to identify any missing requirements or issues with the initial conditions. During the iteration, the developer, target users, and researchers worked through these issues, evolving the codes that can have the guidelines for accomplishing and finishing throughout.

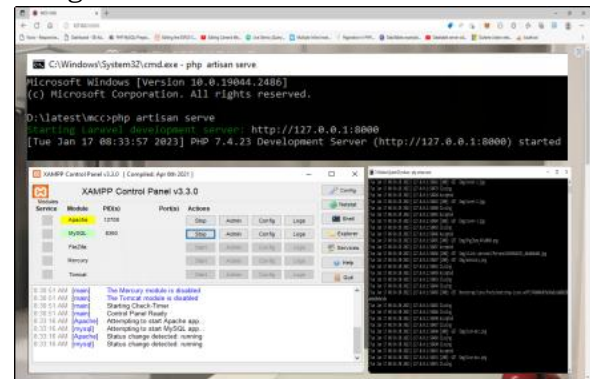


Figure 24. System Local Domain

Testing and Integration

In this phase, all of the difficulties had to be evaluated and assessed by the researchers, based on the findings of the researchers' assessment using test cases, for possible correction of these flaws. The researchers returned to the short design process to identify these issues or bugs while adding new functionality and correcting system features based on user input and suggestions throughout usage, mistakes, and failures. The researchers intended to upgrade and improve the hardware and software as a result of all the information and recommendations. Finally, any flaws or failures in the system or mobile application will be addressed before they are released to the public.

According to Etikan (2016), the purposive sampling method, also known as the judgment sample, is a measured person-selection based on their characteristics. It is not a random

method that does not necessitate using primary scientific theories or a specific number of participants. Simply put, the researchers determine what information must be understood and seek out an organization that can and is willing to share information based on knowledge or expertise.

Homogeneous purposive sampling was used because researchers would obtain the correct sample quickly and where proportionality sampling was not the primary goal.

The researchers prepared a questionnaire using a survey to determine if they met the needed objectives. Z.com Philippines was able to upload the system created by the researchers. In the beta testing, the researchers approached three (3) I.T professionals as alpha testers and thirty (30) Mabalacat City College students and employees as beta testers to test and evaluate the system using the statistical tool such as mean score and Likert Scale (see Table 2).

The study uses the score to determine if the respondents' data set's average score (or mean value) is equivalent to the sum of all matters contained in this data set (divided into the total of their values). To determine the definition of "mean" (or the word "average") is:

$$A = N/S$$

Where:

A = average (or mean),

N = number of terms (the number of items or numbers averaged, and

S = sum of the numbers in the set of interest (e.g., the sum of the numbers averaged).

Table 2: Likert Scale

Limit of Index	Rating	Verbal Description
4.20 – 5.00	5	Excellent
3.40 – 4.19	4	Very Good
2.60 – 3.39	3	Good
1.80 – 2.59	2	Fair
1.00 – 1.79	1	Poor

Deployment of Software

This stage determines how well the system works. Once all patients who take the beta tests pass, MCC HSU personnel will install the system on HSU. The system fully utilize its internet platforms, which are browsers. The programming languages used in this section of

the system are exact and fully functional for both the HSU environment and the patients. Z.com Philippines was able to upload the researchers' system. As a result, the researcher-created web-based system would be freely accessible at the domain repository website address of <https://mcc-hsu.com/>.

Maintenance

The maintenance phase comprises the processes needed to monitor, review, and organize the progress and results of the project. They will also find any areas where adjustments are required and start the necessary changes.

RESULT AND OUTCOMES

The requirements analysis and documentation, data requirements gathering, development technique, and testing, system prototype and description, implementation strategy, and results are all covered in this section.

System Requirements

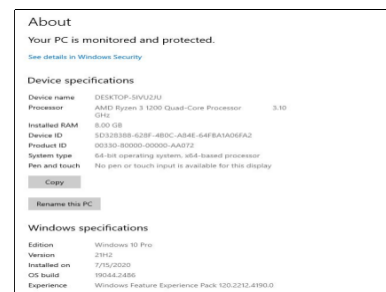


Figure 25. System Properties

The system requirements must contain needs of a system characteristics of user interface. It is to keep the Web-Based Mabalacat City College Health Services Appointment and Inventory with Report Generation System to fulfill the needs to maintain properties object that identifies the current working environment configuration.

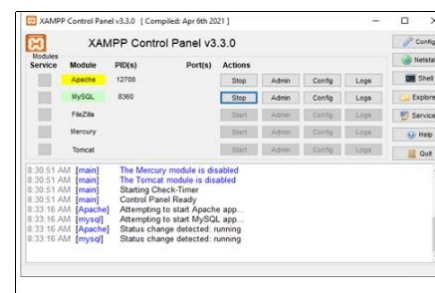


Figure 26. Software Used (XAMPP)

Based on the figures shown, one of the software used in the system is XAMPP. With the help of the web development tool XAMPP, researchers could create an offline WordPress website on the local server installed in the computer. This would display the output interface designed based on the scripts such as PHP, CSS, javascript, Laravel, and HTML5 created by the team programmer.

Data Gathering



Figure 27. Researchers Data Gathering & Collaboration with MCC-HSU Personnel

The researchers collaborate with MCC-HSU Clinic Personnel to understand requirements, needs, and what they want to add to the system. Based on the MCC-HSU Clinic Personnel wants the system that is specific and simple to use. While doing an interview the researchers ask the Clinic Personnel how they manage the record of medicine and supply inventory including the Patient Records. Clinic personnel have problem in compiling files in manual process it because in finding files of the person it is difficult to find in manual process that's why clinic personnel request a system that is able to find the files of the patient's, researcher create system from the MCC-HSU and maintain the privacy of the concerned clientele. Every visit need to check the system if the clinic personnel has an additional request from the system.

System Prototype Deployment

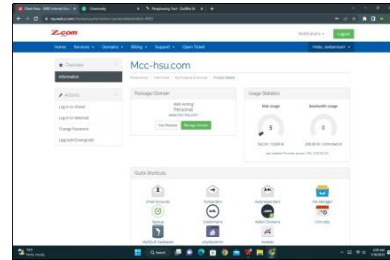


Figure 28. System Domain

Figure 28 shows the location of the system's upload, where students and employees at Mabalacat City College can now access the system online. Z.com Philippines was able to upload the researchers' system.

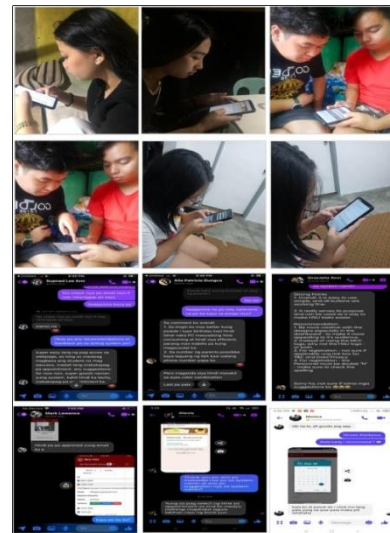


Figure 29. Alpha and Beta Tester Administration

The researchers conduct alpha testing at Mabalacat City College with the support of students and employees. While in beta testing, those are the IT sector or professionals. It is essential to thoroughly evaluate every component of the system because a large portion of the participants. To identify what needs to be changed and gather any issues or suggestions that may come up. Many testers remarked that the system is user-friendly, scheduling appointments, the design and the background color are pleasant in the user interface, and it is simple to access to know the news events in MCC-HSU. They have an inventory and the times of the appointments,

including a message when it's needed to contact the admin on these issues or any other pertinent. Although all MCC-HSU personnel are also administrators, this system has a log-in session that identifies the person in charge at any given time. The person in charge will see the name above if there is a problem.

Alpha Testing

After fulfilling all of the panelist's criteria, the researchers conducted the alpha test using survey forms as an evaluation tool for the developed web-based system. The researchers hired three (3) IT professionals to test the system. The alpha test participants are (Marian Glino, John Peter Melle M. Dungca and Marco Polo Sanchez). Respondents answered the test based on six (6) categories by rating the system using the Likert Scale.

Table 3: Summary of Alpha Testing

CRITERIA	MEA N	VERBAL INTERPRETATION
Functionality	4.42	Excellent
Performance Efficiency	5.00	Excellent
Usability	4.56	Excellent
Accessibility	4.50	Excellent
Security	4.33	Excellent
Reliability	4.67	Excellent
TOTAL MEAN	4.58	Excellent

Table 3 shows the summary of the alpha test result of the system. The "Performance Efficiency" criteria of System Quality Standard rated with the highest weighted mean of 5.00 with a verbal description of "Excellent." It indicates that Alpha testers noticed something piqued their interest in exploring the system. Something in the system may have entertained them, such as fast web page loading times.

The second highest in the alpha result is the criteria of "Reliability, User Interface Aesthetic and Availability" of the System Quality Standard, which has a rating of 4.67 and has a verbal description of "Excellent." It indicates that the system does not become monotonous as it progresses, which made the alpha tester personally exert effort and manage to explore the system.

The total mean of the summary of Alpha Testing Results is 4.58, with a verbal description of "Excellent," indicating that the system is good overall and agrees with the fundamental question in the System Quality Standard.

Beta Testing

To complete the study, the researchers approached thirty (30) people to test the system. Fifteen (15) employees and fifteen (15) students at Mabalacat City College served as beta testers. The survey was conducted online using Google Forms. (see appendix G)

Table 4. Summary of Beta Testing

CRITERIA	MEA N	VERBAL INTERPRETATION
Functionality	4.73	Excellent
Performance Efficiency	4.53	Excellent
Usability	4.66	Excellent
Accessibility	4.73	Excellent
Security	4.83	Excellent
Reliability	4.90	Excellent
TOTAL MEAN	4.73	Excellent

Table 4 summarizes the system's beta testing results. The "Reliability" criteria of the System Quality Standard received the highest weighted mean of 4.90 with a verbal description of "Excellent," indicating that something intrigued the interest of Beta testers in exploring the system. Something in the design, such as the fact that it can function without or with little assistance from the developer, may have amused them.

The second highest weighted mean. the "Security" rating is 4.83, with a verbal description of "Excellent,". The beta testers enjoyed exploring the system and ignored the time. Specifically, users can only access information after it has been validated. Only authorized users have access to data, and the system's primary or anticipated function is present.

The total mean of the summary of Beta Testing Results is 4.73, with a verbal description of "Excellent," indicating that the system is good overall and agrees with the fundamental question asked in the System Quality Standard criteria.

Table 5: Comparative Summary of the Alpha and Beta Testing Results

CRITERIA	ALPHA TEST ING RES ULTS	VERBAL INTERPRE TATION	BETA TEST ING RES ULTS	VERBAL INTERPRE TATION
Functionality Completeness	4.42	Excellent	4.73	Excellent
Performance Efficiency	5.00	Excellent	4.53	Excellent
Usability	4.56	Excellent	4.66	Excellent
Accessibility	4.50	Excellent	4.73	Excellent
Security	4.33	Excellent	4.83	Excellent
Reliability	4.67	Excellent	4.90	Excellent
TOTAL MEAN	4.58	Excellent	4.73	Excellent

The alpha and beta testing results generally show that the system met the users' requirements. The alpha testers' feedback helped the researchers improve the system features that satisfied the alpha testers' requirements. Engage with the system. Alpha and beta testers have similar ratings. The criteria for "Functionality" have ratings of 4.4 and 4.8; verbal descriptions of "Excellent." indicate that the system webpages are operational. The testers noticed something piqued their interest in exploring the system. Finally, both Beta and Alpha users are satisfied with the system, with a total mean of "4.58" and "4.73" and a verbal description of excellent, indicating that the system is overall great and agrees with the fundamental question asked in the System Quality Standard criteria.

System Implementation

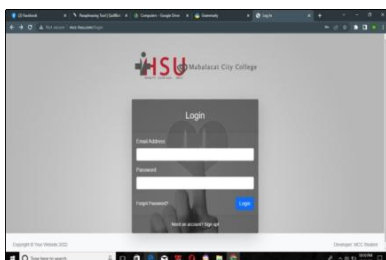


Figure 30. MCC-HSU Log in User Interface

MCC-HSU Log in User Interface

Figure 30 shown above is the log-in page. The patient must log in using email account as username. The password created must at least contain one special character, at least one uppercase. Note that a new user can only log in until the HSU admin activated the registered account by the employee or the student. Note that, the system can only register one account per patient. In case the user forgot the password, forgot password button can be clicked to retrieve or change the user password by providing user email.

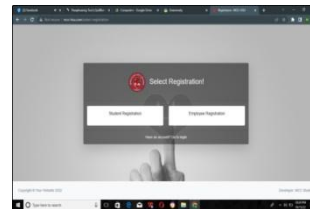


Figure 31. MCC-HSU Registration User Interface



Figure 32. Users Registration Form

MCC-HSU Registration User Interface

Figure 31 shown above is the registration page. The user must click one type of account from the given student account and employee account buttons of the page. The registration screen 1 of figure 32 is for the student account registration form while the screen 2 of figure 32 is for MCC employee registration form. Note that almost all of the text box of each form is the same except the labels for each ID text box are different.

Admin Session

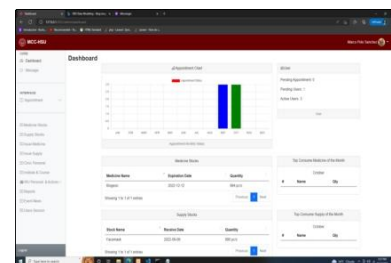


Figure 33. Admin Dashboard

Admin Dashboard

The patients, doctors, and the administrator are all depicted in the illustration. Note that administrator or the HSU personnel can see the results of appointment, medicines and supplies while patients are limited only in viewing the news and banners post.

Message Chat Box Page

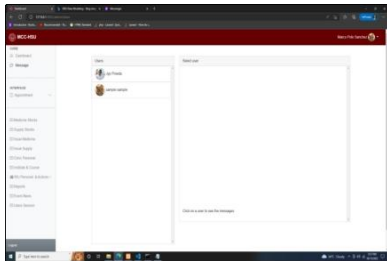


Figure 34. Message Chat Box

Figure 34 describes the system's message features. The message will be the bridge to the users regarding their complaints and any questions, other concerns on HSU personnel. After messaging, the dotted button after the text box represents other features like sending a picture, video and other documents regarding on medical purposes. They noted that the patients or users could message regarding the system.

Appointment Booking

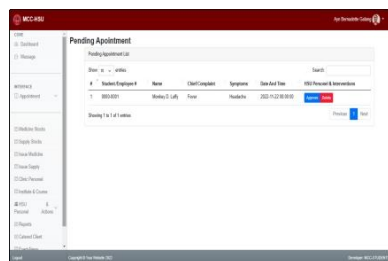


Figure 35. Pending Appointment

Figure 35 shown is the pending appointment page, which will be approve by the HSU administrator within 24 hours, before approving, it checks the information apart from the registration done by the students and employees. It can notify the patient's account activation thru email whether it is approved or not. Note that double check the email address that's been using on the system to notify on email the account activated. The message button after the delete button is used to

message the student and employee in rescheduling the appointment.

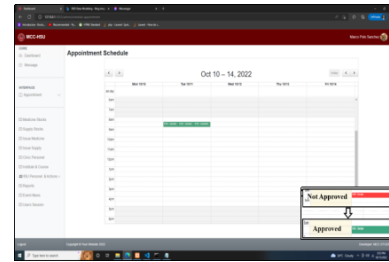


Figure 35.1. Appointment Schedule

Figure 35.1 shown is the approval appointment calendar, which will be approved by the HSU administrator within 24 hours. The appointments that have been approved are green while those that have not been approved are red. Note that only 3 appointments are allowed each time.

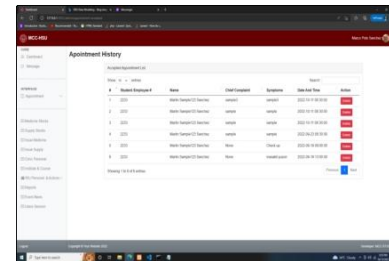


Figure 35.2. Approved History

Figure 35.2 above shows all the booked appointments of every student and employee approved by the HSU administrator. The delete button allows the admin to delete old records of meetings.

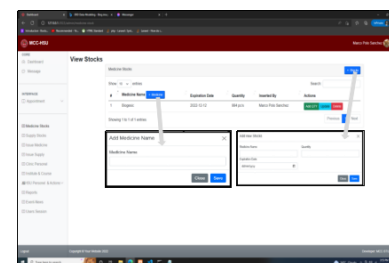


Figure 36. Medicine Stocks

Figure 36 shows the medicine stocks, which will take place on the HSU administrator to put medicine in the clinic, and whatever is left in the medicine cabinet. Adding stores on the "+ stocks" button, adding what's medicine name, and the quantity on it affect the amount. When the HSU personnel adds some medicine, it

adds another row, the same medicine, or a different medicine name. Still, the different expiration will total the number of medications if the medicine name is the same. Add the Medicine Name to the "+ Medicine" button to add the medicine name to the admin dashboard.

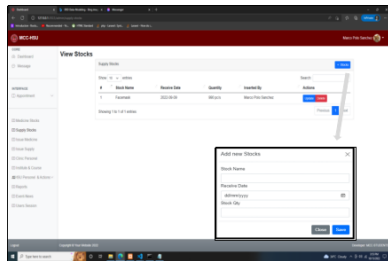


Figure 37. Supply Stocks

The supply stocks page shown in figure 37 will allow the staff to update the number of stocks by clicking the update button colored blue. While adding a new store is done by clicking the + (add) button at the upper right of the page. The staff can also delete specific stock thru the delete button colored red.

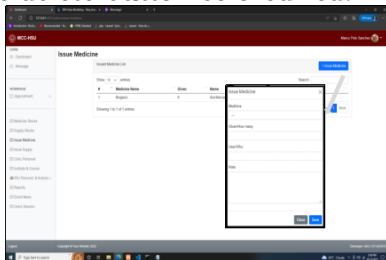


Figure 38. Issued Medicines

Figure 38 above illustrates the names of students and employees who received or requested medicine at the clinic, the quantity of treatment, the date of issuance, and the name of the staff member who administered the medication. Staff can also add students and employees who have received or requested medicine by clicking "+ issue medicine" at the top right of the page.

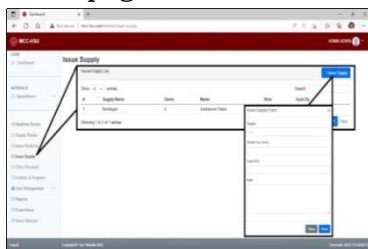


Figure 39. Issued Supplies

Similar to figure 39, the supplies page can add a new collection by clicking the upper right corner of the page. It also shows the quantity issued, to whom it is given, and the on-duty staff name. Note that staff can also delete a specific supply stock.



Figure 40. Clinic Personnel

Figure 40 shows the Clinic Personnel Page. Students and employees can find the names of the staff working in the Health Service Unit on the main menu dashboard. Administrators can also add new members by clicking the + personnel button in the top right corner of the page.

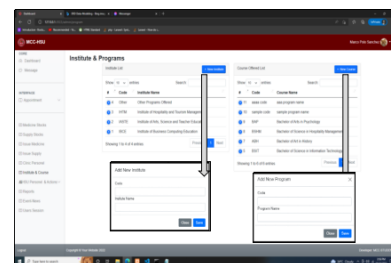


Figure 41. Institutes & Courses

Figure 41 above illustrates all of Mabalacat City College's Institutes and Programs. It is for the students unfamiliar with their institutes and programs to register and become acquainted with all the students listed on it. The admin can add new, edit, and remove all available listed institutes and their programs, if there is a need for update or change.

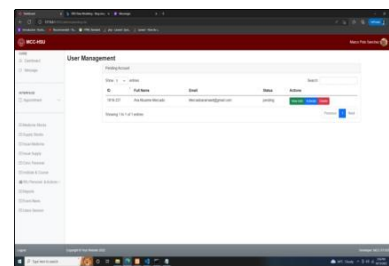


Figure 42. Pending Users

The image above shows the entire list of pending registrations, which will be approved by the administrator within 24 hours, regardless of whether they accept their terms. Before the admin activates the newly registered account, s/he will check all the information placed by clicking the View Info button. The admin can only approve if all the information is correct by clicking the Activate button. Also, the admin can delete accounts if the user is absent or inactive. Note that users can only use one email account to access the system.

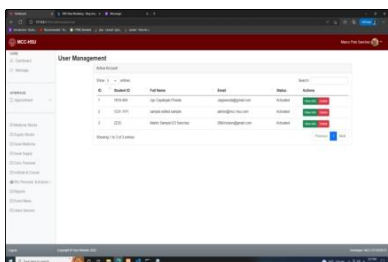


Figure 42.1. Active Users

The image above shows all the active list users. Like figure 28 above, the admin can delete accounts if the user is absent or inactive.

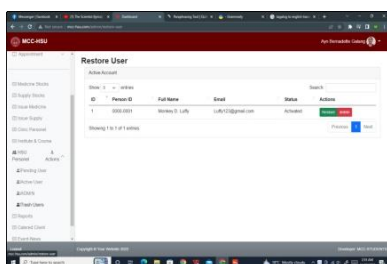


Figure 42.2. Trash Users

Figure 42.2 above shows the list of trash or inactive accounts that the admin recently deleted. Note that the admin can restore the report by clicking the restore button.

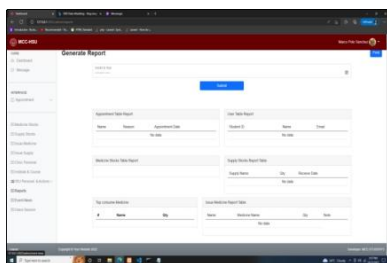


Figure 43. Reports

Figure 43 shows the total number of students/employees with their institutes who made an appointment at the clinic, the total number of students/employees who were given medication, and the total number of top consumers of drugs and supplies. Note that the admin can print reports by putting the year and month in the upper left corner of the report page.

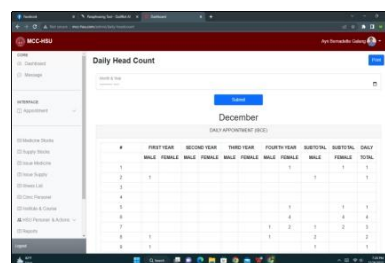


Figure 43.1. Daily Head Count

Figure 43.1 shows the total number of patients with their institutes who made an appointment at the clinic daily within a month. Note that the patient who made an appointment in the system can reflect in the Daily Head Count of the Reports. Note that the admin can print reports by putting the year and month in the upper right corner of the report page.

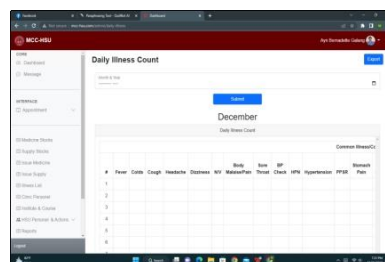


Figure 43.2. Daily Illness Count

Figure 43.2 shows the total number of patients with their institutes who made an appointment with the respective common illness at the clinic daily within a month. It reflects the count of the Daily Illnesses in the Accepted Appointment of the system. Note that only the admin or the clinic personnel can determine the Illness of the Patient's Chief Complaints to reflect the count in the Daily Illness Reports. Note that the admin can print reports by

putting the year and month in the upper right corner of the report page.

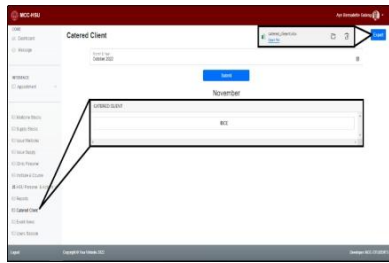


Figure 43.3. Catered Client

Figure 43.3 above shows the number of students/employees with their institutes who made an appointment at the clinic. Like figure 45.2, the admin can print the list of catered clients by putting the month and year in the upper left corner of the report page. Note that the admin can also export the catered clients to an excel file.

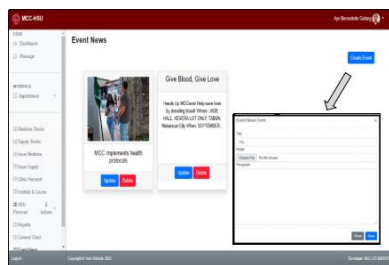


Figure 44. Events & News

This figure above shows the news that is taking place at the MCC-HSU and events sponsored by the HSU. Admin can add new events or information by clicking the create event button on the upper right corner of the events page.

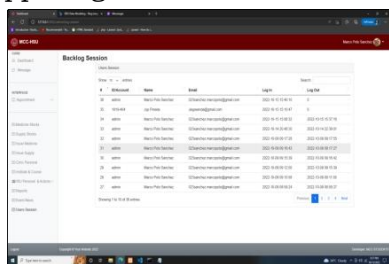


Figure 45. Users/Backlog Sessions

Figure 45 shows the Users Session or Backlog Session. The admin can view the list of users' names with their id/account, users' email, and the time of logging in and out. Note that the

admin can use the search box at the upper right corner if they want to check someone.

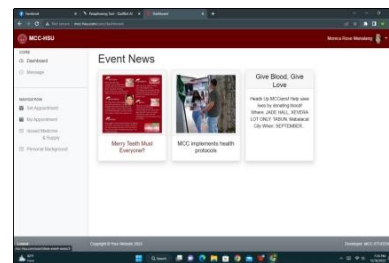


Figure 46. Students/Employees Dashboard

Figure 46 above shows the students'/employees dashboard. Users can view all the existing and upcoming events sponsored by the Health Services unit.

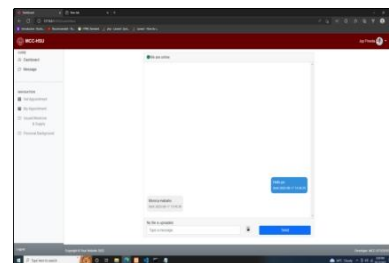


Figure 47. Message

As shown in this figure 47, users can message the clinic personnel as they log in to their accounts. It is vital for the user when they have a concern or questions about their schedule or any subject matter about their health. Admin of the clinic will answer all the inquiries about their problems.

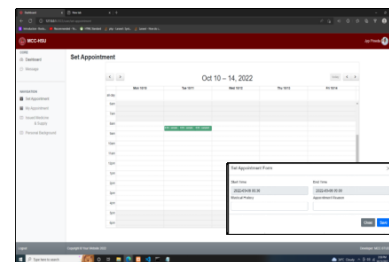


Figure 48. Appointment Booking

Figure 48 above shows the appointment booking. Only users can book an appointment by clicking any of the dates in the calendar that is available between 8 am to 5 pm. Users can put their history of medication like fever and

their reason, for example, headache, upon booking an appointment.

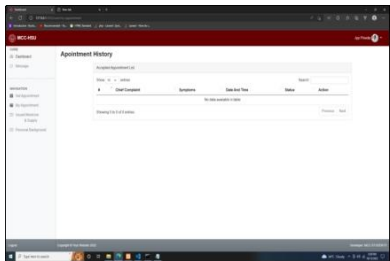


Figure 49. Appointment History

As shown in the figure above, the users can monitor and check the list of their recent appointments approved by the HSU's administrator. But if an emergency, there's no need to appoint a schedule on the system, one can go to the clinic as a walk-in patient, and they will assist you immediately. Note that users can go to the clinic when their appointments are approved.

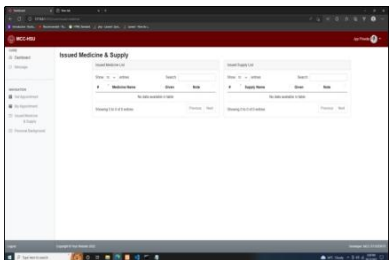


Figure 50. Issued Medicines and Supplies

The figure above shows the list of medicines and supplies the doctors gave the user. Users can view the number of drugs or supplies given to them with the instructions on how they will drink or use them.

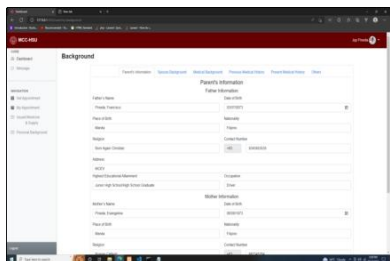


Figure 51. Users Information

In Figure 51 above, a patient must fill up the necessary information for the clinic to check if the patients have a history of sickness or

medications. Also, users must do this for the clinic for each student and employee information personnel.

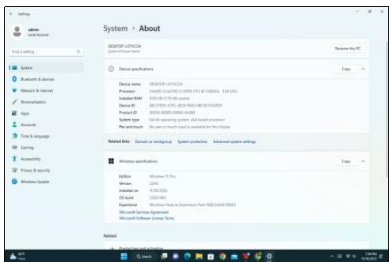


Figure 52. Computer System Properties

As shown in figure 52, the system requires a specification on the component device will use. It requires the following that must use in the MCC-HSU: Web-Based Mabalacat City College Health Services Unit Appointment and Inventory with Report Generation System, describing physical, functional, and performance requirements on the system and capability.

DISCUSSIONS

This section discusses the summary of the findings based on the objectives and section 4, Conclusion, and Recommendations based on the results of MCC-HSU: Web-Based Mabalacat City College Health Services Unit Appointment and Inventory with Report Generation System.

Summary of Findings

Based on the given results from designing, development, and testing, all features stated in the scope of the study for MCC-HSU: Web-Based Mabalacat City College Health Services Unit Appointment and Inventory with Report Generation System are working as expected. Based on the testing process, the functionality, appropriateness, performance effectiveness, compatibility, and portability criteria of the stated recommendation are working, according to the test cases used to validate them. To successfully achieve the proponent web-based objective, the panel had several issues with developing this Web-based for MCC-HSU; some have dummy accounts that can log in to this site, and only students of Mabalacat City College can Log in. The researchers decided to secure some dummy accounts that can interact with and visit our sites; every Student of Mabalacat City College has a student number

that will register to the Admin Account to Access the person if they belong on Campus. Based on the Test Case Result, the initial Web-based seemed to work correctly; it only shows that the method used by the researchers was effective. The main important while developing the system is to make the system usable. Evaluation is conduct the HSU clinic personnel to give their evaluation and also opinion to make the system more usable for the clinic daily operaton. In general, to produce the necessary improvements in care services that are in line with the ongoing demand from the patients is to serve the initial process of the patient before. Using the system that created of the researchers, at present clinic will utilize the whole school clinic from paper-based to electronic up system. Through the data analysis, the patient's health provides information on the system which means that the clinic grants more control to the patient. Clinics frequently provide non-emergency regular or preventative outpatient care. Researchers created the Appointment and Inventory with Report Generation System to improve HSU's operations and services. It helps to lessen the burden and need for human resources among HSU personnel. It also strengthens management and control over the Health Services Unit.

Conclusion

Finally, the researchers accomplished the functions outlined in the study's objectives. In terms of alpha and beta testing summaries, the total mean for alpha testing is 4.54 with a verbal description of "Excellent," and the actual mean for beta testing is 4.72 with a verbal description of "Excellent". These results indicate that the system developed met the needs of the users.

As a result, it concluded that researchers met the study's overall goal of application acceptance.

Recommendations

The following are the recommendations to improve the developed MCC-HSU system:

The system must consider adding log-detail functionalities as an advantage to safeguard the information of employees and students

The system can consider different user access level for easy identification of specific transaction made by a specific user.

The system can be improved by adding also a retrieving location of accidentally deleted data records.

The system can be improved by including CSV files, which are easier to import into a spreadsheet or another storage database, regardless of the software you use. Organize massive amounts of data better.

REFERENCES

- [1] <https://ijsea.com/archieve/volume8/issue5/ijsea08051001.pdf> author Jibrin Muhammad & Salisu Garba
- [2] <https://www.sciencedirect.com/science/article/abs/pii/S0963868712000170>Besson,P.,Rowe, F. (2012). Strategizing information systems-enabled organizational transformation: A transdisciplinary review and new directions. *Journal of Strategic Information Systems*
- [3] <https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.137.665&rep=rep1&type=pdf> Erstad L. 2007. Analyzing Computer-based patient record: A review of literature;
- [4] Joy Lyzette R. Carreon. Clinic. (2016). [Online]. Available: <https://cvc.pshs.edu.ph/2014-08-18-00-27-40/2014-08-18-02-00-57/clinic> [Accessed: April 2, 2022]
- [5] Patient Medical Records System Review of Related Literature
iNetTutor.com.<https://www.inettutor.com/source-code/patient-medicalrecords> system-review-of-related-literature/
- [6] Adesina, D. (2009). The National Health Insurance Scheme. Retrieved October 3, from <http://www.nigeriandoctor.Com/news.php?extend.85D>.
- [7] Klassen, K. J., T. R. Rohleder. 2004. Outpatient appointment scheduling with urgent clients in a dynamic, multi-period environment. *Internat. J. Service Indust. Management* 15(2) 167-186.
- [8] Koole, G., and G. Kaandorp. 2006. Optimal outpatient appointment scheduling, Working Paper, Department of Mathematics, Vrije Universiteit Amsterdam, The Netherlands, <http://www.math.vu.nl/~koole/articles/hcms07b/>.
- [9] Zhang X, Yu P, Yan J. Patients' adoption of the e-appointment scheduling service: a case study in primary healthcare. *Stud Health Technol Inform* 2014; 204:176-181. [Medline]
- [10] Jones R, Menon-Johansson A, Waters AM, Sullivan AK. eTriage - a novel, web-based triage and booking service: enabling timely access to sexual health clinics. *Int J STD AIDS* 2010;21(1):30-33. [CrossRef] [Medline]
- [11] -. Online scheduling applications may improve customer satisfaction, but setup is not always easy. *Internet Health Strateg* 2004;6(5):1-5. [Medline]
- [12] Wang W, Gupta D. Adaptive appointment systems with patient preferences. *Manuf Serv Oper Manag* 2011;13(3):373-389. [CrossRef]

- [13] Tang PC, Black W, Buchanan J, Young CY, Hooper D, Lane SR, et al. PAMFOnline: integrating EHealth with an electronic medical record system. In: AMIA Annu Symp Proc. 2003 Presented at: AMIA Annual Symposium; November 8, 2003; Washington, DC p. 644-648 URL: <http://europepmc.org/abstract/MED/14728253>
- [14] Denizard-Thompson NM, Feiereisel KB, Stevens SF, Miller DP, Wofford JL. The digital divide at an urban community health center: implications for quality improvement and health care access. *J Community Health* 2011;36(3):456-460. [CrossRef] [Medline]
- [15] Zhang X, Yu P, Yan J, Hu H, Gourea N. Patients' perceptions of web self-service applications in primary healthcare. *Stud Health Technol Inform* 2012; 178:242-249. [Medline]
- [16] Siddiqui Z, Rashid R. Cancellations and patient access to physicians: ZocDoc and the evolution of e-medicine. *Dermatol Online J* 2013;19(4):14. [Medline]
- [17] Clingan SA. Going online: the role of web-based initiatives in health information technology. *J Med Pract Manage* 2011;26(4):225-227. [Medline]
- [18] Healthit. What is a patient portal? URL: <https://www.healthit.gov/providers-professionals/faqs/what-patient-portal> [accessed 2016-09-26] [WebCite Cache]
- [19] Healthit. Meaningful use definition and objectives URL: <https://www.healthit.gov/providers-professionals/meaningful-use-definition-objectives> [accessed 2016-10-03] [WebCite Cache]
- [20] Congressional Budget Office. Limiting tort liability for medical malpractice [Internet]. Washington (DC): CBO; 2004 Jan 8 [cited 2010 Jul 1]. Available from: <http://www.cbo.gov/ftpdocs/49xx/doc4968/01-08-MedicalMalpractice.pdf>
- [21] Kessler D, McClellan M. Do doctors practice defensive medicine? *Q J Econ.* 1996; 111 (2): 353 – 90. Crossref
- [22] PriceWaterhouseCoopers. The factors fueling rising healthcare costs 2006 [Internet]. New York (NY): PriceWaterhouseCoopers; 2006 Jan [cited 2010 Jul 1]. Available from: <http://www.ahip.org/redirect/PwCCostOfHC2006.pdf> f Google Scholar
- [23] Elmendorf DW. Letter to Hon. Bruce L. Braley [Internet]. Washington (DC): CBO; 2009 Dec 29 [cited 2010 Jul 1]. Available at http://www.cbo.gov/ftpdocs/108xx/doc10872/12-29-Tort_Reform-Braley.pdf Google Scholar
- [24] M, Suriya & K, Meenakshi & P, Sneha & B, Venkata. (2020). Intelligent Medical Information System. *INTERNATIONAL JOURNAL OF ADVANCED INFORMATION AND COMMUNICATION TECHNOLOGY*. 56-63. 10.46532/ijaict-2020014
- [25] Balsita M. (2017). "Clinic and Dental Information System", University of the Philippines Manila College of Arts and Sciences Department of Physical Sciences and Mathematics, Vol. 2, Page 19. <https://www.pcmag.com/encyclopedia/term/55407/cellular-modem> [16] Related Literature and Studies

OJT Record Monitoring System: A Web View Application for Logging In and Out using QR Code.

Sherwin D. Bognot
Jasmin S. Cauguiran
Jay Brian P. Dela Cruz
Paul Vincent A. Gran
Jason G. Mallari
Philip G. Masanque
Marilou B. Cabuñag (Technical Adviser)

ABSTRACT

On-the-job training (OJT) is one of the many duties assigned to students, in which they begin practicing and gaining experience in the industry for their future. Therefore, the researchers conducted a study OJT training monitoring system that may help out the struggles of trainees and trainers in terms of time management, communication, logging in and out, and monitoring each student. Not only the Trainees and Trainers will be going to have less hassle time. The researchers chose OJT monitoring system as a study for android APK for easiest way to be accessible and more efficient for students to operate using mobile phones. The convenience of the study is to give more benefits for the students, OJT coordinator, and the Mabalacat City College, a massive role in providing more advancement of technology in the modern world. Modified Waterfall model used in methodology and the best software that was more efficient in developing and improving the model. Also, to test the system and improve it as needed. For the conclusion mean score of the Alpha tester has 95.08% that can be Verbally interpreted to “Very Valid”. For the mean score of the beta tester has 98.33% that can be verbally interpreted to “Very Valid”. Finally, successful alpha and beta testing results demonstrated that the web view application met the specifications using the collected evidence. The research concluded that the application: OJT Records Monitoring system: A Web View Application for logging and Out using QR Code was a success.

INTRODUCTION

According to Heathfield, On-the-job training, also known as OJT, is teaching the skills, knowledge, and competencies that are needed for employees to perform a specific job within the workplace and work environment. Employees learn in an environment in which they would need to practice the knowledge and skills taught in the on-the-job training [1]. OJT is meant to assist people in becoming ready for the role they will play. The instruction and practical experience they receive as part of their training will help them acquire the knowledge, abilities, and skills necessary to perform their duties within the company or firm. Conforming to J. L. Lerios and S. B. Sapin, Exposure to actual working environment plays an important role in the development of future professionals in various fields of specialization. Thru this, numbered higher education institutions (HEIs) is establishing their best to provide an effective OJT program integrated and implemented in some of their curricular offerings. Any

organization that wants to succeed, and to continue to succeed, has to maintain workforce consisting of people who are willing to learn and develop continuously. Training and developing human capital are tremendously important in the effective management and maintenance of a skilled workforce. Training is one of the ways of improving organization's effectiveness. In order to implement right training methods, organization should be aware of the training methods and their effectiveness [2]. The company's practices and procedures would be taught during OJT. It's likely that they'd

be able to use every piece of machinery, equipment, or tools needed to do their job. OJT may include observing an experienced employee complete particular job duty. It also benefits the entire company through lower costs for training more efficient, enthusiastic employees. OJT usually involves watching other people as well as having practical experience in executing tasks under the

supervision of a supervisor, a coworker, or an external professional trainer. Once their OJT is completed and they can fulfill the majority, at least all of the duties associated with their job with lack of supervision.

As mentioned by A. Ylagan, On the Job Training (OJT) is one of the mechanics of Higher Education industries in developing the needed competencies of its graduates. Its goals and objectives served as a guide in developing the needed competencies for a particular job, and translating the training into a gainful working experience [3]. Some colleges promote or mandate that 8student's complete internships that provide them the chance to get real-world experience in the field they choose to pursue while earning academic credit. After finishing their studies, students may also receive substantial on- the-job training during their first job. During an internship, students gained knowledge of the business world's practices and culture. They took their time in determining if a career is suitable for them by working in a specific sector for a short time. The on-the-job training, they received was far more in-depth because they had no prior expertise in the field or profession. In some instances, students who completed OJT during their time at a Technical high school, college, or university. Students are required to be taken for their on-the-job training sessions is a lengthy task particularly when the scope of their job is extensive. On-the-job training is given to students to help prepare them for their future career opportunities [11]. They are monitored during the course, and records are saved as a vital source of reference and proof of their education completion. There are some disadvantages with the manual and traditional methods of keeping records and monitoring, for instance the loss of certain trainee information and the barriers between the trainee contact with the coordinator and the management [12]. The system is easy to use for students to access because of the user interface of application. In addition, those students would be not confused to use the system [13]. The website of the OJT monitoring system can access the application, and the administrator will be able to see a list of the users' students in the database. [21].

The QR-code is used to efficiently track student attendance using a mobile phone to clock in and out, allowing the students to save more time than they would by using a biometric. Devices can access the system without high-end specs. [9]. Additionally, QR codes may be read by cellphones with cameras. [10].

OJT Records Monitoring System for Mabalacat City College that enables admin to interact with HR. The student starts their on-the-job-training on the list of companies where they would be deployed. Additionally, the student can track their attendance and time-in and time-out using the QR code. However, administration has access to student records and each trainee's evaluation.

Background of the Study

According to B. R. Samonte, the process in the application of On-the-Job Training of students who are enrolled in the subject consumes a lot of time, money and energy. OJT Coordinators cannot always update the company relative to schedule of visits. Monitoring attendance and getting accurate evaluations of students could be difficult. The task of supervising students' immersion and on-the-job training is one that keeps instructors busy. While tracking multiple graduating students at once is challenging, they would individually find the ideal organization. In addition to, by B. R. Samonte, by using the developed system, OJT Coordinators can easily update the interns and track their records by using the site, likewise the students can track their internship progress in the site supported by an android application, which is developed to provide faster services without opening a web browser. Likewise, industry partners are provided accounts for intern monitoring. The study intends to make it simpler for students' interns to apply for on-the- job training and to improve the recording system used both during and after training. Additionally, it would make it easier for the OJT Coordinator to communicate with program participants. [4].

Mabalacat City College (MCC), formerly Mabalacat College (MC), is a higher education institution established by the local Government Unit of Mabalacat in 2007. 'An ordinance establishing a local college in the Municipality of Mabalacat to be known as the "Mabalacat College" and granting its charter providing for

the Rules, Regulations and Pertinent Guidelines for its establishment and operation thereof was passed on October 4, 2007 under Municipal Ordinance No. 2, series of 2007. The Ordinance No. 66 series of 2017, An Ordinance Amending Section 18 (1) of City Ordinance No. 60 series of 2016 entitled “The New Charter of Mabalacat City College” was passed on 2017. MCC is steadfastly committed to supporting high-quality education for the community and delivering great academic experiences for learning, intellectual development, discovery, companionship, and dialogue. It is currently regarded as a Local University and College (LUC). Together with its co-LUCs, MCC seeks to strengthen the community by encouraging students' pursuit of equality, freedom, justice, and level-up literacy. This fosters the development of high caliber leadership abilities and interpersonal skills that are motivated to protect the welfare of the country and the greater good.

The Mabalacat City College is still having issues with OJT students. The main issue is the manual technique of logging in and out. Additionally, there would be no backup for the records kept if the paper was lost or forgotten, so they would think a daily task was attended even if it might not be accurate.

The OJT Records Monitoring System, which the researchers hope to implement at Mabalacat City College, will benefit the college's students enrolled in OJT courses.

Additionally, this system will track the attendance of OJT students by scanning their own QR codes instead of using the traditional technique. Due to digital technology, it will also reduce the amount of paper that needs to be produced. Moreover, this system will secure student information and provide accurate information.

Lastly, the technology will be beneficial to Mrs. Ritchell Z. Escoto, the OJT coordinator at Mabalacat City College.

General Objective of the Study

The study's general objective was to develop a system entitled “OJT Records Monitoring System: A Web View Application for Logging in and Out using QR Code”. This system would enable the monitoring and tracking of trainees who are undergoing on-the-job training in an effective manner to assist the aforementioned

users. The system would make it easier for students to keep track of their records, improving data monitoring.

Specifically, the study aims:

1. To gather information about the study:
 - 1.1 Related literature and Related Study articles from the internet
 - 1.2 Collected information to the OJT Coordinator
 - 1.3 Statistical details from various students from different courses
2. To identify all the hardware and software requirements
 - 2.1 Hardware Requirements;
 - 2.1.1 Laptop
 - 2.1.2 Mobile Phone
 - 2.2 Software Requirements;
 - 2.2.1 XAMPP
 - 2.2.2 Mobile Flutter
 - 2.2.3 Sublime3
 - 2.2.4 Visual Studio
3. To design the systems using diagrams and analysis tool;
 - 3.1 Use-case Diagram
 - 3.2 Visual Table of Content
 - 3.3 Story Board
4. To create a Web view mobile application with four user levels that has the following features;
 - 4.1 Super Admin;
 - 4.1.1 Can Add, edit, and view the students, Company list including HR personnel and Trainor, information
 - 4.1.2 Can upload CSV for the list of students and companies
 - 4.1.3 Can announce if there is a submission of requirements of students via an announcement
 - 4.1.4 Notified when each student's time in and messaged by the human resources
 - 4.1.5 Messenger capable of file attachment (Super-Admin only to Human Resources)
 - 4.2 Human Resources;
 - 4.2.1 Messenger capable of file attachment (Human Resources to Super-Admin only)
 - 4.3 Trainor;
 - 4.3.1 Can view the list of students he/she handling
 - 4.3.2 Can view the rendered time and time to render
 - 4.3.3 Can view the time in and time out history of the student

- 4.3.4 Can approve and disapprove the time in and time out of students
- 4.3.5 Notified if the student time in
- 4.4 Trainee;
- 4.4.1 Can scan the QR code using built-in app scanner to time in
- 4.4.2 Can submit a word file in the diary for submission of requirements, reflections, documentation, etc.
- 4.4.3 Can add and edit OJT schedule
- 5. To test the system using
 - 5.1 Developer Testing
 - 5.2 Beta testing
 - 5.3 ISO25010
- 6. To deploy the mobile application to Mabalacat City College via APK.

Scope and Limitations

The researchers gathered information from the internet by browsing different articles to support the ideas they came up with. Collecting information from an OJT coordinator and students participating in OJT training is a great way for researchers to support and clarify the feelings and makes it possible to conduct the study.

For the system and study, the researchers used laptop devices: an HP laptop with a specification of processor AMD Ryzen 5, installed RAM 8GB, 64-bit operating system, an Asus laptop with a specification of processor Intel Celeron, 8GB installed Ram, and 65-bit operating system used for editing the documents and saving different files, and the leading hardware where the software's used installed and to code the entire system is the Lenovo laptop with specifications of processor Intel core i5, installed RAM 8GB and System 64-bit operating system. Software requirements needed to create the system such as XAMPP that create a dynamic content that can interact with database. Offline applications were produced using HTML QR codes. CSS3 was utilized to format the content structure. Oriented and procedural API is provided by MySQLi, jQuery, and JavaScript. Emails were sent using SendInBlue. HTML is used to create web pages. CSS concentrates on system design. To create the codes, Sublime3 was utilized. Presentations, spreadsheets, and other documents are the main focus of Viewers.js. as well as mobile flutter to create applications for many platforms. Lastly With the help of the

use-case and V-toc (Visual Table of Contents) diagram, the researchers were enlightened by the system's different parts, functions, and structures. An analysis tool is also necessary to correct any errors found during additional testing and to make improvements.

The researchers would create a system called OJT Records Monitoring System: A Web View Application for Logging in and Out using QR Code considering information gathered from the articles from the internet, details collected from the coordinator of OJT in Mabalacat City College and Statistic's survey from random students in Mabalacat City College in different courses and an OJT coordinator for beta testing and Developer testing. According to what was previously stated, the system would aid students, businesses, and schools in having an effective OJT process. Depending on the courses they are managing and the companies to which they have placed the students, the OJT coordinator at the school would have a list and information on the students. To avoid the coordinator having to travel to several businesses on many occasions and to save time, Human Resources would be the one to communicate with the coordinator via file attachment. It would be the Supervisor's responsibility to monitor the students assigned to each organization. Last but not least, the coordinator would be the one to observe the trainee during the supervisor's OJT days and assess its performance. OJT Records Monitoring System: A Web View Application for Logging In and Out using QR Code would have 4 different user level including Coordinator/Admin, Human Resources, Supervisor/Trainor and Student aim to have features for the Coordinator/Admin Received notifications when students on its list Time in, View and edit the list and information's of students, companies with supervisors/Trainor, Can make announcement for all of students when they need something to submit with due date and can Communicate with the Human Resources via messenger. With the aforementioned feature and the coordinator's ability to attach files, HR can connect with the Coordinator/Admin. A button for approval and disapproval is available for each student's time in and time out, allowing the trainer to both monitors the students while also preventing

attendance scheme. The final user level is student, where he or she can scan the offered QR Code using the application's built-in scanner.

The researchers conducted developer and beta testing on the locale and used random sampling method to select respondents. In addition, the researchers used a test case based on the ISO25010 to get the results on the system. Additionally, after collecting all the data in ISO25010, the researchers contact thirty (30) respondents to test the system and evaluate it. The researcher can then draw a conclusion by using the Likert scale, frequency distribution, percentage, and mean score computation. This offers comprehensive information to support the interpretations of the sub-criteria and criteria conclusions.

Once the online application has been completed successfully and the beta respondents and board of panelists are satisfied with the results, the researchers will deploy and upload the program on the web repository site.

The study's limitations include the fact that it won't issue a certificate to the trainee as payment for finishing the OJT days. Last but not least, the application has a built-in camera facility for direct uploading and voice recognition with typing functionality. To make entering trainee information on the repository of researchers' website easier, CSV files are being uploaded. Additionally, Super Admin can view a user's list of students in the database, and the website for the OJT monitoring system is accessible.

SYSTEM DEVELOPMENT METHODOLOGY

This methodology section would mention specific SDLC models important to the project's development. The best software would be available for each sort of SDLC model, and this SDLC model would save more time and resources early in the development stage. Supporting changing requirements would be the next benefit. The iterative model is the initial SDLC model. In this SDLC method, iterative developments are well recognized for being able to develop the project more efficiently than the typical SDLC approach. It often divides a large program into smaller components and iteratively improves each

module to create a usable application for the project. At the conclusion of each iteration, this process would continue and be improved, resulting in a better version of the application. This might be expressed by reviewing, implementing, and testing the project's previous iteration before improving it into a more sophisticated and complex software. The benefit of an iterative approach is that it may start off some modules faster and more efficiently. More time and money would be saved by using the SDLC model early in the development process. Supporting changing needs would be the next benefit. To prevent a system failure in the future, it may be necessary to replace or modify some functional requirements when they do not produce the desired outcomes.

Modified Waterfall

In 1996, Steve McConnell's work was the first to use the Modified Waterfall paradigm. The Modified Waterfall model features phases that are comparable to those in the Original Waterfall model, but it also allows for phase overlap and breaks the project into smaller projects. The constraints of the original Waterfall model led to the creation of this enhanced version.

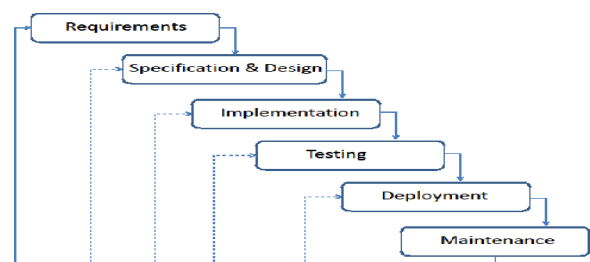


Figure 6: Modified Waterfall Model

(Source:

<https://www.semanticscholar.org/paper/Implications-of-modified-waterfall-model-to-the-and-Gao-Hembroff/6ad11aed72ff31c0dbdaf8b9123b28b9bef422b7>)

Requirements

Potential requirements, deadlines, and guidelines for the project are analyzed and placed into a formal requirements document, also called a functional specification.

This stage of development defines and plans the project without mentioning specific processes. The researchers gathered everyone's suggestions, followed the technical adviser's

advice, and transformed them into actual ones. Interviews with the Mabalacat City College OJT coordinator and other students also contributed to the development of the OJT Monitoring System by providing additional insights into the ideas that went into its design.

Table1: Hardware Specification Requirements for Application Development

Computer Components	Specification
Processor	i5 5th Generation 2.20 GHz
Random Access Memory (RAM)	8 GB
Free Space Hard Drive	500 GB

Our development hardware consists of a laptop with the following specifications: Intel® Core™ i5-5200U CPU @ 2.20GHz 2.19 GHz, Installed RAM, Device ID and System type 64-bit operating system, x64-based processor.

Table2: Software’s Specifications used for the table properties

Software	Description
XAMPP	Cross-platform web server XAMPP is free and open-source. Before publishing to a local web server, XAMPP is a local host or server used to test clients or websites. XAMPP server software on a local computer is suitable for testing MYSQL, PHP, Apache, and Perl projects.
Mobile Flutter	Google's UI toolkit, Flutter, builds beautiful, natively built apps for mobile, web, and desktop from a single codebase. Flutter is open- source, free, and compatible with existing programs.
Sublime3	Sublime Text is a freeware text and source code editor for Windows, macOS, and Linux.

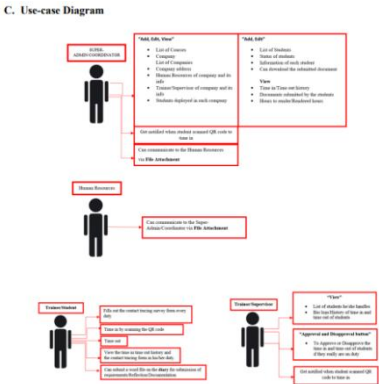
Many programming and markup languages are natively supported. Themes and plugins, usually community-built and maintained under free-software licenses, allow users to modify and improve its functionality. Windows, macOS, and Linux clients could use Visual Studio Code, a lightweight but efficient desktop source code editor.

Visual Studio

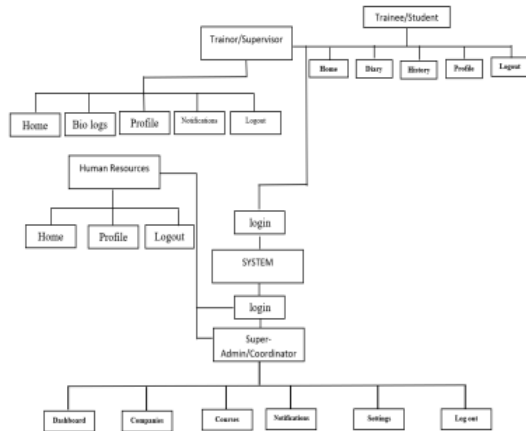
The software used for development was XAMPP, Sublime 3, Visual Studio, and Mobile Flutter are programs that may be downloaded to desktops to facilitate system operation.

Specification Design

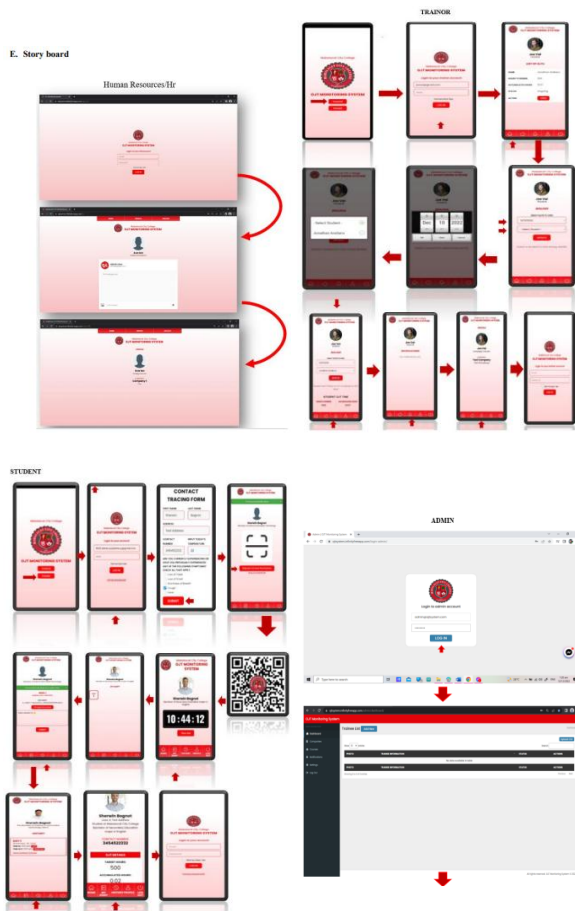
In order to build this system, the researchers use the analysis tools; Use-case Diagram (UCD) (see in Appendix C) It was used to demonstrate and clarify the needs and context of a system as a whole or its key components. and Visual Table of Content (VTOC) (see in Appendix D) It was used to develop a top-down hierarchical framework that allows observation, discussion, and improved understanding of a system's operations and linkages and also to identify the roles of each user level and their system capabilities, and Storyboard (see in Appendix E) documentation for planning is made before the finished product is generated and is intended to explain a narrative or demonstrate scene changes. A timeline will frequently determine this, but it may also be determined by the user's selections or navigational decisions and serve as guide for the flow of the system.



D. Volume table of contents (VTOC)



E. Story board



Implementation

The researcher's implementation stage is examined and modified at this level. The basic specification was delivered to the target users,

Mabalacat City College OJT students, and an explanation was provided by the developer. Target users examine the system at this point to find any requirements that aren't there or problems with the initial conditions. During revisions, the developer, intended users, and researchers developed codes that may provide instructions for fulfillment and completion all throughout. During development, the researchers also carry out a number of tests, such as unit testing, where the developer codes all the requirements and the researchers fix any errors that are found.

The on-the-job training (OJT) is one of the various tasks of the students, wherein they start practicing and experience the hard work on the field for their future. Therefore, the researchers conducted a study on the job training monitoring system that may help out the struggles of trainees and trainers in terms of time management, communication, logging in and out, and monitoring each student. The OJT coordinator will also have less hassle time, which will free up more time for her to rapidly fill out the students' applications to the companies they have chosen to work with.

The researchers chose the OJT monitoring system as a study for android APK for the easiest way to be accessible and more efficient for students to operate using mobile phones. The study's convenience will provide more advantages for the students, the OJT coordinator, and the Mabalacat City College itself, and will play a significant part in fostering further technological improvement in the contemporary world. SDLC was a model used in the methodology and the best software that was more efficient in developing and improving the model.

Testing

It is when quality assurance, unit, system and beta tests identify issues that must be resolved. This might cause a forced repeat of the coding stage for debugging. The Modified Waterfall goes on regardless of whether the system passes integration and testing. Following the implementation phase, the system will also be tested and improved as necessary. The alpha and beta testers' feedback is crucial for the researchers as they do beta and developer testing to gather new ideas and reduce the system's flaws. Finally, successful alpha and

beta testing results demonstrated that the web view application met the specifications using the collected evidence. The research concluded that the application: OJT Records Monitoring system: A Web View Application for logging and Out using QR Code was a success. Developers testing is a type of testing that verifies a fully integrated, finished piece of software. A developer test's objective is to assess the complete system requirements. The software is typically just a small part of a bigger computer-based system. During development, the researchers also carry out a number of tests, such as unit testing, where the developer codes all the requirements and the researchers fix any faults that are found. Developers Testing for app debugging offers a debugger that allows users to choose the device to debug the app on, establish breakpoints in C++ code, and finally, inspect variables and evaluate expressions in real-time. Application testing continues the compilation of the system development and use the created APK file to test the system through a smartphone device to see if there are any errors or whether an update is required. Researchers performed developers testing and beta testing for their system with help from a variety of twenty-nine Mabalacat City College students in their respective OJT location and one OJT coordinator by adopting the ISO25010 as a software quality standard for testing to detect and fix system issues.

The researchers obtained results from developer and beta testing to simple random sampling.

Statistical Treatment

ISO 25010 stands for "Systems and software engineering – Systems and software Quality Requirements and Evaluation (SQuaRE) – System and software quality models" A quality or level of a software system's ability to communicate with other methods while utilizing the same software and hardware. The quality or level of software and hardware, which is the system, can read and display the different software and hardware.

The 4th Year student at Mabalacat City College served as the researchers' beta tester. The application will be tested to make sure the system is functional and to see how it responds to the test scenario. The user interfaces showed

the system as the 30 beta testing students were being interviewed to provide an answer.

The average or computed center value of a group of numbers is known as the mean, and it measures the central tendency of the data. The mean formula in statistics for a collection is defined as the sum of the observations divided by the total number of observations. Mean = (Sum of Observations) is the formula for the mean for a set of given observations (Total Numbers of Observations). Where: $\bar{x} = \Sigma fx / \Sigma f$. The frequency distribution was identified as the answer to the Yes or No to ISO25010 questionnaire. The frequency distribution table organized the question to answer the information of the question table to make it easily understood. The mean score is to get the percentage of the question, which they need to compute to get the score to the Likert scale.

Table 3: Summary of Developer Tester in terms of ISO25010 criteria

No.	Percentage Average Score	Category
1	0 – 20%	Very Invalid
2	21% - 40%	Invalid
3	41% - 60%	Quite valid
4	61% - 80%	Valid
5	81% - 100%	Very Valid

(Source: https://www.researchgate.net/figure/Category-Percentage-of-the-Likert-Scale- Score_tbl1_351761518)
Deployment

The product and its functioning are continuously upgraded, updated, and enhanced through correction and adaptation. Currently, this also entails the release and updating of the required system improvements based on the tests mentioned above to further update the system in the future. The OJT monitoring system and a web-view application developed by the researchers can be downloaded from the website <https://ojtsystemapp.000webhostapp.com> via APK and for the Super-admin to access can visit the site <https://ojtsystem.infinityfreeapp.com/login-admin>. Recommended specification of smartphone to access the said application at least two GB ram with a version of starting in Linux 2.6 up to the updated version. And for

the laptop or pc, at least Intel Core i3 with four GB memory up to the latest version.

Maintenance

After the deployment, researchers come across a few application problems. Maintaining the application would be based on the feedback from the beta testers and selected alpha testers. Additionally, researchers would maintain the previous version of this program for future tracking of similar issues. So that it would be simpler to identify the issue.

RESULTS AND DISCUSSION

The researchers successfully achieved their goals using their method and what they proposed. A user interface that satisfies the researcher's needs and expectations for a realistic overview.

The researchers acquired and used a desktop PC running the Microsoft Operating System to create the OJT monitoring application. The researcher used a desktop PC with an i5 5th generation processor, 8 GB of RAM, 500 GB free space hard drive storage, and a onboard graphics accelerator to develop the web application

Software tools used and operating the system

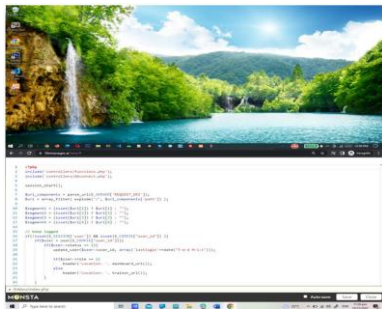


Figure 9: The software's shown on the desktop, and a sample of code is

The researchers installed XAMPP, Visual Studio, Mobile Flutter and Sublime 3, all those scripting language code created by the researchers will interact on the system GUI and the database.

Website and Mobile Application

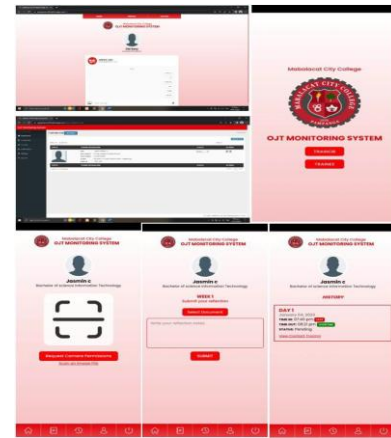


Figure 10: OJT Monitoring System Interactive User Interface

To create the shape for a specific button interface and other designs, the researchers used MS Word. Paint was another tool they employed. The hue should match the theme of Mabalacat City College. After combining all the tools, the researchers made an interface that is similar to the color and design of the Mabacalat City College

Developers Test Administration

The Web view mobile application called OJT Monitoring system was tested for the first time by the researchers while they were doing developer testing. The developers include Mr. Bognot Sherwin, Mr. Gran Paul Vincent, Mr. Masanque Philip, Mr. Mallari Jason, Mr. Dela Cruz Jaybrian, Mrs. Jasmin Cauguiran, and Mr. Jonathan Arellano, an IT graduate who also serves as one of the testers. The responses to the ISO25010 survey questionnaire from each of the aforementioned people are calculated and are displayed below.

Beta Testing Administration

The researcher gathered 29 participants for the beta testers and used ISO20510 as the format for the questionnaire. The 29 respondents, all of whom are participating in OJT, are students at Mabalacat City College. One OJT coordinator was also surveyed to help make sense of the results.

Developers Testing

Table 4: Summary of Developer Tester in terms of ISO25010 criteria

Criteria	Percentage	Verbal Interpretation
Functional Suitability	94.43	Very Valid
Compatibility	100	Very Valid
Usability	89.48	Very Valid
Portability	85.71	Very Valid
Performance Efficiency	100	Very Valid
Total	93.92	Very Valid

The table of Developers, which has the two highest Scores, is Compatibility and Performance Efficiency. Both have a mean score of 100% to get Verbal Interpretation as Very Valid. The lowest is Portability, reaching 85.71% Interpretation is still Very Valid. The total overall mean score is 93.92%. For illustration, which has the answer "YES" is "The system can interact with different client web browser applications without causing any problems with different operating systems (OS) running on the internet capable gadgets like desktop PC, laptop, and mobile phone?" It shows that the respondents highly approve of the compatibility and performance efficiency of OJT Coordinator to Students interaction. The lowest total means score question was "The systems client browser was able to adapt active sessions from the server side to the client side and able to receive systems response?", Meaning that the system has a lot to improve in terms of distributing the information from the super admin to HR.

Beta Testing

Table 5: Beta Testing Result

Criteria	Percentage Average Score	Category
Functional Suitability	96.33	Very Valid
Compatibility	100	Very Valid
Usability	96.22	Very Valid
Portability	100	Very Valid
Performance Efficiency	100	Very Valid
Total	98.51	Very Valid

The table of Beta testers with the three highest scores is Compatibility, Portability, and Performance Efficiency, which must total 100%.

The Verbal Interpretation is Very Valid. Usability, which has the lowest beta tester score (96.22%), yet received Very Valid, and the overall mean score, which is 98.51%, also received Very Valid. The illustration of who answered the "YES" is "The system allows to record the attendance time of students?" It shows how the OJT

Monitoring System works for the users. It is reasonable to infer that even the time in and time out were precisely logged if the system records all of the attendance, and the ISO20150 result served as the evidence. Under ISO20150, Usability got the lowest mean score because some of the respondents were unsatisfied with one of the questions. "The system allows the user to operate and manipulate user entries like user profile, search inquiries, etc.?" According to the interview we conducted, people have trouble saving and looking for the daily diary that the researchers are creating to better it.

Table 6: Comparison of Developers and Beta Tester

Criteria	Developer %	Verbal Interpretation	Beta %	Verbal Interpretation
Functional Suitability	95.29%	Very Valid	98.47%	Very Valid
Performance Efficiency	100%	Very Valid	100%	Very Valid
Compatibility	100%	Very Valid	100%	Very Valid
Usability	85.71%	Very Valid	96.67%	Very Valid
Total	95.08%	Very Valid	99.02%	Very Valid

The table for comparison developer and beta tester under Functional Suitability is almost the same, that most of the ISO20150 by the two different respondents were likely to be identical. The developers' total mean score was 95.29%, and the beta tester's total means score was 98.47%: functional Completeness, Correctness, and Appropriateness from the user-level access up to inner features. Likely to give a high chance to being completed because the result from the survey ending with verbal interpretation is Very Valid. Under Performance Efficiency, both developers and beta testers

said that 100% of the performance from the system was good and that they both answered YES drastically. Same as the compatibility section that ended with a 100% total mean score with verbal interpretation Very Valid. Meaning that even though they have different thoughts on the systems, they evaluated them carefully until they knew the user-client server were all compatible with the website and mobile applications (android and iOS). However, usability developers and the beta tester have different answers to this. Developers (85.71%) were lower compared to beta testers (96.76%), meaning the learnability and operability of the systems could be better. Since the designs cannot be applied using common sense, it is crucial for everyone who is about to utilize this web view type application to have the manual and sufficient information, according to the professional opinion of the developers. From the point of view of a beta tester, the system's usability is good. They were able to use it correctly and with ease. Comprehensive explanation, the result from the developers and beta testers were likely the same, which justifies that the system has good quality from the super admin to HR to Coordinator to OJT student, which was proven in the study process.

DISCUSSIONS

This section provides the presentation of the results of the study. Corresponding analysis and interpretation regarding some presented data were discussed.

Summary of Findings

Provides a presentation of the study's findings. Regarding some of the data that was presented, pertinent analysis and interpretation were discussed. The researchers conducted an interview on the locale to collect a data gathering from the locale and online research. The researchers used software development tools such as XAMPP [32], Visual Studio [33], Mobile Flutter [16] and, Sublime3 [34]. Mobile phone and laptop are the hardware components. To create the system, the software has to meet all of these requirements. The researchers employed story boards, use case diagrams, and visual tables of contents in their design and analysis. The reader will get an overview of each diagram's purpose from this

diagram. The process of Mobile App Creation is to analyze what software to use, after that the researchers start to develop the mobile app. Moreover, if there are any bugs that need to be fixed after development is complete, it will go through testing. As soon as the bug or errors have been fixed the mobile application is available for download and use in OJT. The back-end system employed by the researchers, XAMPP, was designed to focus more on databases and verify that the website functions appropriately. The researchers employed test case questionnaires based on ISO25010 (see in Appendix H), and their summary of the Developer Test's data collection showed that verbal interpretation is highly valid and functional suitability was at 94.43%. Additionally, verbal interpretation is quite valid, and Performance Efficiency was 100%. The system can interact with different client web browser applications without causing any problems with different operating systems (OS) running on the internet capable gadgets like desktop PC, laptop, and mobile phone?" It demonstrates the OJT Monitoring System's impact and operation. Have the developer test how the OJT Monitoring helps the researchers and the testers to do their tasks. Additionally, verbal interpretation is very valid, and compatibility was 100%. The researchers' overall average percent in the criterion of test case questionnaires based on ISO25010 is 93.92%, and verbal interpretation is very valid. In addition, Usability got 89.48% and verbal interpretation is very valid. Beta Test to begin with functional suitability scored 96.33% and verbal interpretation is very valid. In addition, in Performance Efficiency received 100% and verbal interpretation is very valid. Furthermore, in Compatibility received 100% and verbal interpretation is very valid. Moreover, in Usability received 96.22% and verbal interpretation is very valid. In conclusion, the researchers' overall average response rate to test case questionnaires based on ISO25010 was 98.51%, and verbal interpretation is very valid. The illustration of who answered the "YES" is "The system allows to record the attendance time of students?" It shows how the OJT Monitoring System works for the users. Have the beta tester show how to use it to accomplish the researcher to satisfaction. The

future researchers could use this for references and to improve the system for better version.

The OJT Records Monitoring System, which can be downloaded via APK on the site [https://ojtsystemapp.000webhostapp.com/\[D1\]](https://ojtsystemapp.000webhostapp.com/[D1]), would be implemented by the researchers at Mabalacat City College to assist the institution in acquiring the new technology they propose.

Conclusions

The researchers used related literature and internet articles to obtain material for the study, and some of the information was sent to the OJT coordinator. Numerous students for a variety of courses also contributed statistical data. On the other hand, the researchers identified all the hardware and software requirements that had been used in creating the system in the study. The laptop was also utilized by the researchers to design their system and documentation. In order to build the system, the researchers also needed various software needs, such as PHP, which produces dynamic content that can communicate with databases. To create offline applications, HTML QR codes were used. Content formatting was created using CSS3. Oriented and procedural API is provided by MySQLi, jQuery, and JavaScript. Emails were sent using SendInBlue. HTML is used to create web pages. CSS concentrates on system design. To create the codes, Sublime3 was utilized. Presentations, spreadsheets, and other documents are the main focus of Viewers.js. as well as mobile flutter to create applications for many platforms. Furthermore, to design the system the researchers came up with the solution using the Use-case diagram, Visual Table of content and story board to give more ideas and guides

on designing the system. Moreover, on creating a web view application with four user levels the researchers gave much lighter work each one of the users such as Super Admin, Human resources, Trainer and the Trainee that can be easily accessed on the OJT monitoring system. On the contrary, to test the system, the researchers used Developer testing, beta testing and ISO25010 to show if the system was fully functioning. In addition, the researchers deployed the mobile application to

Mabalacat City College via APK, and all the objective was successfully achieved.

The researchers started this study without a tangible prediction of the system's output. To build the said system, the members of this study used a laptop with the specification Processor: Intel® Core™ i5-5200U CPU @ 2.20GHz 2.19 GHz, Installed RAM, Device ID and System type 64-bit operating system, and x64-based processor to develop the said system. The software used to construct the system were PHP, HTML5 QR code, CSS3, HTML5, MySQLi, jQuery, JavaScript, DataTable, SendInBlue, and Viewer.js. The laptop in question has Visual Code, XAMPP, Sublime 3, and Mobile Flutter installed as software. The researchers' desired system has been created with the use of such software. Furthermore, the researchers combined everything to produce the learning system indicated above. (See section 4: I and II. Hardware and Software used); researchers can conclude the study before the final presentation.

The researchers needed more self-assurance when using the tools they learned to design a system with last semester. The researchers intended to leverage technologies like PHP, HTML, MySQL, JavaScript, and others that were covered in the previous academic year in order to make the system's design easier. They can be incredibly helpful when creating a system. Although it was acknowledged that the software used was still prone to faults, it was difficult for the researchers to build the system. The technical adviser rigorously tested numerous versions that had been developed. But even if it did, the problem was solved through persistence and patience. Fortunately, developer testers and researchers connected the production system after considerable trial and error.

The original plan for this study was to have alpha and beta testers assess the entire system and provide helpful input on the survey. After the final defense, the panelists altered their recommendation, advising against switching the tester to beta and instead advising against selecting an OJT student (see Chapter 4: Beta Testing Administration) who would be utilizing this device and observing user interaction. Thirty beta testers were OJT students from

Mabalacat City College who were chosen using simple random sampling to provide feedback on the system's hardware, software, and mobile application.

The result shown above illustrates how well and quickly the system works. It was easier to understand how to incorporate all the elements that the researchers desired to be included after having a beta tester test and evaluate the systems. The device's performance satisfied the tester. As seen in Chapter 4, the frequency and percentage results plainly indicate that all aspects are delicate. In order to assess how many people agreed with them using the Likert scale, the researchers transformed the average score for all the data they had collected during their research and testing into a percentage. The Verbal Interpretation is shown to be very valid in the comparison table of the alpha and beta tests.

Recommendations

The Researcher's recommend adding a feature giving a certificate after to students once on-the-job training is complete. A chat box and call for important needs and links with classmates and professors to inquire whether they need anything or require help are added to that. Last but not least, the researchers suggest getting a camera with a direct upload capability for photos and a voice recorder with a typing feature so they can easily write or list down what transpired while performing their duties on a daily basis.

REFERENCES

- [1] S. M. Heathfield, "How On-the-Job Training Brings You Value," [Online]. Available: liveabout.com/how-on-the-job-training-brings-you-value-1917941. [Accessed 6 January 2021].
- [2] J. L. Lerios and S. B. Sapin, "Performance of Bachelor of Science in Information Technology (BSIT) Students in Their On-the-Job Training (OJT) for the Academic Year 2016-2017," Institute of Education Sciences, April 2017. [Online]. Available: <https://eric.ed.gov/?id=ED574125>.
- [3] D. A. P. Ylagan, "Intensifying the OJT program of the college of business administration, Lyceum of the Philippines University-Batangas," E-International Scientific Research Journal, vol. V, no. 1, pp. 220-220, 2013.
- [4] B. R. Samonte, "Intern-Net: BatstateuOn-the-Job Training Online Portfolio System with Mobile Application," Ascendens Asia Journal of Multidisciplinary Research Abstracts, vol. II, no. 6, 2018.
- [5] S. Arora, D. C. Verma and V. A. Athavale, "A secured automated Attendance Management System implemented with Secret Sharing Algorithm," 2020 Sixth International Conference on Parallel, Distributed and Grid Computing (PDGC), pp. 141-145, 2020.
- [6] V. M. Vinod, S. Thokaiandal, C. S. Sindhuja, V. Mekala, M. Manimegalai and N. Prabhuram, "A comprehensive study on academic and industry authentication and attendance systems.," International Journal of Scientific & Technology Research, vol. 9, no. 3, 2020.
- [7] D. D. Saputra and A. R. Tanaamah, "Optimizing the Use of QR Codes in Web- Based Attendance Information Systems During the Covid-19 Pandemic (Case Study: KONI Salatiga City)," Jurnal Mantik, vol. 5, no. 2, pp. 1076-1086, 2021.
- [8] N. Marco Jr and R. A. Dela Cruz, "Internship Program Management Information System with Lean Management," International Journal of Information and Education Technology, vol. 12, no. 1, 2022.
- [9] N. Sam Kee, "Student attendance system based on QR code with unique identification capturing," 2021. [Online]. Available: <http://eprints.utar.edu.my/4338/>. [Accessed 18 March 2022].
- [10] D.-J. Cho and M.-Y. Bae, "A Study on Development of OTIP System using QR Code based on Smartphone," International Journal of Multimedia and Ubiquitous Engineering, vol. 9, no. 10, pp. 261-270, 2014.
- [11] A. G. G. Oliveros, "Design and Development an Interactive On-the-Job Training Monitoring and Help Desk System with SMS for College of Information and Communication Technology," Journal of Computer and Communications, vol. 10, no. 7, pp. 72-89, 2022.
- [12] J. E. Velasquez and J. V. Vengco, "Online Practicum Monitoring System for Lyceum of the Philippines University Batangas Campus," International Journal on Computer Science and Engineering, vol. 6, no. 2, p. 75, 2014.
- [13] J. H. Almarinez, "Assessment of Online OJT Performance Monitoring," International Journal of Computer Science and Software Engineering, vol. 6, no. 12, pp. 303-305, 2017.
- [14] W3Schools. (n.d.). jQuery introduction. W3Schools. [Online]. Available: https://www.w3schools.com/jquery/jquery_intro.asp. (accessed Jan. 20, 2023).
- [15] "OJT Records Monitoring System Free Database Design Tutorial - iNetTutor.com," [Online]. Available: https://www.inettutor.com/diagrams/ojt-records-monitoring-system-free-database-design-tutorial/?fbclid=IwAR037_G5Tri1Em2eQ_kovK61d0LM2ASaE_C9DrdgYWhE-Nd-o4DxSBcGo. [Accessed 4 February 2022].
- [16] <https://www.adservio.fr/post/what-is-flutter-and-what-are-its-advantages?fbclid=IwAR1Cf9eOVAQ-cD7Zunu0y4fxaLbpRm3x9ybDrtYudRIIBF99D-ZnG5fQzCY>
- [17] "OJT Timesheet Monitoring System using QR Code - Free Capstone 2022," [Online]. Available: <https://www.inettutor.com/source-code/ojt-timesheet-monitoring-qr>

- code/?fbclid=IwAR3csy5akWthNIKOzIQW3SL6vj4hZm6yLwQtjIC7ufo355Hr7 39jjjT2KU. [Accessed 12 May 2021].
- [18] A. Ssenteza, "IMPROVING INTERNSHIP MANAGEMENT IN HIGHER INSTITUTIONS OF LEARNING: A case study of University of Kisubi (Unik)," [Online]. Available: <http://localhost:8080/xmlui/handle/123456789/29..> [Accessed 2017].
- [19] P. A. Harris, R. Taylor, R. Thielke, N. Payne, N. Gonzales and J. G. Conde, "Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support," *Journal of Biomedical Informatics*, vol. 42, no. 2, p. 377–381, 2009.
- [20] M. Muhardi, S. I. Gunawan, Y. Irawan and Y. Devis, "Design Of Web Based LMS (Learning Management System) in SMAN 1 Kampar Kiri Hilir," *Journal of Applied Engineering and Technological Science (JAETS)*, vol. 1, no. 2, pp. 70-76, 2020.
- [21] A. Nuhi, A. Memeti, F. Imeri and B. Cico, "Smart Attendance System using QR Code," [Online]. Available: <https://ieeexplore.ieee.org/abstract/document/9134225/references#references>. [Accessed 1 June 2020].
- [22] M. Anif, A. Dentha, and H. W. S. Sindung, "Designing internship monitoring system web based with Laravel framework," 2017 IEEE International Conference on Communication, Networks and Satellite (Comnetsat), Oct. 2017, doi: 10.1109/comnetsat.2017.8263583.
- [23] H. Pain, "A Literature Review to Evaluate the Choice and Use of Visual Methods," *International Journal of Qualitative Methods*, vol. 11, no. 4, pp. 303–319, Sep. 2012, doi: 10.1177/160940691201100401.
- [24] O. Siddique, A. Siddique, F. Ashraf, and R. Broderick, "Chronic intestinal pseudo- obstruction: An unusual presentation," *The Turkish Journal of Gastroenterology*, vol. 27, no. 6, pp. 564–565, Nov. 2016, doi: 10.5152/tjg.2016.16554.
- [25] M. Boshernitsan, R. Doong, and A. Savoia, "From daikon to agitator," *Proceedings of the 2006 international symposium on Software testing and analysis*, Jul. 2006, doi: 10.1145/1146238.1146258.
- [26] Salamon, D. Arisandi, Sukri, Y. Jusman, I. P. Sari, and L. Elvitaria, "Analysis of Beta Testing Performance for Lecturer Monitoring System: (Case Study: Abdurrahman University)," *IEEE Xplore*, Oct. 01, 2021. <https://ieeexplore.ieee.org/abstract/document/9649717> (accessed Jan. 20, 2023).
- [27] O. Gordieiev, V. Kharchenko, N. Fominykh, and V. Sklyar, "Evolution of Software Quality Models in Context of the Standard ISO 25010," *Proceedings of the Ninth International Conference on Dependability and Complex Systems DepCoS-RELCOMEX*. June 30 – July 4, 2014, Brunów, Poland, pp. 223–232, 2014, doi: 10.1007/978-3-319-07013-1_21.
- [32] F. Agustin, H. Kurniawan, Y. Yusfrizal and K. Umami, "Comparative Analysis of Application Quality Between Appserv and Xampp Webserver Using AHP Based On ISO/IEC 25010:2011," 2018 6th International Conference on Cyber and IT Service Management (CITSM), Parapat, Indonesia, 2018, pp. 1-5, doi: 10.1109/CITSM.2018.8674345.

PADYHAC: Proprietary Application for Dietary, Your Health and Cycling

Jayson B. Bañares
Aira T. Bolima
Franzel Djamarko M. Granados
Calixtro Daniel P. Paras
Kelvin Carl C. Rivera
Noel P. Santiago
Lovely Ruth C. Valdez (Technical Adviser)

ABSTRACT

Nowadays, due to the change in eating patterns brought on by the more than two years of global lockdown, people all across the world have gained a lot of weight. People had no alternative but to stay at home and engage in inactive behavior as all gyms, parks, and other facilities were closed to prevent the virus from spreading. The focus of the study is that it allows cyclist to cycle indoor with a use of a roller and outdoor while tracking the cyclist's speed, calorie burned, and total distance. The researchers developed a mobile application and IoT prototype titled "PADYHAC: Proprietary Application for Dietary, Your Health, and Cycling". The researchers used Arduino, a hall sensor, and a breadboard to build a microcontroller-based Internet of Things prototype that can be attached and detached to a bicycle. The following features were included in the creation of the mobile application: input of BMI, trivia, tracking of distance, viewing of real-time speed, completion of daily tasks, and virtual reality road. Based on the findings and analysis, the generated study was found to be satisfactory. The study PADYHAC: Proprietary Application for Dietary, Your Health and Cycling was implemented by the researchers after the development, testing, and evaluation of the created mobile application. The following suggestions are made in light of the discussion of the results and conclusions for further developing PADYHAC: The mobile software can be made much better by include comprehensive diet and nutrition charts, Users of the study may be able to import and export data so they can save, restore, or backup their files whenever they like, The researchers advise incorporating new features into the application and attempting to create an iOS version of the current application for future researchers.

INTRODUCTION

Some people nowadays either lack time to do a quick workout at home or insufficient financial capacity to go to the gym. Making those as some of the reasons why people are becoming unhealthy. Regular physical activity is essential to live a happy and healthy lifestyle. Creating a workout routine that allows individuals to keep their fitness goals is one of the best strategies to attain physical fitness. People must have a number of gym equipment available in order to maintain their physical fitness. Rowing machines, treadmills, and elliptical trainers are some of the most effective workout equipment for strengthening muscles and improving physical fitness [1].

Fitness equipment allows people to perform aerobic and anaerobic workouts, which help them improve their overall fitness. There are several fitness machines available that train all of the body's muscular groups. Regular gym

activity helps people become in shape and maintain a healthy body weight. Machines such as ellipticals, treadmills, and rowing machines provide a full-body exercise while also helping people to burn calories. Treadmills and cross trainers are gym equipment that improve muscular strength and general health and fitness. Working out on these pieces of equipment improves the stamina for lengthy durations of jogging and running. Moreover, free weights and other weight machines are considered to be beneficial to increase strength and power. They provide resistance training and aid in the development of muscular growth and strength. Exercising on weight equipment improves the stability and balance by increasing individual's range of motion [2].

A lack of physical activity and a balanced diet leads to a variety of health problems and an unhealthy lifestyle. However, regular exercises with fitness equipment can help prevent heart

disease, diabetes, obesity, and other health problems. The good thing about gym equipment is that it allows people to include different workouts that train different parts of their body. Regular physical activity improves not only their physical health but also their emotional being significantly.

Over the last decade, various advancements on how people identify, prevent, and cure diseases have driven the healthcare industry. This is because of the tremendous rise of AI-driven technology and the digitalization of healthcare operations as a response to tougher global conditions and increased demand for accessible and high-quality health care. The incorporation of technology into medical applications opens up new opportunities for people and medical personnel to live in a more sustainable environment and overcome previously incurable diseases. Artificial intelligence (AI), machine learning, virtual care, the Internet of Things, and smart wearables are just a few examples of technologies that improve health care [3].

Extended Reality in Healthcare Settings is another technology trend in the health care digital transformation. Extended reality, which includes augmented reality, virtual reality, and mixed reality, has enormous potential in the healthcare industry. AR and VR technology have the potential to significantly enhance the healthcare industry, from assisting surgery to assisting telemedicine applications. Virtual reality is beneficial in a wide range of healthcare settings. Surgeons' usage of mixed reality headsets such as Microsoft HoloLens 2 is one of the most prominent and useful applications of this technology. VR development is primarily reliant on specialized sensors in order to function. Developers would need appropriate data and software knowledge whether they are working for mobile devices or other types of hardware [4].

In addition, IoT and wearables are current health care technology on the market. Wearables and IoT technologies' potential in the health industry has expanded significantly as they have gained popularity. Wearable technology advancement is one of the most major advances. The capacity to remotely monitor a person's status throughout the day, or for an individual to monitor their own

status, is extremely significant. Heart rate is one of the most basic features that a wristwatch can provide which can be valuable for monitoring a person's health. A smartwatch, however, can measure more than just this. With pedometers and blood oxygen saturation sensors, these devices can also track physical wellness. Without appropriate equipment, low blood oxygen saturation is difficult to detect. Because this is a life-threatening disease, smartwatches equipped with this sensor have the potential to save lives. Smartwatches aren't the only wearables with applications in the healthcare industry. The impact of bio patches and smart hearing aids is similar. Without the usage of a smartwatch, bio patches can give a better insight of a person's vitals [5].

The latest software and communication technologies have changed the face of the health care. Electronic medical records (EMR), telehealth, mobile health, and wireless health are all new and rising healthcare trends. Digital health devices and applications are becoming into a new type of medical prescriptions throughout the world [6].

Smartphones and tablets combine computing and communication features in a single device that may be held in one hand or carried in one's pocket, providing for quick access and usage at the point of care. New mobile device models have advanced functions such as online searching, global positioning systems (GPS), high-quality cameras, and sound recorders in addition to voice and text. Mobile devices have effectively become portable computers with these characteristics, as well as strong processors and operating systems, big memory, and high-resolution displays. Many aspects of health care practice have been transformed as a result of the usage of mobile devices. Mobile devices have become widespread in health-care settings, resulting in a surge in the creation of medical software applications (apps) for these platforms. There are now numerous apps available to help individuals with a variety of important tasks, including information and time management, health record maintenance and access, communications and consulting, reference and information gathering, health monitoring, clinical decision-making, and medical education and training [7].

Mobile applications, or apps for short, have been identified as the ultimate marketing tool and a key promotional approach for attracting and retaining business. Because of specific characteristics (e.g., vividness, novelty, and built-in features), they have a high potential for customer engagement and facilitate one-to-one and one-to-many interactions. Apps, in essence, transform communication efforts into interactive customer experiences that heighten cognitive, emotional, and behavioral reactions. Apps, for example, facilitate value-creating actions such as purchasing and accessing information. As a result, apps provide businesses with several chances to fulfill marketing goals by influencing and shaping the customer journey. Overall, apps enable businesses to establish a digital customer orientation and gain competitive advantages by providing greater customer experiences. Applications have grown in popularity over the previous decade (there are presently more than 2.87 million apps accessible, according to Buildfire 2021), and while their growth has steadily halted, they remain at the center of digital marketing strategies, impacting economies globally [8].

Moreover, the Internet of Things (IoT) is a new paradigm that allows electronic devices and sensors to communicate with one another over the internet in order to improve everyday lives. IoT uses smart devices and the internet to bring creative solutions to many business, governmental, and public/private enterprises throughout the world. IoT is gradually becoming a major component of people's lives, and it can be experienced all around. IoT is an innovation that brings together a wide range of smart systems, frameworks, intelligent devices, and sensors. Furthermore, it takes use of quantum and nanotechnology in terms of storage, sensing, and processing speed, which were before inconceivable. Extensive research studies have been conducted and are available in the form of scholarly publications, news reports, and printed materials to prove the potential usefulness and application of IoT transformations. It might be used as a preliminary task before developing unique inventive business concepts while keeping security, assurance, and interoperability in mind [9]. Aside from its general application in

autonomous vehicles and smart homes, some of the top applications of IoT technology in health care monitoring are worth considering. With the advancement of technology, health professionals are taking full use of these electronic devices. IoT devices are widely employed in the health world. Cardiac patients, high blood pressure people, hypertension problems, and diabetic individuals, in particular. IoT is just a more advanced idea of information and communication technology (ICT). Web-based or online systems have greatly increased in terms of technology. Nowadays, gathering information in real time is important [10].

Without a doubt, technology is growing with each passing day, making human life easier. Virtual reality (VR) is yet another computer-based technology that assists numerous areas, with millions of technologies thriving internationally by aiding in every work. Although it is commonly associated with gaming, virtual reality (VR) is a next-generation technology with applications that have the potential to change a wide range of industries. Virtual reality in healthcare employs computer-generated technology for a variety of healthcare applications, such as providing virtual health care training or performing diagnosis, among others. Another use of VR in health care is physical activity assistance for people who are unable to exercise due to discomfort. VR assists and inspires individuals to accomplish their physical activity by diverting their focus away from discomfort using specific visual and auditory assistance [11].

Both individual and community health are improved through active transportation like cycling. It also reduces the expense of an individual's healthcare. As obesity, heart disease, and diabetes rates decrease, as well as costs associated with bicycling. According to the World Health Organization (WHO), there were 45.3 air-pollution related deaths for every 100,000-person living in the Philippines. [12] By choosing to cycle instead of purchasing a vehicle or commuting as every individual know that buses, tricycles, and specially jeepneys in the Philippines produce a lot of black smoke, a person would gain a lot of health benefits and they can also help reduce the problem with air pollution. With cycling, it can also help people

in reducing their weight and lessen physical inactiveness. In addition, cycling lowers the cost of healthcare and allows people to save a lot of money [13].

Most people work every weekday, which can be stressful at times; cycling can help people lower stress hormones in their bodies. It could also be an activity that they can continue to enjoy while being healthy throughout their life. Cycling can provide a quieter, safer, and less crowded environment. Furthermore, it can encourage the people around, such as neighbors or family members, to cycle in order to increase interaction and encourage each other to live an active and healthy lifestyle.

The researchers study entitled “PADYHAC” an acronym meaning Proprietary Application for Dietary, Your Health and Cycling would have huge impact on every individual as it has features that allows the user to track and provide tasks to accomplish. With the help of the application, users can also learn the proper way of riding a bicycle, right hand signals when cycling outside, and provides suggestions such as trivia, on what to eat to help with the user’s diet. In addition, it lets users ride in a virtual environment when the cyclist chose to ride their bicycle indoors with the use of bike rollers.

SYSTEM DEVELOPMENT METHODOLOGY

This section contains the methodology and design to explain the parameters and process for the development of the study. This section would show the Software Development Life Cycle methodology, analysis diagrams and the research instrument to collect data used by the researcher in the development of the PADYHAC IoT prototype and mobile application.

In the design and development of the official website, the researchers used the Software Development Life Cycle (SDLC). It is a structured process for producing high-quality, low-cost software in the shortest amount of time. The aim of SDLC is to create superior software that meets and exceeds all customer expectations and demands. The SDLC defines and outlines a detailed plan comprised of stages, or phases, each with its own process and deliverables.

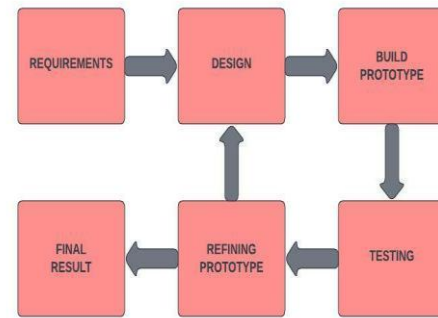


Figure 2. Prototyping Model
(Source: Upadhyay, 2022)

A prototype is constructed, tested, and revised according to the prototyping paradigm of software development until a workable prototype is produced. It also lays the groundwork for the creation of the finished software or mobile application. The process is iterative and based on trial and error between the user and developer. PADYHAC is a proprietary application for dietary, your health and cycling. An IOT project that would help the user to experience cycling even at home, measure the distance travel and guide to proper cycling using MIT app inventor. Prototyping is the most applicable method that is used in this project for it represents all of the necessary phases to accomplish the project.

The following are the methods that the researchers used in developing the mobile application, test it and then reworked as needed until a satisfactory result is obtained from which the entire mobile application can be developed.

Requirements

The first step in the research process is requirement analysis, during which the researchers compile all the data necessary to carry out the study. The researchers looked for related studies and literature to broaden the knowledge of the researchers about the study, identified the problems that needed to be solved, and specified the requirements that would be beneficial in developing the developed mobile application. The researchers analyzed all the collected information to define the requirements needed to develop an effective and efficient mobile application that can help the end-users. Also in this step, the

researchers focused on the sensors, microcontrollers, and modules that are essential to the process, detailing in detail the mobile application's specifications as they list all the components required to construct the prototype.

Hardware and Software Requirements

The following tables below shows the specification of the required hardware and software used in the development of the IoT prototype and mobile application.

Table 1: Hardware Specification

Components	Specification
Processor and Frequency	Pentium 4 or above
RAM	256 MB RAM
Operating System	Windows XP or above

Table 2: Software Specification

Software	Description
Arduino IDE	Used to write codes and upload programs to Arduino compatible boards.
Fritzing	Used to create the circuit diagram of a specific device.
MIT App Inventor	Used to develop and create GUI of a mobile application for Android phones.
Blender	A 3D designing software.

Design

The second stage is a preliminary design, also known as a quick design. In this phase, simple design of the system is created. This defines the elements of the system, the components, modules, architecture and the different interfaces and type of data that goes through the mobile application. To graphically describe the flow of data in the mobile application, the researchers created conceptual framework, block diagram, system architecture, storyboard of the mobile app and circuit diagram. The Conceptual Framework (see Figure 1) illustrates the relationship between variables of the study. It comprises a visual diagram or

model that highlights the study's concepts as well as a narrative description of the model given. The researchers created a conceptual framework that is based on the input, process, and output model, or IPO model.

Architectural Design (see Figure 3) is a visual representation that shows the design of the bicycle with the IoT prototype. The researchers designed this architecture to visualize the actual PADIYHAC.

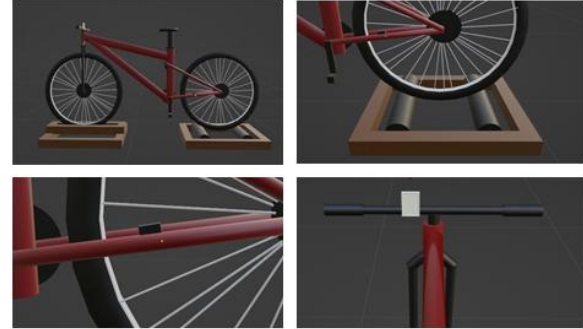


Figure 3. Architectural Design of PADIYHAC

Block Diagram (see Figure 4) allows the researchers visualize the mobile application as a collection of large, linked components that can be conceptualized and developed separately. Early in the development process, creating a block diagram is essential for organizing the researchers that can work on the project continuously.

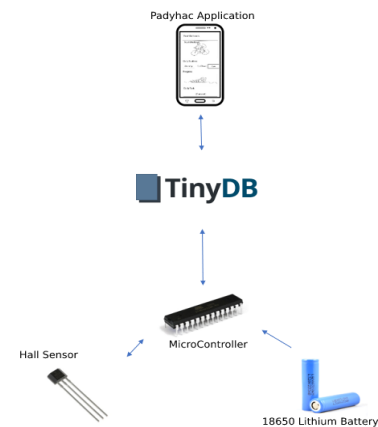


Figure 4. Block Diagram of PADIYHAC

The System Architecture (see Figure 5) is a visual representation that depicts the links

between the various system components as well as the functions that each component performs. The design reflects how it is utilized and how it interacts with other components and the outside environment. The researchers created this diagram to visualize how the mobile application and IoT prototype works in the real world. The users can use their Android device to connect to access the PADYHAC: Proprietary Application for Dietary, Your Health and Cycling and connect it to the bicycle with IoT prototype through Bluetooth. All information would be stored in the database.

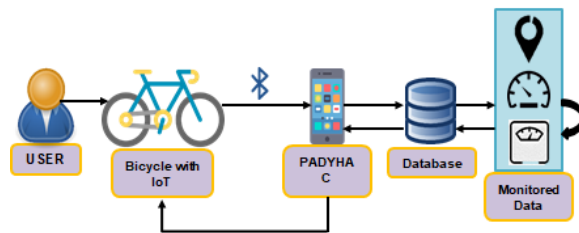


Figure 5. System Architecture of PADYHAC

The Circuit Diagram (see Figure 6) were employed by the researchers because they are important in displaying the exact layout and path of the desired electrical circuit. The diagram does not depict the actual configurations but rather the fundamental circuit or wire connections of electrical components within the electronic equipment.

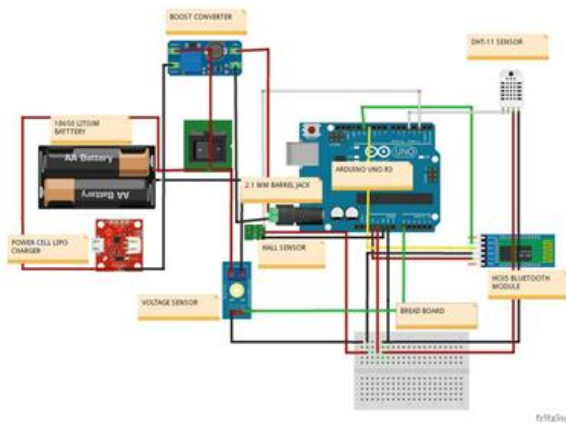


Figure 6. Circuit Diagram of PADYHAC

Storyboard (See Figure7) was utilized by the researchers to keep their focus on the flow and prevent becoming distracted by the UI their

designing as an independent entity. Storyboard helps to enforce a discipline of thinking in terms of experiential flow. It also enables users to put these UIs in the real-world contexts where they would be encountered.



Figure 7. Story Board of PADYHAC

Overall, these diagrams were created to understand, perfect, and deploy new processes or systems in a simple and efficient method. Since these diagrams are the visual representation of the mobile application, these would help the researchers to understand and code the developed mobile application.

Build Prototype

The preliminary design is used to develop the prototype of PADYHAC. This is usually a simplified system that approximates the final mobile application's qualities. The researchers decided to incorporate common and additional features that would help all users of the developed mobile application. Input BMI, Trivia, Track the Distance, View Real-Time Speed, Achieve Daily Tasks, and Virtual Road are the main features of the PADYHAC. The mobile application's Input BMI feature would allow the cyclist to enter information such as height, weight, and so on. This would immediately calculate the cyclist's BMI. The

application's Trivia feature would provide information on proper hand signals to use when cycling outside, good posture, healthy living, and trivia to keep the body physically active even at home. The researchers would also integrate a Track the Distance feature. This would allow cyclists to track the distance traveled as well as their current and last locations. The mobile application would then calculate the estimated calorie burned, the top speed, and the total distance based on the cyclist's current and last locations and with the use of IoT prototyping attached in the bicycle. The cyclists would also be able to view their real-time speed per kilometer. In addition to the features, the mobile application would also give cyclists daily tasks to complete. Furthermore, the researchers would also develop a virtual reality road feature. This would allow cyclists to ride indoors while yet feeling as though they were riding outside. The PADYHAC was developed using online application development platform and software development tools such as Arduino IDE, MIT App Inventor, and Blender. These tools were used to develop and design the IoT prototype and mobile application. The researchers developed PADYHAC based on the objectives of the study.

Testing

In this phase, the researchers would test the mobile application's functionality after the development of the mobile application and the IoT prototype. The mobile application has been put through testing to identify errors and see where it could be improved. In order to develop and incorporate complete quality features into the developed mobile application, the researchers utilized mobile application testing to determine whether or not a mobile application meets the expected requirements and ensuring that it is bug and defect free. It is a type of testing that verifies a software product's completeness and compatibility and is used to evaluate the end-to-end mobile application specifications. System testing's objective, in comparison to the actual requirements, is to detect mistakes, gaps, and missing requirements. At each phase, it assesses the features and validates the mobile application's performance against the requirements.

The researchers created test cases with test scenarios for each feature. Test cases are the test to be performed, whereas test scenarios are the procedures on how the test should be carried out. Expected results for each test scenario were also defined, allowing the researchers to evaluate whether the mobile application meets the needs of its users (see Tables 5-11). In addition, the researchers would put the hall sensor on the frame and a magnet on the crank to test. The researchers would test the hall sensor in a 1-to-100-meter run and record every single revolution to test the accuracy of the speedometer in the mobile application and sensor, which would then be used as a reference in indoor cycling for data accuracy.

In this phase, the researchers also used a user evaluation method that gathered the users' thoughts and opinions on the functions and services offered by the mobile application. The PADYHAC: Proprietary Application for Dietary, Your Health and Cycling was evaluated by the respondents based on the following criteria of ISO 25010: Functionality, Usability, Compatibility, and Portability.

Sampling Method

The researchers used Purposive Sampling to choose the respondents for the study. This method of choosing respondents is judgmental or selective wherein the researchers rely on their own judgement to choose who would participate in the study. Purposive sampling was chosen by the researchers since they had a clear idea about the purpose of the study and which respondents were both eligible and required to answer the evaluation form. By using purposive sampling, the researchers selected individuals or a subset of the population to make statistical inferences. It is one of the most important criteria for determining the reliability of research findings. The table below shows respondents of the developed study. The respondents of the study are students of Mabalat City College. The respondents would evaluate the developed PADYHAC. The evaluation results would indicate if the developed mobile application is acceptable or subjected for improvement.

Statistical Treatment of Data

Frequency Distribution. This is graphical or tabular representation that shows the number of observations within a given interval.

Weighted Mean. The researchers used the mean to measure the ratings of the respondents regarding on the performance and effectiveness of the developed mobile application.

$$\text{Weighted Mean (WM)} = \frac{\sum f(x_1 + x_2 + \dots + x_n)}{N}$$

Where:

$\frac{\sum f(x_1 + x_2 + \dots + x_n)}{N}$ = Represents the summation of all means of each criterion.

N = number of criteria

Percentage. This was used to determine the qualitative ratio of the data gathered. This is a number or ratio expressed as a fraction of 100.

$$\text{Percentage(P)} = \frac{F}{N} * 100$$

Where:

F = frequency of a numeric rating for some given criteria

N=represents the total number of the respondents

Likert Scale. It functions by having a person complete a questionnaire that requires them to indicate the extent to which they agree or disagree with a series of statements.

The Likert Scale is a scale that allows people to indicate how strongly they agree or disagree with a statement. Likert Scale works by having the respondents fill out an evaluation form in which they must rate how much they agree or disagree with a series of assertions. The functional suitability, usability, compatibility, and portability of the mobile application would be evaluated.

Table 3. Likert Scale

Scale	Weighted Mean	Verbal Interpretation
5	81% - 100%	Strongly Agree
4	61% - 80%	Agree
3	41% - 60%	Neutral
2	21% - 40%	Disagree
1	0 - 20%	Strongly Disagree

Refining Prototype

After the thorough testing done by the researchers and the evaluation of the

respondents, the researchers continued to improve the mobile application in order to satisfy and meet the user's qualifications. The preceding procedures were repeated as needed until the users are satisfied with the mobile application that was given during the evaluation.

Final Result

Upon completion of the numerous evaluations and tests conducted on the device's performance and This step results in the creation of the finished mobile application. The researchers were able to build and develop the final product in accordance with the goals they set out to attain and the panelists' suggestions. The final mobile application is developed based on the user's needs where it underwent extensive testing and evaluation. After this, the source code would be converted and uploaded in order to have a fully functional PADYHAC. The mobile application and IoT prototype would then be deployed on the static webpage the researchers created for the purpose of marketing the IoT prototype. Furthermore, maintenance would be done over time to meet future requirements. This may necessarily require the addition of code or the modification of existing code. To prevent large-scale failures and minimize downtime after deployment, routine maintenance would be carried out on a regular basis.

RESULTS AND DISCUSSIONS

This section shows the result and outcomes based on the study's objectives and how the researchers achieved the main objectives. This chapter discusses the hardware and software requirements, designs, created and the developed application's and PADYHAC prototype functions, testing and deployment. It also presents the analysis and the interpretation of the beta testing made by the researchers.

PC System Properties

The researchers discussed the technical aspect that they would use in the development and implementation of the developed mobile application and IoT prototype. This includes a thorough discussion of the hardware and software used to develop the mobile application.



Figure 8. PC System Properties

Figure 8 shows researcher's PC system properties. The PC utilized by the researchers has the following specifications: AMD Ryzen 3 for processor, 8GB RAM, and a 64-bit operating system.

MIT App Account

The goal of the online platform MIT App Inventor is to introduce computational thinking ideas through the creation of mobile applications. Researchers can build apps by dragging and dropping elements into a design view and programming application behavior in a visual block language. Below is the MIT Application account used by the researchers.

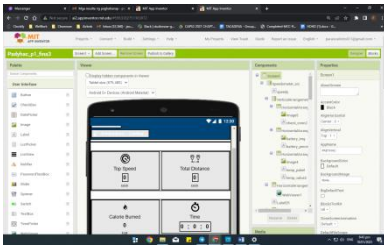


Figure 9. MIT App Account

Figure 9 shows the MIT App account of the researchers. This is the tool used to develop and create GUI of the mobile application for Android phones.

Prototype and Mobile App Feature

This section provides the overall summary of functions and features of the mobile application and IoT prototype.



Figure 10. User Profile Module of PADIYHAC

As shown in Figure 10, this is where the users input their height, weight, cycling activity, wheel circumference and the BMI. The monthly weight report would also be displayed here.

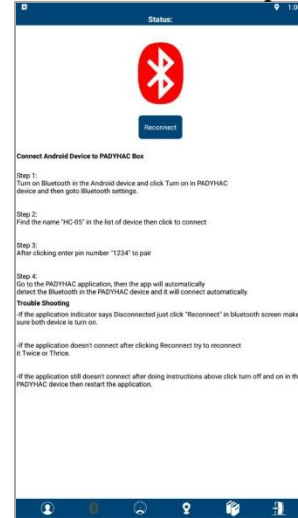


Figure 11. Bluetooth Module of PADIYHAC

Figure 11 shows where the Android device would be connected to the PADIYHAC box through Bluetooth connection. This module also displays a set of instructions on how to connect to the PADIYHAC box as well as shows a guide for trouble shooting.

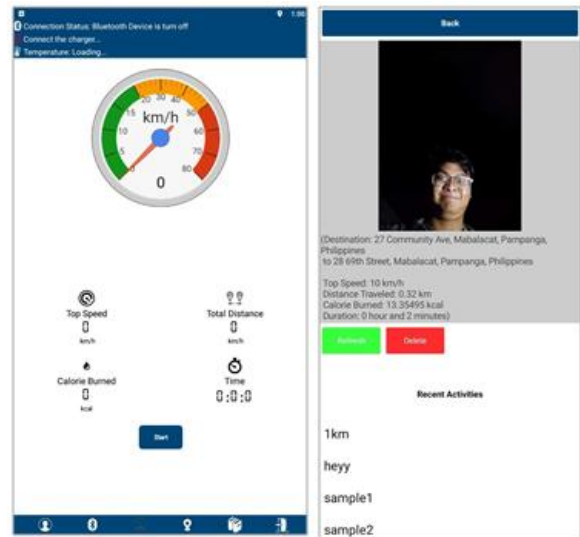


Figure 12. Distance Tracking

As shown in Figure 12, this is where users can monitor and keep track of their real-time

speed. This mobile application would track the cyclist's current and last location. The mobile application would then calculate the estimated calorie burned, the top speed, and the total distance based on the cyclist's current and last locations. In addition, the cyclist can also take pictures here.

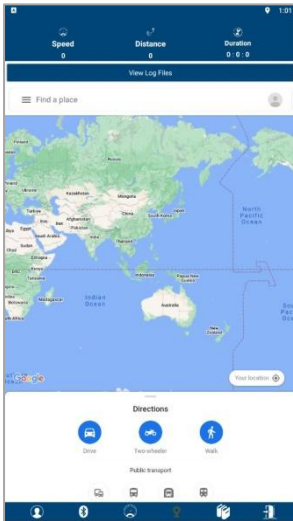


Figure 13. Map

Figure 13 shows the GPS Map where users can find a place by searching it in the search button, view log files, directions, etc. This would help the users to keep track of their location.



Figure 14. Trivia

Figure 14 shows where users can find and learn trivia regarding road rules, cycling rules,

etc. This would help the users to know the rules, which would keep them safe while cycling.



Figure 15. Daily Tasks

As shown in Figure 15, this is where users can achieve daily challenges. This feature would help the users to set a goal and achieve challenges to improve their health and fitness.

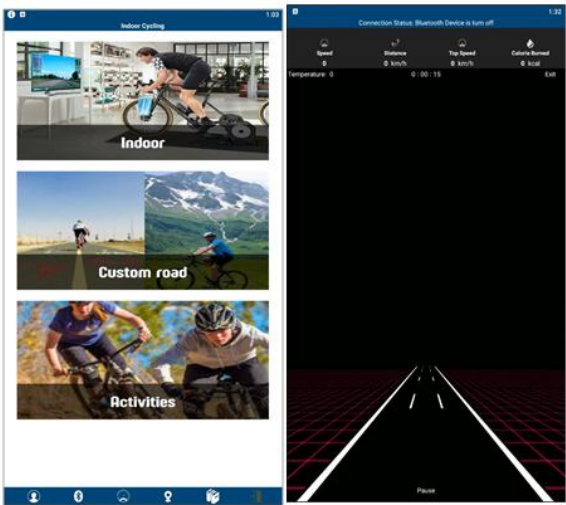


Figure 16. Indoor Cycling

Figure 16 displays the indoor activities and virtual road where users can cycle indoors. Users can also custom the road.

Test Case Respondents

The researchers created test cases with test scenarios for each feature of PADYHAC.

Respondents evaluated each feature based on the criteria of ISO 250101.



Developers Test Case Result

The testing and evaluation of the mobile application conducted by the proponents are presented in below along with the findings and analysis. To verify the stability of the mobile application, the researchers employed test cases as their testing technique. The researchers were able to test info mobile application and mobile app using ISO 25010 as mentioned on the objective of the study.

Table 4: Functionality Test

Questions	YES	NO
1. Can the hall sensor detect the speed when the wheel is spinning?	YES	
2.Does the speedometer on the app moving when pedaling?	YES	
3. Does the hall sensor detect the magnet on spokes of the wheel?	YES	
4.While installing the app and the connection is lost, would the installation be completed?	YES	
5. While loading the app and the connection is lost, would the map still be loaded?	YES	
6.Does the application display the speed in kilometers per hour?	YES	

Table 4 shows the result of the PADIYHAC'S test case in terms of functionality. The PADIYHAC: Proprietary Application for Dietary, Your Health and Cycling passed the

Table 5: USABILITY

Questions	YES	NO
1 Does the application able to give proper guidelines in cycling?	YES	
2.Does the device rechargeable when used outdoor?	YES	
3. Does the device safe to use indoor and outdoor	YES	
4.Does the applicable to beginners in cycling?	YES	

Table 5 shows the test case in terms of usability. The PADIYHAC: Proprietary Application for Dietary, Your Health and Cycling received a 100% result in evaluation.

Table 6: COMPATIBILITY

Questions	YES	NO
1. Does the application compatible to any android device?	YES	
2.Does the application be uploaded to apkpure.com?	YES	
3. Does the application run smoothly?	YES	
4.Does the user interface responsive?	YES	

Table 6 shows the result of the PADIYHAC'S test case in terms of compatibility. The PADIYHAC: Proprietary Application for Dietary, Your Health and Cycling passed the compatibility evaluation with a result of 100%.

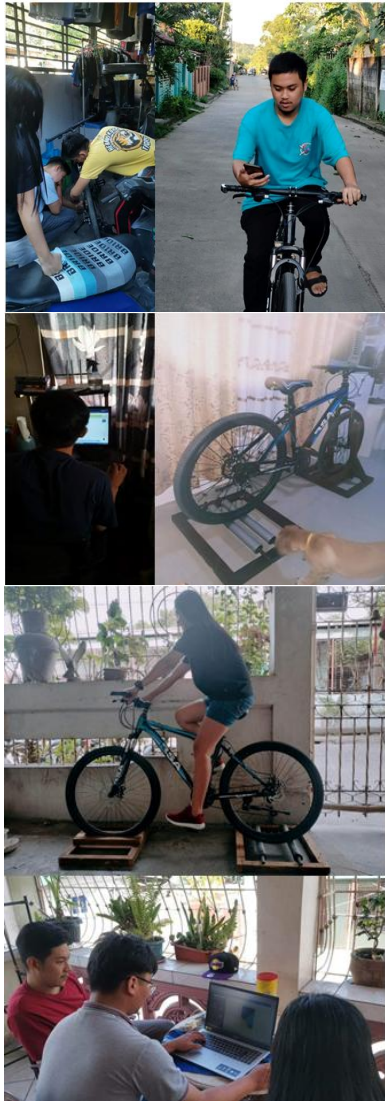
Table 7: PORTABILITY

Questions	YES	NO
1. Does the application working on any android devices?	YES	
2.Does the device can be installed to any bicycle?	YES	
3. Does the device can be used at any weather?		NO

Table 7 shows the result of the PADIYHAC'S test case in terms of compatibility. The PADIYHAC: Proprietary Application for Dietary, Your Health and Cycling passed the compatibility evaluation with a result of 100%.

Beta Test Administration

The researchers conducted a beta testing of PADYHAC: Proprietary Application for Dietary, Your Health and Cycling. The images below were captured while performing PADYHAC's beta testing.



Summary (ISO 25010 Criteria) Results

Table 8: Summary Results

CRITERIA	RESULT
1. Functionality	90%
2. Usability	92%
3. Compatibility	85%
4. Portability	87%
TOTAL: 89%	

The Usability criteria has garnered a highest weighted mean score of 92% with a verbal interpretation of “Strongly Agree”. This means that the beta tester agreed that both application and prototype was easily to learn through proper guidelines of cycling. The Compatibility has garnered a lowest weighted mean score of 85% with verbal interpretation of “Strongly Agree”. This means that some beta testers disagreed with the application has a compatibility issue with their android device. The overall evaluation of the developed PADYHAC: Proprietary Application for Dietary, Your Health and Cycling, obtained a total of 89% result with verbal interpretation of “Strongly Agree”. This indicates the overall satisfaction of the beta testers on the specific criteria of the developed mobile application and PADYHAC prototype was agreed and accomplished.

REFERENCES

- [1] Zheng, Z., Mo, J., & Xu, Y. (2021). Research on Public Fitness Equipment Experience Based on Satisfaction. *Healthcare* (Basel, Switzerland), 9(5), 501. <https://doi.org/10.3390/healthcare9050501>
- [2] Andriopoulos, S. (2021). Top benefits of gym equipment for physical fitness. *TravelDailyNews International*. <https://www.traveldailynews.com/column/featured-articles/top-benefits-of-gym-equipment-for-physical-fitness/>
- [3] Matuszak, J. (2022). Top 10 Healthcare Technology Trends. *KnowHow*. <https://knowhow.distrelec.com/medical-healthcare/top-10-healthcare-technology-trends/>
- [4] Khristich s. (2023). 17 Major Healthcare Technology Trends of 2023. *TATEEDA | GLOBAL - Full Cycle Custom Software Development Services and Outsourcing in the USA and Ukraine*. <https://tateeda.com/blog/healthcare-technology-trends>
- [5] Tsymbal, O. (2023). Healthcare Technology Trends and Digital Innovations in 2023. *MobiDev*. <https://mobidev.biz/blog/technology-trends-healthcare-digital-transformation>
- [6] Stefanuk, A. (2021). Top 10 Healthcare Gadgets You Should Know About. *ReferralMD*. <https://getreferrallmd.com/2019/07/top-10-healthcare-gadgets-you-should-know-about/>
- [7] Ventola C. L. (2017). Mobile devices and apps for health care professionals: uses and benefits. *P & T: a peer-reviewed journal for formulary management*, 39(5), 356–364
- [8] Stocchi, L., Pourazad, N., Michaelidou, N., Tanusondjaja, A., & Harrigan, P. (2021). Marketing research on Mobile apps: past, present and future. *Journal of the Academy of Marketing Science*, 50(2), 195–225. <https://doi.org/10.1007/s11747-021-00815-w>

- [9] Kumar, S., Tiwari, P., & Zymbler, M. (2019). Internet of Things is a revolutionary approach for future technology enhancement: a review. *Journal of Big Data*, 6(1). <https://doi.org/10.1186/s40537-019-0268-2>
- [10] Mamun-Ibn-Abdullah, M., & Kabir, M. H. (2021). A Healthcare System for Internet of Things (IoT) Application: Machine Learning Based Approach. *Journal of Computer and Communications*, 09(07), 21–30. <https://doi.org/10.4236/jcc.2021.97003>
- [11] Li, D. (2023, January 24). How Virtual Reality Is Transforming Healthcare. U.S. Chamber of Commerce. <https://www.uschamber.com/technology/how-virtual-reality-is-transforming-healthcare>
- [12] Imelda V. Abano, 2029. Health experts in the Philippines lead the fight against dirty air. <https://noharm-global.org/articles/news/asia/news-health-experts-philippines-lead-fight-against-dirty-air#:~:text=Air%20pollution%20is%20one%20of,by%20the%20World%20Health%20Organization>
- [13] Selene Yeager, 2018. Riding Consistently Can Cut Your Risk of Early Death by 23%. <https://www.bicycling.com/news/a24083596/cycling-reduces-premature-death/>
- [14] Tong H.L., Maher C., Parker K., Pham T.D., Neves A.L. & Riordan B. (2022) The use of mobile apps and fitness trackers to promote healthy behaviors during COVID-19: A cross-sectional survey. *PLOS Digit Health* 1(8): e0000087. <https://doi.org/10.1371/journal.pdig.0000087>
- [15] Fruh S. M. (2017). Obesity: Risk factors, complications, and strategies for sustainable long-term weight management. *Journal of the American Association of Nurse Practitioners*, 29(S1), S3–S14. <https://doi.org/10.1002/2327-6924.12510>
- [16] Jensen M.D., Ryan D.H. & Apovian C.M. (2018). AHA/ACC/TOS guideline for the management of overweight and obesity in adults. *Circulation*. 2014;129: S102–S138. <https://www.niddk.nih.gov/health-information/weight-management/adult-overweight-obesity/treatment>
- [17] Cronkleton E. (2021). 12 Benefits of Cycling, Plus Safety Tips. <https://www.healthline.com/health/fitness-exercise/cycling-benefits>
- [18] Wang, Y., Wu, T., & Chen, Z. (2021). Active Usage of Mobile Health Applications: Cross-sectional Study. *Journal of medical Internet research*, 23(12), e25330. <https://doi.org/10.2196/25330>
- [19] Samdal, G.B., Eide, G.E., Barth, T. et al. Effective behaviour change techniques for physical activity and healthy eating in overweight and obese adults; systematic review and meta-regression analyses. *Int J Behav Nutr Phys Act* 14, 42 (2017). <https://doi.org/10.1186/s12966-017-0494-y>
- [20] Bailenson, J. (2018). Experience on Demand: What Virtual Road Is, How It Works, and What It Can Do. <https://stanfordvr.com/pubs/2018/experience-on-demand-what-virtual-reality-is-how-it-works-and-what-it-can-do/>
- [21] Kristijan Lucic, 2020. What Are Android Apps? Everything You Need To Know. <https://www.androidheadlines.com/what-are-android-apps>
- [22] Premiumbeat, 2021. Complete Beginner's Guide to Blender. <https://www.premiumbeat.com/blog/blender-software-guide/>
- [23] Luke Edwards, 2022. What Is MIT App Inventor And How Does It Work? Tips & Tricks. <https://www.techlearning.com/how-to/what-is-mit-app-inventor-and-how-does-it-work-tips-and-tricks>
- [24] Weiper, K., Weiskirchen, S., & Weiskirchen, R. (2020). From Mice to Humans: The Study of Obesity. <https://kids.frontiersin.org/articles/10.3389/frym.2020.00092>
- [25] Eszter. (2020). Science-Backed Benefits of Cycling Regularly. <https://www.donkey.bike/science-backed-benefits-of-cycling-regularly/>
- [26] Phillips, L. (2021). 7 Biking Etiquette (and Safety) Rules Everyone on Two Wheels Should Follow. <https://www.realsimple.com/health/preventative-health/safety/biking-etiquette-safety>
- [27] Smith, J. (2020). How to follow a healthful diet. <https://www.medicalnewstoday.com/articles/153998#what-is-a-healthful-diet>
- [28] Arora, G. (2021). For How Long Should You Do Cycling for Weight Loss? Expert Reveals Important Do's and Don'ts Of Cycling. <https://www.ndtv.com/health/for-how-long-should-you-do-cycling-for-weight-loss-expert-reveals-important-dos-and-donts-of-cycling-2344996>
- [29] Bikeradar, 2020. Cycling benefits. <https://www.bikeradar.com/advice/fitness-and-training/30-great-benefits-of-cycling/>
- [30] Jobit Joseph, 2022. Interfacing Hall Effect Sensor Module with Arduino. <https://circuitdigest.com/microcontroller-projects/interfacing-hall-effect-sensor-module-with-arduino>
- [31] James Spragg, 2017. Why you should train with rollers – and three sessions to master <https://roadcyclinguk.com/how-to/technique/train-rollers-three-sessions-master.html>
- [32] Jobit Joseph, 2022. Beginners Guide to Arduino IDE and Arduino Programming. <https://circuitdigest.com/article/getting-started-with-arduino-programming-using-arduino-ide>
- [33] Theresa Schousek, 2018. Embedded control fundamentals. <https://www.sciencedirect.com/topics/engineering/breadboard>
- [34] Evan W. Patton, Michael Tissenbaum & Farzeen Harunani. MIT App Inventor: Objectives, Design, and Development. https://link.springer.com/chapter/10.1007/978-981-13-6528-7_3
- [35] Anurag Gupta, 2020. Blender 3D: A brief introduction to the most popular open-source 3D software. <https://uxdesign.cc/blender-3d-model-animate-create-70c774806691>
- [36] Swaen, B. & George, T. (2022). What Is a Conceptual Framework? | Tips & Examples. Scribbr.

- <https://www.scribbr.com/methodology/conceptual-framework/>
- [37] Opinaldo, N. (2022). Understanding about Architecture Diagram with Templates. <https://gitmind.com/architecture-diagram.html>
- [38] Wong, S. (2017). System Block Diagrams. <https://www.clear.rice.edu/comp310/JavaResources/systemblockdiagrams.html>
- [39] Little, A. (2017). Storyboarding in the Software Design Process. <https://uxmag.com/articles/storyboarding-in-the-software-design-process>
- [40] Altwater, A. (2020). What Is SDLC? Understand the Software Development Life Cycle. <https://stackify.com/what-is-sdlc/>
- [41] Narang, M. (2023). Prototype Model in Software Engineering. <https://www.naukri.com/learning/articles/prototype-model-in-software-engineering/#What-is-a-prototype-model>
- [42] Estdale, John & Georgiadou, Elli. (2018). Applying the ISO/IEC 25010 Quality Models to Software Product: 25th European Conference, EuroSPI 2018, Bilbao, Spain, September 5-7, 2018, Proceedings. 10.1007/978-3-319-97925-0_42.
- [43] Taherdoost, H. (2018). Sampling Methods in Research Methodology; How to Choose a Sampling Technique for Research. SSRN Electronic Journal. <https://doi.org/10.2139/ssrn.3205035>
- [44] Waghmare, P. (2021). Circumference of a Circle: Explanation, Terms, Formula & Examples. <https://testbook.com/learn/maths-circumference-of-a-circle/>
- [45] Zalata, A. (2021). Development of a virtual road traffic generation module | E3S Web of Conferences. <https://doi.org/10.1051/e3sconf/202125802033>
- [46] Zhuoran, H. (2020). Mobile Health Application for Diabetes Self-Management. Computer Science Masters Theses. <https://hdl.handle.net/10365/31846>
- [47] Adewumi, A., Olatunde, G., Misra, S., Maskeliūnas, R., & Damaševičius, R. (2018). Developing a Calorie Counter Fitness App for Smartphones. Achieving Sustainable Development Goals through ICT/Software Engineering, 23–33. https://doi.org/10.1007/978-3-319-74980-8_3
- [48] Żabińska, M. (2020). Development of a Fitness Mobile Application. Haaga-Helia University of Applied Sciences. https://www.theseus.fi/bitstream/handle/10024/349640/Zabinska_Maria.pdf?sequence=2&isAllowed=y
- [49] Chavez, M. C. (2016). HeartMate: A Competitive and Motivational Fitness Application. <https://www.cse.unr.edu/~fredh/papers/thesis/066-chavez/thesis.pdf>
- [50] Paluyo, J., Stake, A., & Bryson, R. (2022). 'Padayon': A New Digital Health Model for Diabetes and Hypertension in Rural Philippines. *BMJ Journals*. <https://doi.org/10.1136/bmjinnov-2021-000900>
- [51] Bender, M. S., Santos, G. M., Villanueva, C., & Arai, S. (2016). Development of a Mobile Phone-Based Weight Loss Lifestyle Intervention for Filipino Americans with Type 2 Diabetes: Protocol and Early Results from the PilAm Go4Health Randomized Controlled Trial. *JMIR research protocols*, 5(3), e178. <https://doi.org/10.2196/resprot.5836>
- [52] Kruglyak, I. (2023). 20 Examples of Wearables and IoT Disrupting Healthcare -. Avenga. <https://www.avenga.com/magazine/wearables-iot-healthcare/>
- [53] Skjong, I., & Roberts, A. (2023). The Best Fitness Trackers. *Wirecutter: Reviews for the Real World*. <https://www.nytimes.com/wirecutter/reviews/the-best-fitness-trackers/>
- [54] Williams, A. (2022). Garmin Vivoactive 4 review. *TechRadar*. <https://www.techradar.com/reviews/garmin-vivoactive-4>
- [55] Watson, M. (2022). 7 Devices to Monitor Heart Health | Caring Senior Service. <https://www.caring seniorservice.com/blog/heart-health-devices>
- [56] Skjong, I., & Palus, S. (2023). The Best Treadmill. *Wirecutter: Reviews for the Real World*. <https://www.nytimes.com/wirecutter/reviews/best-treadmill/>
- [57] Skjong, I. (2023). The Best Exercise Bikes. *Wirecutter: Reviews for the Real World*. <https://www.nytimes.com/wirecutter/reviews/best-exercise-bikes/>
- [58] Olken, F. (1993). Random sampling from databases (Doctoral dissertation, University of California, Berkeley).
- [59] Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., ... & Walker, K. (2020). Purposive sampling: complex or simple? Research case examples. *Journal of research in Nursing*, 25(8), 652-661.

PetPal: A Web Application for Domestic Animal Adoption of Noah's Ark Shelter for Dog and Cat

Jeneal R. Fuellas
Christopher Merk L. Hitutua
Emmanuel John R. Mendoza
Crystal Jade M. Reforsado
Chem Harold G. Sanchez
Melanie M. Valerio
Lorenzo C. Macam, MIT (Technical Adviser)

ABSTRACT

Animal abuse is one of the problems in the community, many pet owners are not responsible in taking care of animals and most common victims of this animal abuse are those domestic animals like dogs and cats. Nowadays innovations and advancements are being made daily in the world of web development. The main objective of this research is to develop a web application entitled "PetPal: An Application for Domestic Animal Adoption of Noah's Ark Shelter for Dog and Cat" that has a feature that can make the process of adopting a pet easier by notifying people when a pet is discovered or lost, displaying knowledge about pets, and creating a platform for pet donations. Because of the flexibility that suits project development, the researcher employed the Modified Waterfall to construct the Web application. The developed application features has a capability to display several information on the available dogs and cats that can be adopted, the pets that were lost and surrendered to the shelter, trivia about several categories that are related about the pets and the display of bank accounts of the locale where anyone could donate. The develop web app has garnered remarkably overall alpha and beta testers response of "Strongly Agree" with a verbal interpretation of "Highly Acceptable" based on Software Product Quality model standards of ISO25010 in terms of Functional Suitability, Usability, Compatibility and Portability. With the summary of findings and complete evidences researchers conclude that the overall objective of the study was achieved.

INTRODUCTION

Animal abuse is one of the problems in the community, many pet owners are not responsible in taking care of animals and most common victims of this animal abuse are those domestic animals like dogs and cats. According to the statics report by the Petpedia, about 10 million of cases of animal abuse every year are recorded worldwide; it is very evident that animals are also suffering from physical abuse by humans. Animal abuse is caused by a lack of adequate treatment and living conditions for animals. Animal rights organizations stress the need of preventing hunger, thirst, suffering, sickness, and discomfort in animals. These needs are sometimes not addressed, according to these groups, in situations where animals are used for food or clothing, experimentation, entertainment, or even in the wild. [1]

This is the reason why there are some people who created non-profit organizations for the animals. Non-profit organizations aim to rescue animals who are suffering from mistreatment

and abuses of owners. These organizations also rescue animals who are abandoned in the streets or houses. Animal welfare refers to an animal's physical and psychological well-being helping animals to experience the right treatments and care. Animal rights are moral concepts based on the conviction that nonhuman creatures deserve the freedom to live their own lives without being influenced by human interests. Autonomy, which is another way of stating choice, lies at the heart of animal rights. [2]

Animals as trade items or household pets—this Act aims to protect and advance the welfare of all animals in the Philippines. For the purposes of this Act, birds are regarded as domestic pets. Acknowledging this act, the researchers cooperate to the Noah's ark Dog and cat shelter. This non-profit organization rescues dogs and cats who are suffering from abuse and abandonment by their previous owners. The organization is located in Sitio Irung, Barangay Tabun Mabalacat City, Pampanga.

This organization helps the animals around the vicinity of Mabalacat City, where people around Mabalacat City can freely to report the animal abuses. The organization takes steps and actions by rescuing animals especially dogs and cats by providing them shelter and food. This organization opens its the door to the people who are responsible in taking care and rescuing animals [3].

Nowadays, innovations and advancements are being made daily in the world of web development, which is rapidly expanding. The days of developing web applications to be seen on desktop computers are long gone. Developers need to make websites adaptable for all devices because there are so many different screen sizes of devices today, including mobile phones, tablets, laptops, and others. Developers need to keep up with the development of our technology. This is where researchers thought to help non-profit organizations that rescue animals that are being abused. Hence, they worked with Noah's Ark Dog and Cat Shelter to find a new homes for those that are being abused.

The goal of this study entitled "PetPal: A Web Application for Domestic Animal Adoption of Noah's Ark Shelter for Dog and Cat" is to help the said non-profit organization to look for responsible owners to be the new home of the stray animals that got rescued. This also aims to decrease accidents caused by the stray animals.

General objectives

The main objective of this research is to develop a web application entitled "PetPal: An Application for Domestic Animal Adoption of Noah's Ark Shelter for Dog and Cat" that has a feature that can make the process of adopting a pet easier by notifying people when a pet is discovered or lost, displaying knowledge about pets, and creating a platform for pet donations. This application will help the non-profit organization look for a responsible owner for the stray animals that got rescued. The specific objectives of the study are as follows:

Specific objectives

1. To gather data that are needed to obtain for the creation of application, the researchers will conduct interviews and search the internet.
2. To identify the software requirements
 - a. XAMPP

- b. Bootstrap
 - c. Laravel
 - d. Adobe Photoshop CS6
 - e. Visual Studio Code
 - f. Heroku
3. To design a web application using analysis tools
 - a. Storyboard
 - b. Use case Diagram
 - c. Visual Table of Content
4. To create and develop a web application with the following features
 - a. Adoption of Available Pets
 - b. Lost and Found
 - c. Trivia
 - d. Submission of voluntary Donation receipt
5. To test the web application using ISO 25010 in terms of:
 - a. Functional Suitability
 - b. Usability
 - c. Compatibility
 - d. Portability
6. To deploy the web application to Google Play Store

Scope and limitation

The researchers would gather information regarding the "Noah's Ark Shelter for Cat and Dogs" by interviewing the founder and know more information about the terms of the process of adoption, management of shelter, including the history on how the shelter started, and the founder's expectations or features the suggested application would have. After the conducted data gathering, the researchers would acquire the application hardware and software requirements. The researcher would use a laptop computer with a hardware specification of Intel i7 processor, 464 gigabyte storage, and 16 gigabyte memory. The XAMPP would be installed and configured to create a local host web service and use MySQL as Database Management System. Using a notepad application, the created web script could be modified, updated and saved in the drive. The researcher would use adobe Photoshop for the creation of application logo. The storyboard, use case diagram, and Visual Table of Content (VTOC) diagram would be used by the researchers to build and depict the application's logical flow. The researchers would make a storyboard that illustrates the

rational flow of the user interface for a web application and how the user would interact with the entire application. It would first outline the issues facing the location before creating a web application as a remedy for how the application would make life easier for the local staff. It would be possible to see how users and administrators would be created using the use case diagram.

In Visual Table of Content (VTOC) diagram shows the menu contained in web application showcases the process of how to adopt rescued animals and the things to consider before deciding to adopt.

The application would be able to display several information on the available dogs and cats that can be adopted—the pets that were lost and surrendered to the shelter; trivia about several categories that are related to the pets and the display of bank accounts of the locale where anyone could donate. Users would be able to browse and apply for adoption for their selected pets. The users could upload files for the donation slip made to the locale and request for administrator for a pet that the users found. The system would give the administrator the ability to manage the information by adding, editing or archiving the trivia and the available pets for adoption. The administrator could then approve or deny for the request of the user's application for adoption of lost pets. The administrator can also browse the donation slip entered to the system.

With the developed application, the researchers would conduct a survey with 3 IT experts for alpha testing and 34 beta testers for testing the application base on the selected categories of ISO 25010. When the application is fixed and passed the test conducted based on the survey created, the application would be given to the locale and uploaded to the Google Play Store for deployment.

SYSTEM DEVELOPMENT METHODOLOGY

This section explains the web application's design, and the plan analysis explains how it operates. Methods and techniques are used to implement the system.

Because of the flexibility that suits project development, the researcher would employ the Modified Waterfall to construct the Web application. The modified Waterfall approach

seeks to build a flow that will improve the efficiency of the web application development process for design and documentation. It also allows researchers to use the modified waterfall technique more successfully throughout the web application development phases.

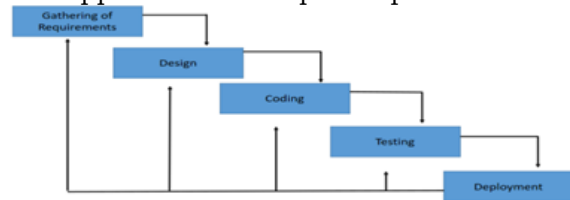


Figure 14: Modified Waterfall

(Source: <https://www.seekpng.com/png/detail/433-4337730-modified-waterfall-model-phases.png>)

Requirements Gathering

The development hardware and software specifications used were presented in Tables 1 and 2. The application was created by following the plan and design phases, utilizing the specifications provided. The programming and database construction processes were performed using a machine that had an Intel Core i7 processor, a 480-gigabyte solid-state drive, and 16-gigabyte RAM. The application was developed using Visual Studio Code, the database was constructed using MySQL, the front-end was created using Bootstrap, and the back-end was developed using Laravel. By combining all of these hardware and software tools, the PetPal: A Web Application for Domestic Animal Adoption of Noah's Ark Shelter for Dog and Cat was successfully established.

Table 1. Hardware specification

Hardware Component	Specification
Processor	Intel Core i7 processor
RAM	16 GB RAM
SSD	480 GB

Table 2. Software specification

Software Component	Specification
Adobe Photoshop CS6	Used for the initial design to create different diagrams for the system.
Appgeyser	Used to convert websites into web app.
Bootstrap	A CSS framework used

	for front end development and also for developing responsive websites.
Heroku	Used for deploying applications.
Larvel	A PHP framework used for back end development.
MySQL	Used for Database
Visual Studio Code	Used primarily for software development.
XAMPP	Used for web application testing on a local host web server.

Design

After collecting data and brainstorming, the researchers created a Use Case Diagram (See Appendix B), Storyboard (See Appendix L) and VTOC Diagram (See Appendix C) on developing the web application, since the use case diagram helps the researchers understand the flow and how the system web application works. In the use case diagram, there is an admin and a user; in the user's web page view, there are Home, About, Adoption Donation, and Trivia's in the home page.

It shows the information of the shelter and the pets in need of care, as well as pets that have been successfully adopted; in About, it shows the story, mission, vision, and process of the shelter; and in Adoption, it shows the available dogs and cats in the shelter. It contains a form under donation where users may select a payment channel and send. Donation payments will be automatically given to the owner of the shelter. In the lost and found area, users can report a lost or discovered pet. Finally, in this part, users can get information regarding dogs and cats. It provides animal care, rabies awareness, laws, and breeds. The VTOCS diagram follows the same procedure as the use case diagram, and both are useful for creating a web application design.

Coding

This process involves translating the design and functionality of a diagram into code. It requires a deep understanding of programming language. In the case of PetPal, the programmers developed a set of features that could be into a web application. These features

included a “lost and found pets”, donation, about Petpal, and trivia. To implement these features, the programmers used software development frameworks like Bootstrap and Laravel, and building the database using MySQL. After the web application was developed, the programmers decided to convert web application into an apk. The process can be achieved using AppGeyser, which provides a simple platform for creating mobile apps from existing web content.

Testing

The researcher managed ISO25010 questionnaires to assess the functionality of the web application after its design and implementation. To conduct a beta test, the researchers randomly surveyed 35 individuals who were proficient in reading and comprehending the application, and assisted them in answering the questionnaire. For the alpha test, the researchers enlisted the help of three professionals with expertise in creating web applications: Cathy Pangilinan, who studied at Holy Angel University; Allen Nicdao, who holds a degree in Computer Science and Marvin Reyes, who also holds a degree in Computer Science.

The questionnaire was distributed both in-person and online using Google form from December 20, 2022 to January 27, 2022. The respondents completed the beta questionnaire that the researchers disseminated, gathered, and administered in less than 15 minutes after utilizing the Mobile application.

The Mean Scale is used by the researcher after distributing, gathering, and delivering the collecting questionnaire to calculate the center value of a collection of numbers and to determine the central tendency of the data. $\text{Mean} = (\text{sum of observations}) \times (\text{total numbers of observations}) \times = \text{fx}/f$ where x represents the average value of the provided data collection, f represents the frequency of each class, and x represents the midpoint of each class interval.

The researcher then utilized the Likert scale to rate respondents' agreement or disagreement with a given topic or statement in the online application interview.

Table 3: Rating Scale for Beta and Alpha Test Survey

Scale	Mean Range	Response	Verbal Interpretation
5	4.51 – 5.00	Strongly Agree	Highly Acceptable
4	3.51 – 4.50	Agree	Acceptable
3	2.51 – 3.50	Neutral	Moderately Acceptable
2	1.51 – 2.50	Disagree	Fairly Acceptable
1	1.00 – 1.50	Strongly Disagree	Not Acceptable

Deployment

The technical adviser, panelist, developed, and improved the web application, after the procedure and testing phase. The developer is now ready to provide the online application to the Noah's Ark shelter and launch the linked mobile application in the Google Play Store, where anybody may simply use it.

Maintenance

This is the final phase of the project after the researchers packaged the system using mobile devices. The researchers uploaded the program on Google Play Store as a repository site to store the web application for future updates on the application.

RESULTS AND OUTCOMES

This section presents the results and conclusions of the study, where critical research output is structured and presented. The discussion is based on the objectives of the study. The section contains the fulfillment of the analysis and testing of the creation of the web application known as PetPal: A Web Application for Domestic Animal Adoption of Noah's Ark Shelter for Dog and Cat.



Figure 15: Data Gathering by interviewing the locale's founder

The researchers interviewed Leah Ibuna, the founder of the Noah's Ark shelter, so the researchers could propose ideas and obtain needed information to be able visualize the structure as well as the design in order to create a web application according to the preference of the founder. The researcher collects data information from the shelter and prepares a consent form of agreement before developing a web application for the Noah's Ark shelter.

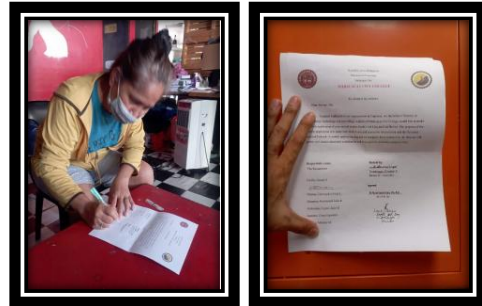


Figure 16: Founder signing the given consent form

As the target locale of the researchers of the project being created, a consent form was given as permission to use the organization's name. When the discussion and clarifications between the two parties were finished, the founder gave the researchers the needed signature on the consent form.

The increasing population of stray animals and the illnesses they carry in the past year were the problems that this project wanted to solve. This was the reason why they partnered with the Noah's Ark Shelter for Dogs and Cats to reduce the population of stray animals—by adopting the rescued ones. In this way, the non-profit organization can rescue more stray animals and reduce the accidents they bring.

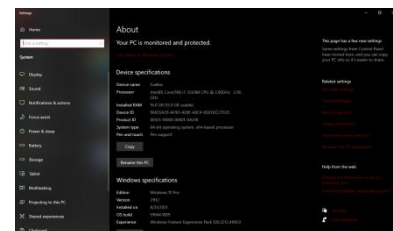


Figure 17: System Properties

The researchers found a system to develop PetPal: A Web Application for Domestic Animal Adoption of Noah’s Ark Shelter for Dog and Cat

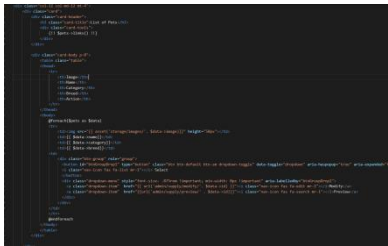


Figure 18: Tools for Software Development

The software-developed tools were employed by the researcher to construct a system. PetPal: A Web Application for Domestic Animals Adoption of Noah's Ark Shelter for Dog and Cat was successfully built and created by the researchers. This is a web app that allows users to adopt a dog or cat from the Noah's Ark shelter as well as report missing or discovered pets. This web application would be beneficial to the people who work at the shelter, particularly Leah Ibuna, the facility's founder.

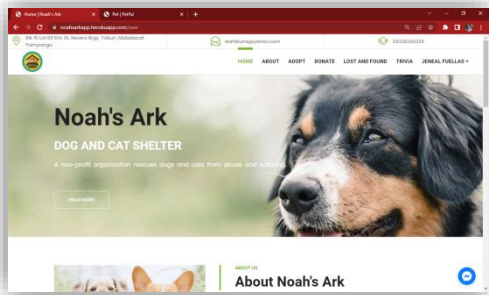


Figure 19: The Petpal web application menu

This section displays the web application's main menu, which includes the "Home" button, from which the user may access the web application's functions. The Noah's Ark Shelter information is discussed in the "About" section. It is possible to adopt a pet from the Noah's Ark Shelter in the "Adoption" section. They can donate in the "donation" section. Then there's "lost and found," where people may report a lost and/or found pet, and finally "trivia" about dogs and cats.

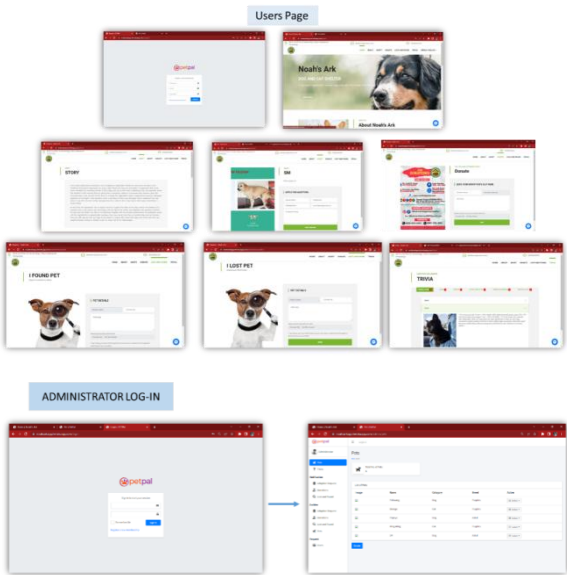


Figure 20: The Petpal web application features

The main source of the shelter is adoption, which is one of the benefits of the web application. This non-profit organization's employees assist homeless dogs and cats on the streets. It can select available dogs at the shelter in the adoption area. In donation, the user may give using the following payment channels: Gcash, BPI, BPO, and Metro Bank. After a user fills out the form and sends it, the user receipt will be sent immediately to admin. Finally, in the lost and found section, the user can report a missing or found pet. In Trivia, a user can also can learn about animal care, laws, breeds, rabies awareness, and dog and cat knowledge.

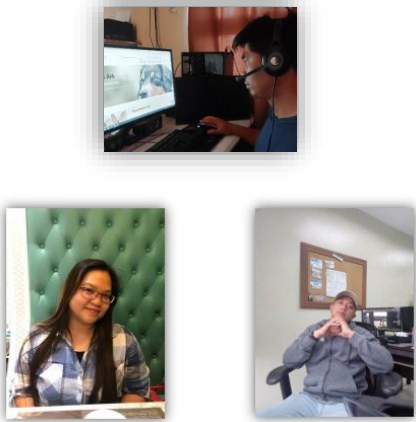
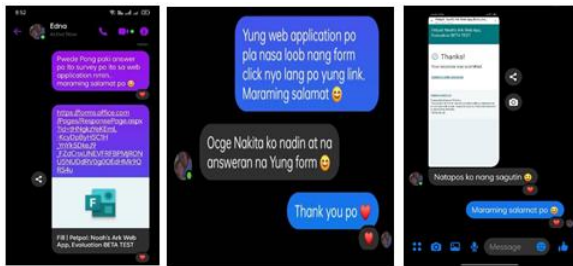


Figure 21: Photos of Alpha Users

The researchers requested the assistance of an IT professional who evaluated the web application, beginning with Allen Nicdao, a bachelor of computer science student from the University of Assumption; Cathy Pangilinan, who studied Bachelor of Information Technology at Holy Angel University, and Marvin Reyes, who also studied at Holy Angel University.



Figures 22: Beta Users' Screenshot

After the web application was created and coding was successfully completed, the researchers created a survey form using ISO 25010 that contains functionality suitability, usability, security, compatibility and portability questions. The researchers conducted the survey form using Messenger to 30 individuals near and around Mabalacat to rate the web application.

Summary of the alpha test

This table serves as the overall summary for the Alpha Test Surveys. There are three columns which contain Criteria, Overall Weighted Mean, and Verbal Interpretation. In the Criteria column, the researcher used only 4 out of 8 criteria from ISO25010. Some of the criteria in ISO25010 are not related to the system. The Overall Weighted Mean represents the total weighted mean for each criterion. Lastly, the Verbal Interpretation is used to explain the meaning of the calculated value for each criterion.

Functionality Suitability (See Appendix D) obtained an overall weighted mean of 5, indicating it is highly acceptable. Usability (See Appendix E) also achieved an overall weighted mean of 5, with a corresponding verbal interpretation of highly acceptable. Compatibility (See Appendix F) received an overall weighted mean of 5 and a verbal

interpretation of highly acceptable. Finally, Portability (See Appendix G) attained an overall weighted mean of 5, with a corresponding verbal interpretation of highly acceptable.

Table 4: Summary Overall of Alpha Test

Criteria	Overall Weighted Mean	Verbal Interpretation
Functionality Suitability	5	Highly Acceptable
Usability	5	Highly Acceptable
Compatibility	5	Highly Acceptable
Portability	5	Highly Acceptable

Summary of the beta test

This table serves as the overall summary for the Beta Test Surveys. There are three columns that contain Criteria, Overall Weighted Mean, and Verbal Interpretation. In the Criteria column, the researcher used only 4 out of the 8 criteria in ISO25010. Some of the criteria in ISO25010 are not related to the system. The Overall Weighted Mean represents the total weighted mean for each criterion. Lastly, the Verbal Interpretation is used to explain the meaning of the calculated value for each criterion.

Functionality Suitability (See Appendix H) obtained an overall weighted mean of 4.82, indicating it is highly acceptable. Usability (See Appendix I) also achieved an overall weighted mean of 4.82, with a corresponding verbal interpretation of highly acceptable. Compatibility (See Appendix J) received an overall weighted mean of 4.76 and a verbal interpretation of highly acceptable. Additionally, Portability (See Appendix K) attained an overall weighted mean of 4.90, with a corresponding verbal interpretation of highly acceptable.

Table 5: Summary Overall of Beta Test

Criteria	Overall Weighted Mean	Verbal Interpretation
Functionality Suitability	4.82	Highly Acceptable
Usability	4.82	Highly Acceptable
Compatibility	4.76	Highly Acceptable
Portability	4.90	Highly Acceptable

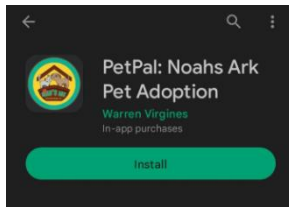


Figure 23: PetPal is available on Google Play Store

The PetPal mobile application that has been linked and is now accessible on Google Play. The responsive update of the web application will be visible in the mobile application as well. The PetPal mobile is regarded as an add-on. However, it is still a web application.



Figure 24: View in mobile app

Figure 24 depicts the perspective of the PetPal mobile application, which has been connected to the Google Play Store.

DISCUSSIONS

This section presents the discussion and conclusions based on the study's objectives, testing, finished analysis, and evaluation of the created Web app. It also includes the IT expert suggestions for how to make the Web app even better for developers or upcoming researchers.

Summary of findings

The researchers successfully collected data from locale, pertinent applications, online research articles, and collaborations before constructing the Website application. This provided them with a variety of information, ideas, and thoughts. The content of the application would comprise of materials acquired from online research journals, libraries, and related applications to make it easier for adopters and users to adopt pets and understand the value itself.

The researchers discovered system requirements and software technologies. The reviewed available hardware that is compatible for configuration and installation has met the

system software requirements, allowing the researchers to construct the PETPAL program. The researchers used SQL to store all of the data, PHP to utilize the open-source programming language for general purpose, and Bootstrap to set vocabulary for template designs. In order to design a visually attractive web application, the researchers created a narrative board to establish the structure and style. Laravel is a web application development framework, and XAMPP is a software toolset that includes the programming language, frameworks, and design toolkit, which enabled them to create a functional application that would catch the interest of users.

The researchers used software developed tools to translate the design into a working system. The researchers successfully developed and created PETPAL, a web application for domestic animal adoption of Noah's Ark Shelter for Dogs and Cats, an app that would help Adopters and Shelter know, understand, communicate, and to adopt a pet with convenience.

The study is open to critique to identify weaknesses and strengths of the application and use this as testing that would serve as feedback to the researchers. The ISO 25010 is being used for the functional sustainability, usability, compatibility, and portability testing of the web application. The programmer code is again set to settle the defect of the mobile application and is ready to be used and put through another test after the testing was done from the experts and users, which would show the researchers that it still has improvements in terms of the features.

Conclusion

PETPAL is a Web application that can help the adopters and shelter communicate, comprehend, and post lost and found animals and be mindful in adopting pets. This Web application would be a source of information for those users who are unfamiliar with the process of adoption. By minimizing the transportation to shelter, it can help adopters to choose and communicate to the shelter to avoid unexpected costs and situations. The PETPAL web application is an informative Noah's Ark application where the user can also read and see many trivia information regarding dog or cat adoption and also regarding the shelter itself. The users can view the pets that

are available to adopt in the Noah's Ark Shelter for Dogs and Cats. On the lost and found section, users are free to post their lost or found pets that will be filtered by the administrator. Users are able to communicate or chat with the administrator via messenger or stand as a guest.

The user will find using the web application easy to use. The Administrator will find it convenient using the Web application because of the quick notification and filtering feature of the PETPAL web application. Users can use the PETPAL by browsing the link on any browser application or software. Users also can download the application on Google play. In terms of functionality, usability, compatibility, and portability, the mobile application, PETPAL A Web Application for Domestic Animal Adoption of Noah's Ark Shelter for Dogs and Cats has been thoroughly developed. The mobile application was released to the Google Play Store after requirement gathering, designing, coding, testing, and after the researchers had finished their ideas and recommendations. With the summary of findings and complete evidences, researchers conclude that the overall objective of the study was achieved.

Recommendation

The researchers intended to provide the Noah's Ark Shelter owner the web application PETPAL. The web application assists the founder in finding adopters who want to adopt their dogs and cats and allows them to effortlessly donate. The PETPAL web app is very simple. Users will not struggle to utilize it, and it is also available on Google Play for mobile phones.

REFERENCE:

- [1] Raenu Kolandaisamy et al., Stray Animal Mobile App, 2019, Accessed on May 9, 2023 [Online]. Available: https://www.researchgate.net/profile/RaenuKolandaisamy/publication/312057960_Stray_Animal_Mobile_App/links/586d910508ae8fce491b5dd4/Stray-Animal-Mobile-App.pdf
- [2] Bell S. Campanilla et al., Pet Adoption App To Free Animal Shelters, 2022, Accessed on May 9, 2023 [Online]. Available: <https://journalppw.com/index.php/jpsp/article/view/10869>
- [3] IRJET, IRJET- Pet Adoption App, 2021, Accessed on May 9, 2023.[Online]. Available: https://www.academia.edu/51338224/IRJET_Pet_Adoption_App
- [4] Katrina E. Holland, Acquiring a Pet Dog: A Review of Factors Affecting the Decision-Making of Prospective Dog Owners, 2019, Accessed on May 9, 2023 [Online]. Available: <https://www.mdpi.com/2076-2615/9/4/124>
- [5] Sloane M. Hawes et al., Factors Informing the Return of Adopted Dogs and Cats to an Animal Shelter, 2020, Accessed on May 9, 2023 [Online]. Available: <https://www.mdpi.com/2076-2615/10/9/1573>
- [6] Christina Raudies et al., Characteristics and Welfare of Long-Term Shelter Dogs, 2021, Accessed on May 9, 2023 [Online]. Available: <https://www.mdpi.com/2076-2615/11/1/194>
- [7] Akanksha Magdum et al., Mobile Application of Pet Adoption System, 2023, Accessed on May 9, 2023 [Online]. Available: https://www.academia.edu/98308313/Mobile_Application_of_Pet_Adoption_System
- [8] Nishtha Aggarwal et al., PLAN A PET, 2021, Accessed on May 9, 2023 [Online]. Available: <https://www.ijres.org/papers/Volume-9/Issue-6/Ser-1/N09066568.pdf>
- [9] Bell S. Campanilla et al., Pet Adoption App To Free Animal Shelters, 2022, Accessed on May 9, 2023 [Online]. Available: <https://journalppw.com/index.php/jpsp/article/view/10869>
- [10] Timoteo B. Aquino, Republic Act 8485 RA 10631 Philippine Animal Welfare Society, 2019, Accessed on May 14, 2023 [Online]. Available: <https://heinonline.org/HOL/LandingPage?handle=hein.journals/uapljl&div=6&id=&page=>
- [11] Nayan B. Ruparelia, Software development lifecycle models, May 2021, Accessed on May 14, 2023 [Online]. Available: <https://dl.acm.org/doi/abs/10.1145/1764810.1764814>
- [12] Mc Conell, Software Engineering Methodologies: A Review of the Waterfall Model and Object Oriented Approach, July 2020, Accessed on May 14, 2023 [Online]. Available: https://www.researchgate.net/profile/Adetokunbo_Adenowo/publication/344194737_Software_Engineering_Methodologies_A_Review_of_the_Waterfall_Model_and_Object-Oriented_Approach/links/5f5a803292851c07895d2ce8/Software-Engineering-Methodologies-A-Review-of-the-Waterfall-Model-and-Object-Oriented-Approach.pdf
- [13] Dalibor D. Dvorski, INSTALLING, CONFIGURING, AND DEVELOPING WITH XAMPP, March 2021, Accessed on May 14, 2023 [Online]. Available: <http://dalibor.dvorski.net/downloads/docs/installingconfiguringdevelopingwithxampp.pdf>
- [14] Jake Spurlock, Bootstrap: responsive web development, March 2020, Accessed on May 14, 2023 [Online]. Available: https://books.google.com.ph/books?hl=en&lr=&id=LZm7Cxgi3aQC&oi=fnd&pg=PR2&dq=Bootstrap+framework&ots=eX3DtZGpKI&sig=Du-Z4GhrLPHKLM3ujREIfcGCi8&redir_esc=y#v=onepage&q=Bootstrap%20framework&f=false
- [15] Ren Yu He, Design and implementation of web based on Laravel framework, April 2019, Accessed on May

- 14, 2023 [Online]. Available: <https://www.atlantispress.com/proceedings/iccset-14/16334>
- [16] Ann Arbor, Introduction of Adobe Photoshop, October 2022, Accessed on May 14, 2023 [Online]. Available: <https://guides.lib.umich.edu/photoshop>
- [17] Priya Pedamkar, What is Visual Studio Code?, 2023, Accessed on May 14, 2023 [Online]. Available: <https://www.educba.com/what-is-visual-studio-code/>
- [18] Daniellson et al., Heroku-Based Innovative Platform for Web-Based Deployment in Product Development at Axis, December 2020, Accessed on May 14, 2023 [Online]. Available: <https://www.diva-portal.org/smash/get/diva2:1524441/FULLTEXT01.pdf>
- [19] Allisa Millenson, Design Research 101: Prototyping Your Service with a Storyboard, 2022, Accessed on May 14, 2023 [Online]. Available: <https://peerinsight.com/blog/prototyping-with-storyboards/>
- [20] Visual Paradigm, What is Use Case Diagram?, 2022, Accessed on May 14, 2023 [Online]. Available: <https://www.visual-paradigm.com/guide/uml-unified-modeling-language/what-is-use-case-diagram/>
- [21] Carleton, Using the Visual Table of Contents, April 2022, Accessed on May 14, 2023 [Online]. Available: <https://carleton.ca/brightspace/instructors/using-the-visual-table-of-contents/>
- [22] Beller et al., How (Much) Do Developers Test?, 2019, Accessed on May 14, 2023 [Online]. Available: https://testroots.github.io/assets/papers/2015_beller_gousios_zaidman_how_much_do_developers_test_accepted_preprint.pdf
- [23] Shalin Hai-Jew, Alpha Testing, Beta Testing, and Customized Testing, December 2019, Accessed on May 14, 2023 [Online]. Available: https://link.springer.com/chapter/10.1007/978-3-030-02713-1_9
- [24] Frank Olken, Random Sampling from Databases, 2020, Accessed on May 14, 2023 [Online]. Available: <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=852d9568d089afd7e61ec736c9cbd16e2f4fbe06>
- [25] Neetij Rai et al., A STUDY ON PURPOSIVE SAMPLING METHOD IN RESEARCH, 2020, Accessed on May 17, 2023 [Online]. Available: https://www.academia.edu/28087388/A_STUDY_ON_PURPOSIVE_SAMPLING_METHOD_IN_RESEARCH
- [26] Donna Mertens, Research and Evaluation in Education and Psychology, 2020, Accessed on May 17, 2023 [Online]. Available: <https://www.sjsu.edu/people/marcos.pizarro/courses/8085/s1/SamplingStrategies.pdf>
- [27] Peters et al., An ISO 25010 Based Quality Model for ERP Systems, 2020, Accessed on May 14, 2023 [Online]. Available: <https://pdfs.semanticscholar.org/2c31/5a699373eb91a5093f071e2dfe71d1bd8535.pdf>
- [28] Hamed Taherdoost, What Is the Best Response Scale for Survey and Questionnaire Design; Review of Different Lengths of Rating Scale / Attitude Scale / Likert Scale, 2019, Accessed on May 14, 2023 [Online]. Available: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3588604
- [29] Sebastian Taylor, What is the Weighted Mean?, 2023, Accessed on May 17, 2023 [Online]. Available: <https://corporatefinanceinstitute.com/resources/data-science/weighted-mean/>
- [30] Oleg Grebenuyk, App Geyser, 2020, Accessed on May 9, 2023 [Online]. Available: <https://appsgeyser.com/blog/appsgeyser-android-app-tool-platform>
- [31] "Pets Adoption - Adopt a Pet", Accessed on May 9, 2023 [Online]. Available: <https://play.google.com/store/apps/details?id=com.SelfappDeveloper.AdoptDog>
- [32] "Adopt Me: Adopt a Pet", Accessed on May 9, 2023 [Online]. Available: <https://play.google.com/store/apps/details?id=com.devayac.app.adoptme&hl=en&gl=US>
- [33] "Appets, Adopt a pet", Accessed on May 9, 2023 [Online]. Available: <https://play.google.com/store/apps/details?id=com.myappets.apps&hl=en&gl=US>
- [34] "PetPalz - Pet Adoption", Accessed on May 9, 2023 [Online]. Available: <https://play.google.com/store/apps/details?id=com.petpalz.app&hl=en&gl=US>
- [35] "Adopt Pet or Post for Adoption", Accessed on May 9, 2023 [Online]. Available: <https://play.google.com/store/apps/details?id=ppaps.petsapp&hl=en&gl=US>
- [36] "Petfinder - Adopt a Pet", Accessed on May 9, 2023 [Online]. Available: <https://play.google.com/store/apps/details?id=com.discovery.petfinder&hl=en&gl=US>
- [37] "Pounce: Adopt a pet", Accessed on May 9, 2023 [Online]. Available: <https://play.google.com/store/apps/details?id=com.guacapps.pounce>

PlantoChick AquaTech: A System-based Farming of Plants, Fish, and Chicken with Mobile Cloud Application Interface

Ann Beatriz C. Piñero
Eliyah Ganduyan B. Magsino
Sean Patrick Y. Mendoza
Haide Burca
Roniño Tan Canlas
Mark Danniol S. Tagnipis
Frederic D. Santos (Technical Adviser)

ABSTRACT

The researchers developed a prototype of Chicken Aquaponics system called "PlantoChick AquaTech", which is a combination of aquaculture and hydroponics that creates an ecosystem of fish, chicken, and plants. The system can also be overridden by users' input to process the automation. Note that the water pump can also be activated manually to refill or un-fill water in the fish tank once it detects that it's more than the average water level. The researchers used tilapia, broiler chicken, and lettuce for this system. Additionally, a linear motor mechanism was added to automatically or manually feed the fish and chicken depending on their age, quantity, and the standard feeding amount. The researchers used chicken manure as a fertilizer to the lettuce to receive more natural nutrients and for healthy growth. A mobile application was also developed with the following remote controlling capabilities; to monitor the temperature of the water and chicken's coop, pH level, and to manually activate the water pump for water level monitoring, and feeding of the fish and chicken. Both the mobile application and the prototype have separate tables of test cases. Each test case was repeatedly performed up to ten trials to assure that the functionalities were achieved according to the design requirements. The developers used the prototyping model as a guide to complete the PlantoChick AquaTech system and its mobile interface.

INTRODUCTION

Everyone is aware that as time passes, the world changes. One of the world's major concerns right now, according to Frontiers, is meeting the nutritional needs of an expanding human population that is projected to reach 10 billion by 2050. Despite the advent of high-yield crop varieties and enhanced food production techniques, the predicted global food demand by 2050 cannot be satisfied by current food production patterns. The situation will worsen if agricultural areas are reduced. However, the technique quickly transitions from a mostly backyard technology to an industrial-scale production due to practical breakthroughs in design and practice that have significantly improved fish and crop output capacity and production efficiency [1]. Climate change and the provision of food for an expanding population are additional problems in this area. There are significant concerns about climate change. To start, a rise in global temperatures is to blame for droughts, other natural catastrophes, floods, and other odd

occurrences. Hydroponics requires 20% of the water used for watering because of these conditions. Water use is considerably less than in conventional agriculture [2].

More than only a water-reuse innovation, aquaponic systems are now a successful technology for reusing energy and recycling wastewater [3]. Household and commercial aquaponics activities have been directly linked to ensuring food security in rural and urban settings in Egypt and South Africa.

The amount of output from aquaculture is positively connected with the spread of aquaponics across the continent. Egypt, Nigeria, Kenya, and South Africa are among the nations that have embraced aquaponics the fastest and are major contributors to the continent's aquaculture [4].

According to the 2020 State of Food Security and Nutrition in the World Report, the Philippines had the highest number of people experiencing food insecurity in Southeast Asia from 2017 to 2019, with 59 million Filipinos

experiencing a moderate to severe lack of ongoing access to food [5].

In addition to effective water use, it offers other environmental benefits. Agricultural land is not required because deforestation and its damaging effects on the soil are avoided. The neighboring land and water habitats are not harmed by pesticide or fertilizer runoff. Local farmers and customers may always have fresh fish and lush vegetables thanks to aquaponics because it offers a hygienic and environmentally friendly system [6].

In order to collect products or replicate a natural means of production, farming involves managing a biological process, such as cultivating crops or caring for livestock, on a farm [7].

The farming system method is essential for managing farm resources effectively in order to boost farm productivity, lessen environmental damage, enhance farmers' quality of life, and—most importantly—maintain sustainability in farm production and productivity.

The farming system approach is critical for the effective management of farm resources in order to increase farm productivity, reduce environmental degradation, improve the quality of life of farmers, and most importantly, maintain sustainability in farm production and productivity [8].

In order to increase farm production efficiency, farm-household systems and rural communities must be sustainable. This will increase agricultural and household income, as well as the well-being of agricultural households and their ability to meet their basic needs.

The researchers thought of ways to overcome these problems by creating a system-based hardware assembly to help farmers in their agricultural lives. The researchers target to construct a smart breeding aquaponics system that's defined as a combination of chicken, aquaculture, and hydroponics and it creates an ecosystem that passes fish water through plant bedding material. The system would be named the "PlantoChick AquaTech". The researchers are interested in the farming of three specific sets which are fish, chicken, and plants. The researchers developed a system that aims to provide a life hack for farmers to reduce their workloads in terms of easy labor, easy access,

and monitoring of the farm without a physical presence on the farm. The hardware system, on the other hand, would make use of microcontrollers such as water pumps connected to other sensors inside the PlantoChick AquaTech system to create an automated regulator.

Objectives of the study

The general objective of the study is to develop a chicken aquaponic system entitled "PlantoChick Aqua: A System-Based Farming of Plants, Fish, and Chicken, with Mobile Cloud Application Interface".

Specific Objectives

The specific objectives of the study are the following:

1. To gather information through online interviews, online articles; and published academic research studies.
2. To identify the hardware and software requirements needed for system and prototype development.
3. To design the system using the following analysis tools.
 - Storyboard
 - Architectural design
 - Block diagram
 - Flowchart
4. To construct a microprocessor-based and microcontroller-based prototype with an attached sensory modules, linear actuators, motors for living things ambience controlling, watering and feeding system integrated in the miniature fish pond, aquaponics, and chicken coop
 - 4.1 Create a user interface and an automatic fish tank water refiller that can ingest water from the reservoir.
 - 4.2 Create a fish tank feeding module that is automatic and automated, taking the fish's age and population into account.
 - 4.3 Install a sensory modules in the fish tank that can measure the pH level, water level, and ambient temperature.
 - 4.4 Create an automated chicken coop feeding module taking into account the age and number of chicks in the flock.
 - 4.5 Install sensors in the chicken coop that can detect the surrounding temperature.
5. To create a mobile application capable to control and monitor the following parameters:

5.1. Fish tank monitoring and feeding controller

5.1.1 Fish tank water level

5.1.2 Fish tank water temperature

5.1.3 Fish tank water pH level

5.1.4 Fish feeding system

5.2 Chicken coop monitoring and feeding controller

5.2.1. Chicken's coop temperature

5.2.2. Chicken feeding system

5.2.3 Chicken coop cooling system

5.2.4 Chicken coop lighting

6. To test and evaluate the mobile application and prototype using the Software Quality Standards of ISO 25010 in terms of Functional Suitability, Compatibility, Usability, and Portability

Scope and limitations

The scope of the study is to create a system named "PlantoChick AquaTech" for the residents of the Province of Pampanga who depend on agriculture, particularly those who practice simple fish, chicken, and plant farming. For this study, the researchers would use chickens, tilapia, lettuce, or snow cabbage. The ability of these three types to be independent with one another led the researchers to choose to employ them in farming. One of the benefits of fish and chicken to plants that the researchers have examined is the use of manure as organic fertilizer. Micronutrients are also present in fish manure, in addition to naturally occurring nitrogen, phosphorus, and potassium minerals. The focus of this study is to create a system that would use a mobile application to track and control six factors, including water temperature, pH level, chicken coop temperature, and fish and chicken feeding. The user can also control the system's parameters and necessary operations with the aid of this application program. Without physically being present among the farmer's fish, plants, and chicks, it will enable more effective farming. This technique is very useful for food cultivation and monitoring without a human control at any hour of the day. Additionally, the system can verify that the fish and chicken are receiving appropriate nutrition. Farmers save hundreds of pesos per month on their water expenses by using the technology to recycle water repeatedly rather

than watering the soil and letting most of it evaporate due to runoff or solar evaporation. The hardware system, on the other hand, would use a microprocessor and a microcontroller, along with sensors and water pumps, to build an automatic regulator inside the PlantoChick AquaTech system. In order for users to monitor using an Android application, data from the system would be transferred through a server to a wireless network feature. The researchers would gather data through online research and ensure the accuracy and reliability of the data collected. To come up with ideas for capstone projects, the researchers planned, organized, and conducted online and library research. In order to describe the problems and ascertain the fundamental requirements for the application development, the researchers first used the internet to gather data from academic publications, journals, aquaponics websites, application development websites, electronics websites, and websites for IoT devices. They also conducted interviews with resource people. The researchers constantly checked in with the applicable consultants, technical mentors, and capstone mentors to assess how the documentation and application development were progressing. In accordance with the parameters of the investigation, the researchers developed activity plans, communicated ideas, and assigned tasks.

The hardware and software were identified using the acquired data. For the construction of the prototype for the miniature fish pond, aquaponics system, and chicken coop, the researchers will use the Raspberry Pi 4B microprocessor, relay 5v 8port 1 channel module, Node MCU microcontroller, pocket WiFi, DHT222 temperature sensor, linear actuator, DS18B20 water temperature sensor, ultrasonic/distance sensor, pH sensor, breadboard, electric fans, light bulbs, electrical wirings, submersible water pumps, hose and pipes. For developing mobile applications and programming microprocessors and microcontrollers, the researchers would use a laptop computer running the Microsoft Operating System and equipped with a 3 GHz dodeca-core processor, 8 Gigabytes of RAM, a 256 Gigabyte Solid State Drive, and 4 Gigabytes of video RAM. The project was

launched using this hardware. The researchers used the DHT22 Temperature Sensor to keep an eye on the temperature in the fish tank and chicken coop. It takes measurements of the environment and spits out a digital signal on the data pin of the relays to control by turning on and off the electric fans, heaters, motor pumps, and actuators. The researchers employed a pH level sensor to keep track of the water's acidity and alkalinity inside the fish tank. The common pH range, which runs from 6 to 8, has been set. Ranges above or below would set off a relay to send a digital signal to its data pin, turning the two motor pumps on and off. The fish tank would be drained using one motor pump while being refilled with water from the reservoir using the other. The distance in inches between the ultrasonic or distance sensor and the water in the fish tank was measured. The motor pump that refills water would be turned on or off at a minimum distance of 5 inches and a maximum distance of 10 inches, respectively. Throughout the "PlantoChick AquaTech" process, these sensors would record data and transmit it to the actual programmable circuit board.

The researchers would employ the software development needed to configure and program the microprocessor, microcontroller, sensors, motors, actuators, and electronics relays after identifying the hardware. For the development of the mobile application, the researchers would use Visual Studio Code as an efficient code editor and debugger. Thonny was used as an IDE for Python development. The Node MCU microcontroller, which interprets the distance sensor, was programmed using the Arduino IDE. An online database called Firebase was employed. The mobile application dashboard and controller buttons were arranged in a certain order using the Figma program. Lastly, the researchers emulated the prototype's 3D structural design using 3D Blender.

In order to illustrate the flow of the system prototype and mobile application, the researchers used storyboards, architectural designs, flowcharts, tables, and diagrams. For users to comprehend and visualize the prototype's interface flow and functionality, a storyboard is used as a handbook. The researchers utilized the Blender program to construct a 3D simulation design of the

prototype's architectural layout, which comprises the fish tank, chicken coop, and plant beds. The flowchart shows the process flow of each system and how the sensors operate depending on parameter signals read by the sensors or gets control instructions from the mobile application. Additionally, the researchers used tables to identify the hardware and software requirements that will be needed in the system, a block diagram to categorize the inputs and outputs in hardware, and a block diagram to categorize the hardware itself.

An automatic water refiller for fish tanks that can draw water from a reservoir has been developed by the researchers. The device could detect the usual water level of the fish tank, which ranges from a maximum of 5 to 6.99 inches, using the distance sensor. A critical water level is defined as a range from 7 to 9.99 inches at the lowest level. When the level rises above the minimum, the system will automatically start dispensing water and filling the tank until it reaches the standard 5 inch level. Using the created mobile application for automated controls, the system enables users to avoid the automatic fish tank water refiller.

The researchers have developed an automated fish tank feeding module using a linear actuator. Users would be able to set and reset the feeding time, age indicated as the number of days old, and feeder quantity using the system's built-in programming. The computation of dispensing food pellets required variables such as the set number of fish and fish age. Every time the linear actuator's motor cycled, food pellets would be pushed out and eventually fall into the fish tank. Using the created mobile application for automated controls, the system enables users to avoid the automatic fish tank feeding module.

The sensor modules were installed by the researchers to measure the pH level of the water, the distance of the water from the sensor, and the ambient temperature of the fish tank. There were two pump motors installed. One would be used to ingest water from a reservoir, while the other is used to flush out warm water, water with an unsatisfactory pH level, and controls that require user interaction. The technology would enable automatic water pumping into a

reservoir or automatic water pumping out of fish tanks using a regulated temperature sensor. The user would need to configure and establish the maximum and lowest temperature using the designed mobile application in order for the automatic pumping in and out of water to happen. The mechanism would pump out and drain fish tank water if the temperature rose over the maximum setting until it was 8 inches away from the sensor that set it off. When it reaches the maximum normal water level, it would then cause the water refiller module to start pumping water into the tank. The heater system would automatically turn on if the temperature dropped below the minimum. As a result, cold water would automatically warm up to a desirable temperature until it reached the maximum normal temperature.

The system automatically determines the acidity and alkalinity of the water using the pH level sensor. The system sensor is configured with a normal pH level between 6 and 8. Water would automatically be pumped in or out if the temperature was below 6 or over 8. The distance sensor would turn on once the pH sensor reached a crucial reading. When the sensor distance reaches a maximum level of 5 to 7 inches, the pump will start to drain the fish tank's water, and when it reaches 8 inches, it will stop. The refill module would then be activated, pumping water from the reservoir until it reached the maximum level of 5 inches, at which point it would stop. When the distance sensor registers an 8 or higher, the refill module will automatically start pumping water from the reservoir until it reaches the maximum level of 5 inches, at which point it will stop.

Using a linear actuator, the researchers have created a module for automatic and automated chicken coop feeding. The user should initially configure the system using the mobile application that has been designed. The user could set and reset the two feeding timers, the chicken's age in days, and the feeder quantity using the user interface. The calculated amount of feeding required taking into account both the predetermined number of chickens and the age of the chickens. Feeds are pushed out and eventually dumped into the feeder whenever a linear actuator's motor turns. With

the aid of the mobile application developed for the system, it is possible to get past the automated controls for the chicken coop feeding module.

The system would enable automatically turning on the lighting or the cooling system once again using a controlled temperature sensor. Using the created mobile application, the user must configure and set the temperature range's maximum and lowest values. The electric fan will automatically turn on if the temperature rises over the maximum setting and run until the desired temperature is reached, at which point it will turn off automatically. If the ambient temperature falls below the minimum setting, the lighting system will raise it until it reaches the desired temperature, at which point it will turn off automatically.

The created mobile application would give the user the ability to modify and save the settings of the interface dashboard's six categories of Fish, Chicken, Plants, Temperature, pH Level, and Water Level.

The fish dashboard controller would show a text entry box where users could set or reset two feeding times, enter the number of fish days, and enter the quantity. The user could instantaneously trigger and start the feeding module, which releases fish food pellets in 6 seconds, by pressing the manual fish feeder button. The previously mentioned automatic fish tank feeding module would be applied by the system based on the user's configured and saved settings.

The chicken dashboard controller would show an entry box where users could set or reset two feeding times, input the quantity, and enter the number of chicken days. By pressing the manual chicken feeder button, the user can promptly start the feeding module, which releases feeds in 6 seconds. The system would activate the previously described automatic chicken coop feeding module based on the user's defined and saved settings.

The temperature dashboard controller would show the following parameters: the current temperature of the fish tank and the chicken coop or cage; the automated pump in and out of water slide controller; the automated heater system slide controller and its submit button; the minimum and maximum temperature setting slide controller; the automated cage fan

and manual light slide controller; and the minimum and maximum temperature setting slide controller. The system would activate the previously described automatic fish tank water refiller, chicken coop cooling system, and its lighting system based on the user's preset save setting.

The system's pH level would be displayed by the pH level dashboard controller. The system sensor is set to operate at a pH level that falls between 6 and 8. Based on the pH level between 6 and 8, the water would automatically be pushed in or out depending on whether it was acidic or alkaline.

The fish tank's current water level would be shown on the water level dashboard controller. When the system's usual water level is between 5 and 6.99 inches, it is considered to be at "Good" level. The user interface would display "Warning" for ranges starting from 7 to a minimum level of 9.99 inches, which denote a critical water level. "Danger" would be considered to exist over the critical level. The user must pay urgent attention to this level. By selecting "Pump In" and "Pump Out" from slider options, users of the program may be able to arrange an automatic tank refill or bypass the automated tank refill mode. This would provide the user control over whether to fill or empty the water tank.

After passing the developer test, the "PlantoChick AquaTech" prototype and mobile application would be made available for testing by a select number of external alpha and beta users. The mobile application and prototype would be assessed using the ISO 25010 tool survey questionnaire's software quality product model. The researchers created a survey questionnaire based on the functional adequacy, compatibility, usability, and portability criteria of the ISO25010 model in order to assess the quality of the built mobile application and prototype. The frequency distribution, mean score, and Likert scale would enable the researchers to produce an outcome. This offers trustworthy data to back up the interpretations of the sub-criteria and criteria results. Homogeneous purposive sampling would be used in the study because it calls for the researchers to swiftly locate a certain sample. Five (3) Alpha testers and ten (10) Beta testers would be contacted by the

researchers to test and assess the prototype and application. One of the main advantages of beta testing is the direct user feedback. This testing's objective is to evaluate the project in a live setting.

The created system would not, however, include the automatic application of external fertilizer in addition to the normal cycle of giving plants nutrients from pond water and vice versa. Other things to keep in mind for the future are the requirement for automatic pond water cleansing and automatic manure disposal. Additionally, a mobile phone error notification will be activated as a system alert when the fishpond's water level overflows. Additionally, the program only supports Android-based devices and does not support iOS or other platforms.

The study focuses on the Province of Pampanga as a whole. In the province of Pampanga, there are 30 plant nurseries, according to Google Maps. 9 are temporarily closed, while 21 are open right now. It will take place in the academic year 2022-2023 at MABALACAT CITY COLLEGE. This study does not cover the locations outside of Pampanga due to design limitations.

SYSTEM DEVELOPMENT METHODOLOGY

This section will discuss the type of methodology used including the lists of hardware and software requirements for the system. It also includes the sample quick design of the mobile app. This chapter also displays the flowcharts and diagrams on how the system will work process by process on each parameter as well as the architectural design of the system.

General Method Used

The prototype model was the research design model used by the researchers. A prototype is built, tested, and modified using the prototyping methodology of software development until it is effective. It also acts as the framework for the finished system. Because this project calls for tasks such as prototype construction, experimentation, and implementation, the researchers chose this modeling for it. Since the researchers created PlantoChick AquaTech, the prototype modeling procedures (see Figure 25) are the most appropriate methodology for this study. The following Figure shows the steps taken to arrive at the finished result.

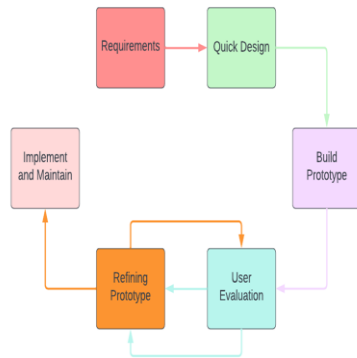


Figure 25. PlantoChick AquaTech used the Prototyping Model

Requirements gathering and analysis

In this phase, Interviews and online research were used by the researchers to acquire information. Throughout this procedure, all requirements and necessary items were discussed. The researcher attests to the integrity and accuracy of the data gathered, which was acquired through online research. The researchers planned, organized, and conducted online and library research to generate ideas for capstone projects. Interviews with experts on the intricate system were also conducted by the researchers. The researchers first used the internet to gather information from academic publications, journals, aquaponics websites, application development websites, electronics websites, and websites for IoT devices in order to describe the issues and determine the fundamental requirements for the application development. ScienceDirect, ICHTHYS Aquaponics, Epic Gardening, How to Aquaponics, Food and Environment, and other websites that the researchers found as a source of additional material linked to the study are some specific websites that were used as the basis for the system. Before moving on to the next phase, every aspect of the system, including how to begin developing it, has been explained in this one. The researchers checked in on the development of the documentation, prototype, and mobile application at regular intervals with the relevant consultants, technical adviser, and capstone lecturer. The researchers created activity plans, shared ideas, and allocated scheduled activities in accordance with the study's specifications.

The information gathered was used to identify the hardware and software (see 12 Appendix C). The building materials for the fish tank system, aquaponics system, and chicken coop system in the Internet of Things prototype are displayed in Table 1 below. The Raspberry Pi 4B processor, relay 5v 8 port 1 channel module, Node MCU microcontroller, pocket WiFi, linear actuator, pH sensor, ultrasonic/distance sensor, DS18B20 water temperature sensor, breadboard, electric fans, light bulbs, electrical wirings, submersible water pumps, hose and pipes were all used by the researchers. In order to monitor and record the temperature in the fish tank and chicken coop, the researchers used a DHT22 Temperature Sensor. It takes measurements of the environment and spits out a digital signal on the data pin of the relays in order to control the electric fans, heaters, actuators, motor pumps, and other devices. The pH level sensor was used by the researchers to monitor the water's acidity and alkalinity in the fish tank. The pH scale, which ranges from 6 to 8, was established. A relay would spit out a digital signal on its data pin in ranges above or below, turning the two motor pumps on and off. The ultrasonic or distance sensor's distance in inches from the fish tank's water was calculated. At a minimum distance of 5 inches and a maximum distance of 10 inches, the motor pump that refills water would be turned on or off, respectively. These sensors would gather readings and communicate data to the actual programmable circuit board throughout the "PlantoChick AquaTech" process. The prototype materials, material costs, and total project costs for the IoT prototype are all displayed in Appendix F.

Table 1. PlantoChick AquaTech prototype hardware specification and description

Components	Function
Raspberry Pi 4B	Microcontroller
Relay 5v 8port 1 channel Module	To control all lights, fans, linear actuators, pump in and pump out
DHT22	To monitor chicken coop temperature
Linear actuator	To feed fish and chicken
Water Temperature	To monitor the water

Sensor DS18B20	temperature of the fish tank
Ultrasonic Sensor or Distance Sensor	To monitor the water level of fish tank
pH sensor	To monitor the Ph level of water in the fish tank

On a laptop (see Table 2) running the Microsoft operating system, the researchers developed mobile applications and programmed microprocessors and microcontrollers. The laptop's hardware included a 3 GHz dodeca core processor, 8 GB of RAM, 256 GB of solid state, and 4 GB of video RAM.

Table 2. PlantoChick AquaTech hardware specification for prototype development and for mobile application development

Hardware components	Specification
Processor	AMD Ryzen 5 4600H
Display	15.6-in FHD IPS 144Hz
Memory	8 GB DDR4 RAM
Graphics	NVIDIA GeForce GTX 1650 4GB
Storage	256 GB SSD
Battery	4 cell Lithium-Ion (li-Ion)
Power Adapter	135W

The researchers use the software development (see Table 3) needed to configure and program the microprocessor, microcontroller, sensors, motors, actuators, and electronics relays after identifying the hardware. For the creation of mobile applications, Visual Studio Code would be used by the researchers as an efficient code editor and debugger. Thonny was used as the IDE for Python programming. The online database used was Firebase, and the Node MCU microcontroller that interprets the distance sensor was programmed using the Arduino IDE. Using the Figma program, the dashboard and controller button sequence was illustrated as well as the user interface design for a mobile application. Lastly, the researchers used 3D Blender to replicate the prototype's 3D structural design.

Table 3. PlantoChick AquaTech software specification for prototype development and for mobile application development

Application	Function
Visual Studio Code	Development of mobile application
Firebase	Online database
Raspberry Pi OS	The operating system of raspberry pi
Figma	Design and illustrate a mobile user interface
3D Blender	Computer Aided Design for prototype structural design
Thonny	An IDE software used for python
Python	The programming language used for prototype development
Arduino IDE	An IDE software used for Prototype development

Quick Design

After gathering and deciding what type of system to use, the researchers checked the quick design of the system to visualize what it would look like. The researcher's flowcharts, tables, and diagrams were used to illustrate how the prototype mobile system and application worked. The storyboard (see Appendix A) serves as a guide for the researchers, assisting them in understanding and visualizing the functionality and flow of the prototype's user interface. The fish tank, chicken house, and plant beds were all included in the 3D simulation design of the prototype's architectural layout that the researchers produced (see Appendix D). The operation of each system, including how the sensors read parameter signals or receive control instructions from a mobile application, is depicted in a flowchart (see Appendix E). The inputs and outputs of the hardware were categorized by the researchers using Fritzing software and block diagrams.

Build Prototype

The build phase includes various testing, problem-solving, and application programming. This entails putting the design phase's interpretation into practice. On the basis of the diagrams, the hardware specifications, software specifications, and prototype (see Appendix I), the researchers created the mobile application. The researchers have produced the

programming codes related to the block diagrams, program flowcharts, and prototype architectural design. Integration of the written programming and the storyboard design is a requirement for developing mobile applications. By using the mobile application that was created, the user can modify and save settings for the PlantoChick AquaTech prototype (see Appendix J). Temperature, pH level, water level, fish, chicken, plants, and plants are the six categories that make up the interface dashboard.

The temperature dashboard controller can display the current temperature in a fish tank, chicken coop, or cage in addition to a minimum and maximum temperature setting, a slide controller for a manual heater and an automated fan, a slide controller for an automated light system and a manual light, and a submit button. Using a controlled temperature sensor, the system may activate the lighting or cooling system for the chicken coop automatically. The user must configure and specify the maximum and minimum temperature range using the mobile application that was built. The electric fan is automatically turned on as soon as the temperature exceeds the maximum setting in order to cool the coop's atmosphere until it reaches the desired temperature, at which time it is turned off. When the ambient temperature falls below the minimum preset, the lighting system may switch on and raise it until it reaches the desired temperature, at which point it automatically turns off.

The researchers have created a fish tank water re-filler that can automatically pull water from a reservoir. Using the distance sensor, the device can determine the typical water level of a fish tank within a range of 5 to 6.99 inches. A range of 7 to 9.99 inches at the lowest level is deemed to be a crucial water level. The mechanism would automatically begin releasing water and refilling the tank if the level rose beyond the minimum level, doing so until it reached the recommended 5 inch level. The built mobile application's water level dashboard controller may display the current water level of the fish tank. The system signals "Good" level when the typical water level is between 5 and 6.99 inches at the most. However, ranges beginning at 7 inches and going down to a

minimum level of 9.99 inches indicate a critical water level and can be shown as "Warning" in the user interface. "Danger" is the next step up from "Critical," and this level necessitates quick user attention. Users of the program may be able to configure an automated tank re-filler or disengage the automated tank re-filler mode by using the slider choices for "Pump In" and "Pump Out." The decision to fill or empty the water tank is now in the user's hands.

The system's pH level can be seen on the pH controller dashboard. The pH level that the system sensor is set to run at is between 6 and 8. Water can be mechanically pumped in or out depending on whether it is acidic or alkaline based on the pH level between 6 and 8. In order to measure the pH of the water, determine the water's distance from the sensor, as well as the ambient air temperature of the fish tank, the researchers installed sensor modules. Two pump motors are placed. The other is intended to flush out heated water, water with an incorrect pH level, and controls that require user intervention. One can be used to egest water from a reservoir. The device may automatically pump in water from a reservoir or pump out water from a fish tank using a controlled temperature sensor. The built-in mobile application must be used by the user to setup and set the highest and lowest temperatures for automatic water pumping in and out. When the temperature rises above the maximum preset, the sensor that activates the system's pumping out and draining of fish tank water can be placed up to 8 inches away. When the typical water level reaches its maximum, the water refill system can be activated to start pumping water. The heater system could automatically turn on when the temperature drops below the minimum. This can automatically warm up cold water to a suitable water temperature up until the water reaches the maximum normal temperature.

The researchers created a linear actuator-based automated fish tank feeding module. The mobile application's fish dashboard controller features an entry box where the user can adjust or reset the two feeding times as well as the quantity and number of fish days. The system can be programmed with the feeding time, age indicated as the number of days old, and feeder quantity. Based on the user-

configured and saved settings, the system can run the automatic fish tank feeding module. The predetermined number of fish and the fish's age were factors that had to be calculated while dispensing food pellets. Food pellets were pushed out and eventually dropped into the fish tank every time the linear actuator's motor cycled. Users of the system can turn off the automatic fish tank feeding module using the developed mobile application for automated controls. By pushing the manual fish feeder button, the user can instantly start and activate the feeding module, which releases fish food pellets in 6 seconds.

The user can enter quantity in the entry box that the chicken dashboard controller can display, establish or reset two feeding times, and choose how many days the chicken will be fed. By pressing the manual chicken feeder button, the user can instantly engage and initiate the feeding module, which releases feeds in 6 seconds. The system may use the aforementioned automatic chicken coop feeding module based on the user's selected and remembered settings.

User Evaluation

The fourth phase is the user evaluation, the developed system has undergone a preliminary assessment in this phase. In this study, the researchers used a variety of testing methodologies, including system testing and user interface test cases. A test case, according to West Agile Labs [51], is a sequence of operations carried out on a system to determine whether it complies with software requirements and functions effectively. System Test is referred to as end-to-end testing because it assesses the entire software. It produces a thorough report on the system's effectiveness and compliance with the needs of the organization. At this level, the system's overall performance is also validated by unit-level performance. System testing is beneficial since it will make sure that user data is secure and well-guarded against hackers and leaks.

UI Testing, often known as GUI Testing, is a mechanism for testing the features of any product with which a user will interact, according to TechTarget [68] and BrowserStack [69]. This typically involves assessing the visual components to make sure they are functioning and operating as planned. User

interface testing guarantees that user interface features are error-free. Instead of focusing on the product's underlying logic, which the user would be interested in, UI testing concentrates on the software's visual and structural aspects. The prototype and mobile application had completed a preliminary developer's application test, which was performed by the researchers to detect issues that had gone undetected during earlier tests such as unit and integration testing, before being released for alpha and beta testing. Testing for probable bugs can start when the program has been transformed into an APK file, installed, and used on a mobile device (see Table 4). The objective of this test is to enhance the software product by identifying and fixing defects that were missed during earlier testing.

Table 4. Smartphone hardware specification during application testing

Component	Specification
Processor	QUALCOMM SNAPDRAGON 695 5G
Memory	8 GB
Storage	128 GB UFS2.2
Display	Screen size: 6.6 inch

Refining Prototype

In the fifth phase, comments from the panels/clients were examined and added in order to improve both the hardware prototype, mobile application, and the agreed-upon recommendations. The panel's suggestions and the advisers' comments were taken into consideration while the researchers made certain modifications to the prototype.

The "Plantochick AquaTech" prototype and mobile application would be made accessible for testing by a small group originating from external alpha and beta users after the panel committee's recommended revisions and passing again the developer test. The software quality product model of the ISO 25010 tool survey questionnaire can be used to evaluate the mobile application and prototype. In order to assess the quality of the developed mobile application and prototype, the researchers designed a survey questionnaire (see Appendix G) based on the functional suitability, compatibility, usability, and portability criteria of the ISO25010 model.

The ISO25010 questionnaire was validated to verify that the results of this study are unbiased and unaffected by the researchers, respondents, or the setting in which the evaluation was conducted. Before the survey began, the questionnaire underwent a pre-test. The study's pre-testing process included the following stages:

1.1. Considering if the tests assess, what it is designed to assess? (Test alignment based on Criteria's sub-criteria)

1.2. Choosing a criterion, correlating test results with criterion results in the present (ISO 25010 criteria's)

1.3. Evaluating the constructed questionnaire that underlies the test and correlating these scores with the test (Sampling method, Frequency distribution, Mean scores, and Likert Scale)

Data Analysis

Descriptive statistics were applied in this study. In order to determine the locations of the data and their spread and dispersion, descriptive statistics summarized the data. For data reduction, the following statistical procedures were used:

1. Frequency Distribution

To display how many participants there were in each rating, the study used a frequency distribution. Each step interval-defined group, which was composed of a collection of adjacent possible values, represented a demographic subset of the respondents' scores. A variable's values, which describe the order of the cases, might be of several sorts. Total cases for each category were used to calculate the frequency.

2. Mean

The average or computed central value of a group of numbers is known as the mean, and it measures the central tendency of the data. The mean formula in statistics for a collection is defined as the sum of the observations divided by the total number of observations. The mean formula for a set of given observations can be expressed as, $\text{Mean} = (\text{Sum of Observations}) \div (\text{Total Numbers of Observations})$

$$\bar{x} = \Sigma fx / \Sigma f \quad \text{where,}$$

$\bar{x}$ = the mean value of the set of given data.

f = frequency of each class

x = mid-interval value of each class

3. Likert Scale

The Likert scale (see Table 5) is a rating system that used in questionnaires and is designed to measure respondent's attitudes, opinions, or perceptions. The researchers used the Likert scale to translate each mean score of each survey tool's sub-criteria and criteria into its corresponding verbal interpretation.

Table 5. Interval range for results' verbal interpretation

Response Categories	Numerical Value	Range / Interval	Verbal Interpretation
Strongly Agree	5	4.21 - 5.00	Excellent
Agree	4	3.41 - 4.20	Good
Neutral	3	2.41 - 3.20	Acceptable
Disagree	2	1.81 - 2.60	Marginal
Strongly Disagree	1	1.00 - 1.80	Poor

Questionnaire administration and data gathering

The researchers might come to a conclusion using the frequency distribution, mean score, and Likert scale. This provides trustworthy data that confirms how the sub-criteria and criteria findings have been interpreted. It will be used in this study because homogenous purposive sampling necessitates that the researchers quickly locate the specific sample. Three (3) Alpha testers and ten (10) Beta testers would be contacted by the researchers to test and evaluate the prototype and application. Direct user feedback is one of the key benefits of alpha and beta testing. The purpose of this testing is to assess the project in a real-world setting.

From March 16 until April 3, 2023, the questionnaire was handed out at MCC in Mabalacat City. During the distribution and delivery of the questionnaire, clear instructions are given on how the respondents fill out the checklist based on their experience with the prototype and mobile application. The researchers are native Filipino speakers. The researchers disseminated, collected, and administered the alpha and beta surveys. Respondents completed the form in less than

twenty (20) minutes after utilizing the produced PlantoChick AquaTech App and Prototype and testing it out. Data processing was done using tally sheets. The ultimate tally summary was prepared after the beta survey respondents had finished answering the questions. Data would be entered by the researchers using a tally sheet form.

RESULTS AND OUTCOMES

This section displayed the findings and conclusions in light of objectives of the study. The discussions and conclusions are based on the objectives of the study, the analysis that has been done, and testing of the application prototype that has been created. Additionally, it provides the researchers' analysis and interpretation of their alpha and beta testing. The researchers meticulously calculated the outcomes and results. A written report summarizing the study's findings must be prepared by the researcher after the data have been collected and analyzed. The research result must be presented in an orderly, coherent, and comprehensible manner.

Requirements Gathering

Interviews and online research were used by the researcher to gather information. The researcher confirms that the information gathered, which was obtained through online research, is true and accurate. The researcher set up, planned, and carried out both in-person and online study. A well-known farmer from the Rodrigo Ocampo Farm in San Vicente Ebus, Guagua, Pampanga, Mr. Christian Ocampo, and other complex system experts were interviewed by the researchers as well (see Figure 26). Initially, the researchers used the internet to gather data from academic publications, journals, aquaponics websites, application development websites, electronics websites, and websites for IoT devices in order to describe the problems and establish the essential conditions for the application development. Some specific websites that were used as the foundation for the system are ScienceDirect, ICHTHYS Aquaponics, Epic Gardening, How to Aquaponics, Food and Environment, and other websites that the researchers discovered as a source of extra research connected to the project. The researchers kept the necessary consultants,

technical adviser, and capstone lecturer regularly updated on the progress of the documentation, prototype, and mobile application. According to the objectives of the study, the researchers created activity plans, communicated ideas, and assigned scheduled activities.

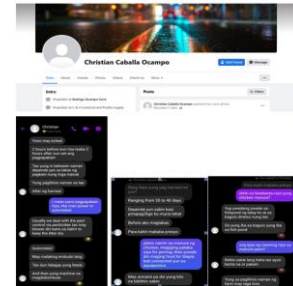


Figure 26. Informal interview via Facebook Messenger of Mr. Ocampo

Figure 26 proves an informal interview the researchers conducted with Mr. Ocampo using Facebook Messenger to learn about his personal experience in farming and agriculture. Information technology project development activities that involve collaborative problem-solving or planning can benefit from learning about their techniques, motivations, difficulties, and goals. The hardware and software were identified using the information gathered.

The researchers used a variety of devices, including a Raspberry Pi 4B computer, a relay 5v 8port 1-channel module, a Node MCU microcontroller, a pocket WiFi module, a linear actuator, a pH sensor, an ultrasonic/distance sensor, a DS18B20 water temperature sensor, a breadboard, electric fans, light bulbs, electrical wirings, submersible water pumps, hoses, and pipes. The DHT22 Temperature Sensor was employed by the researchers as part of the PlantoChick Aquatech prototype device hardware specification (See Table 27) to measure and track the temperature in the fish tank and chicken coop. In order to control the electric fans, heaters, actuators, motor pumps, and other devices, it monitors the ambient temperature and transmits a digital signal on the data pin of the relays. The researchers used the pH level sensor to keep track of the water's acidity and alkalinity in the fish tank. It was decided on the pH level, which runs from 6 to

8. A relay would switch the two motor pumps on or off by sending a digital signal on its data pin in the ranges above or below. The proximity or ultrasonic sensor monitors the distance in inches from the water of the fish tank. The motor pump that refills water can be turned on automatically or manually at a minimum distance of 5 inches and a maximum distance of 10 inches, respectively. During "PlantoChick Aquatech" running, these sensors can record readings and transmit the information to the programmable circuit boards.



Figure 27. PlantoChick AquaTech prototype device hardware specification

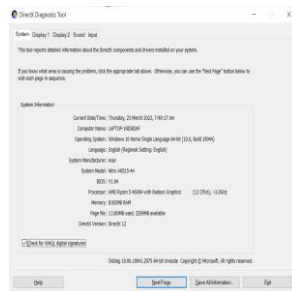


Figure 28. Specifications of laptop hardware are used during the prototype and application development.

The researchers constructed a mobile application and programmed the prototype microprocessor and microcontroller on a laptop running the Microsoft operating system (see Figure 28). The laptop's specs comprised a dodeca core CPU running at 3 GHz, 8 GB of memory, 256 GB of solid state, and 4 GB of video RAM. The PlantoChick AquaTech prototype included a Raspberry Pi 4B computer, a relay 5v 8port 1-channel module, a Node MCU microcontroller, a pocket WiFi module, a linear actuator, a pH sensor, an ultrasonic/distance sensor, a DS18B20 water

temperature sensor, a breadboard, electric fans, light bulbs, electrical wirings, submersible water pumps, hose, and pipes. The researchers used Virtual Studio Code, Firebase, Raspberry Pi OS, Figma, 3D Blender, Thonny, Python, and Arduino IDE to create a mobile application and a viable and operational prototype (see Figure 29). The researchers used Visual Studio Code as both a debugger and a code editor. The Python programming was done using Thonny as the IDE. The Node MCU microcontroller that interprets the distance sensor was coded using the Arduino IDE, and the Firebase online database was used. Using the Figma program, the dashboard and controller button sequence as well as the user interface design for a mobile application were illustrated. Finally, the researcher recreated the 3D structural design of the prototype using 3D Blender.

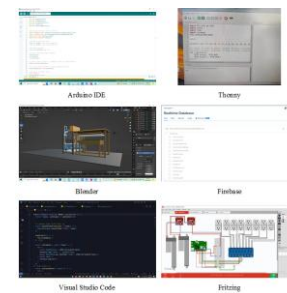


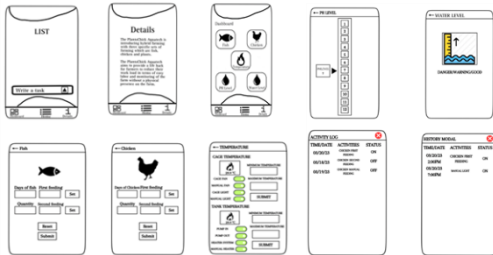
Figure 29. Software development tools are applied throughout the development of the prototype and application.

Analysis Tools

To gain an idea of how the system may appear, the researchers looked at its quick design. The researcher's design and analysis tools were used to demonstrate how the mobile application and system prototype worked. The researcher can utilize the storyboard (included in Appendix A) as a reference to help them comprehend and visualize the user interface's functionality and flow. The researchers created a 3D simulation of the prototype's architectural layout using the Blender software (see Appendix D), which includes the fish tank, chicken coop, and plant beds. A flowchart (see Appendix E) was used to show how each system operates and how the sensors read parameter signals or receive control instructions from a mobile application. In

addition, the researcher used Fritzing block diagrams to arrange the inputs and outputs of the prototype sensors, motors, linear actuators, and relays (see Figure 29).

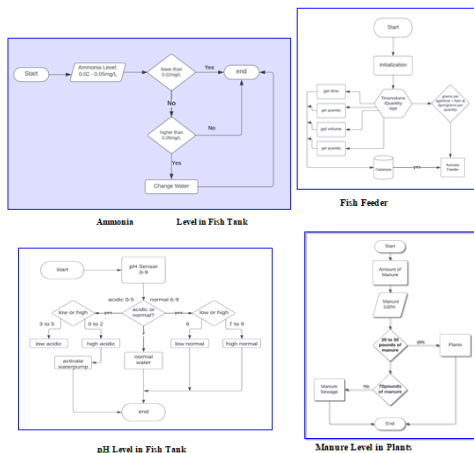
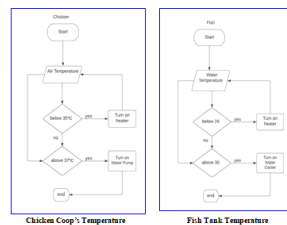
APPENDIX A
Story Board



APPENDIX D
Architectural Design



APPENDIX E
FLOWCHART DIAGRAM



Prototype and Application Development

The researchers' use of the prototyping process served as the guide for developing the prototype and application (see Figure 25). Figure 30 depicts the developed mobile application, which enables users to customize and save settings for the FarmCycle prototype. Chicken, Fish, Plant, Temperature, pH Level, and Water Level are the six categories on the interface dashboard.

The user may modify or reset the two fish feeding times, enter the quantity, and select the number of fish days in the configuration window displayed by the fish dashboard controller. By pushing the manual fish feeder button, the user can instantly start and activate the feeding module, which releases fish food pellets in six seconds. Based on the user's defined and saved settings, the system can be made to set and implement the automatic fish tank feeding module.

The user can set up or reset two chicken feeding periods on the chicken dashboard controller by entering the quantity and number of days the chicken will be fed. By pressing the manual chicken feeder button, the user can instantly engage and initiate the feeding module, which releases feeds in six seconds. Based on the user's set and saved settings, the system can implement the automatic chicken coop feeding module.

The slide controller for automated water pumping in and out, the slide controller for automated heating systems and manual heaters, the slide controller for automated cage fans and manual fans, the slide controller for automated cage lights and automated cage lights, and the submit button are all displayed on the temperature dashboard controller. It also displays the temperature in the fish tank and the chicken coop. The user-configured save option governs the automatic fish tank water refill, chicken coop cooling system, and lighting system.

The pH level dashboard controller displays the system pH level. A typical pH range of six to eight is selected for the system sensor. Water can automatically be pumped in or out depending on whether it is acidic or alkaline based on the pH level being between six and eight. Last but not least, the water level dashboard controller displays the water level in

the fish tank right now. When the water level is between five and six inches at the most, it is deemed to be "Good" for the system. However, ranges starting at a minimum level below ten inches and going up to a maximum level of seven inches denote a critical water level and can be seen as "Warning" in the user interface. It's possible to define "danger" as being over the critical level. The user needs to focus urgently on this level. Users of the program may be able to configure an automated tank re-filler or disengage the automated tank re-filler mode by using the slider choices for "Pump In" and "Pump Out." This gives the user the option to decide whether to fill or drain the water tank.

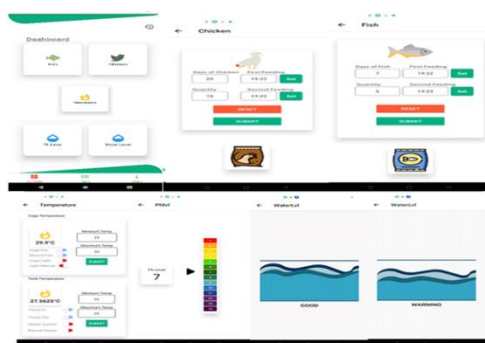


Figure 30. PlantoChick AquaTech dashboard for configuration in mobile application

Test and Evaluation

After the panel committees' recommendations for revisions were made, the "Planto Chick Aquatech" prototype and mobile application went through testing by a small group made up of outside alpha and beta users and passed a second developer test. The mobile application and prototype have been assessed using the ISO 25010 tool survey questionnaire's software quality product model. The researchers developed a survey questionnaire based on the functional adequacy, compatibility, usability, and portability criteria of the ISO 25010 model in order to assess the quality of the mobile application and prototype that was generated. To ensure that the results of the study are objective and unaffected by the researcher, the respondents, or the environment in which the evaluation was conducted, the ISO25010 questionnaire (see Appendix G) completed expert validity testing. Using the Likert scale, mean score, and frequency distribution, the

researchers may make a conclusion. This offers precise data that validates the interpretation of the sub-criteria and criteria findings. Since the researcher needed to quickly reach the intended sample and sampling proportionality was not the main concern, homogenous purposive sampling was used in the study. To test and assess the application and prototype, the researcher got in touch with three (3) alpha testers and ten (10) beta testers directly.

Between March 16 and March 17, 2023, the alpha tester questionnaire was administered at MCC and online. Additionally, the beta tester survey was administered at Mabalacat City College on April 3, 2023, as well as through in-person application demonstrations and prototype video presentations. Clear directions on how to complete the checklist are provided with the distribution and delivery of the questionnaire, based on the respondents' knowledge of the prototype and mobile application. The researchers were native speakers of Filipino. The beta and alpha surveys were distributed, gathered, and overseen by the researchers. Test subjects completed the form in less than ten (15) minutes using the produced Planto Chick Aquatech App and Prototype. Tally sheets were used for data processing. After the alpha and beta survey participants had finished responding to the questions, the finalized tally summary was created. The gathered information had been entered into the tally worksheet for use with the spreadsheet program.

It is an essential study result that is presented in an orderly and appealing manner. The data are grouped into tables using the statistical formula applied to the ISO 25010 standard for alpha and beta testing. Additionally, it offers suggestions for improving the prototype and application after the alpha test.

Alpha Test

An alpha test was conducted to determine whether the prototype and its application were acceptable after the panel committees' recommendations and passing the developer test. Before being made accessible for commercial use, the prototype and its application must pass one last round of testing. Developers and IT professionals frequently implement the outcomes of the alpha.. Mr.

Andrey Lorilla, a business analyst at DAKSH Concentrix with a Bachelor's degree in Information Technology, Mr. Ralph Cadalzo, the head of the ICTDU at SPCF with a Master's degree in Information Technology, and Ms. Ronilyn Telan, a part-time ICT instructor at SPCF and H with a Master's degree in Information Technology, were the three IT experts and specialists who took part in the alpha test. Figure 31 displays how the researcher formed, distributed, and conducted the alpha survey.



Figure 31. Performing an Alpha Test

Table 6. Summary of Alpha Test Results

Criteria	Weighted mean	Interpretation
Functional	4.60	Excellent
Sustainability		
Compatibility	4.75	Excellent
Usability	4.80	Excellent
Portability	4.45	Excellent
TOTAL	4.65	Excellent

A summary of the Planto Chick Aquatech application and prototype's alpha test results utilizing the Software Quality Standards of ISO 25010, with an emphasis on the criteria's for Functional Suitability, Compatibility, Usability, and Portability test, is shown in Table 6. Usability, which had a mean score of 4.80 and was verbally interpreted as "Excellent" in the criterion results, came out on top. The application interfaces can thus be self-taught, according to this. Even without consulting the user manual, the testers were able to easily use it, traverse the user control page, and manipulate entries. The Portability score, which has a mean of 4.45 and a verbal interpretation of "Excellent," is the lowest in the criteria results. This suggests that setting up and installing the application were easy, however alpha testers selected to test on an Android smartphone. Significantly, the testers

ask for the application's installer repository URL even though it wasn't yet freely available.

Beta Test

To finish the system evaluation and validate the system's quality and effectiveness, the researchers used the same evaluation tool for beta testing after alpha testing. For beta testers, ten (10) randomly chosen Mabalc City College students were used. Five (5) seniors in the BSIT and five (5) seniors in the BSBIO programs made up the group of randomly selected beta testers. The beta survey was distributed, gathered, and carried out by the researcher (see Figure 32). Within fifteen (15) to twenty (20) minutes of using and operating the developed application, respondents completed the survey.



Figure 32. Conducting Beta Test

Table 7. Summary of Beta Test Results

Criteria	Weighted mean	Interpretation
Functional	4.35	Excellent
Sustainability		
Compatibility	4.57	Excellent
Usability	4.63	Excellent
Portability	4.70	Excellent
TOTAL	4.56	Excellent

The beta test results for the Planto Chick Aquatech application are summarized in Table 7 utilizing the Software Quality Standards of ISO 25010 with a focus on the functional suitability, compatibility, usability, and portability test criteria. The criteria result with the highest portability score is 4.63, which is interpreted as "Excellent" verbally. This indicates that installing and configuring the application was simple. Notably, the software was able to autonomously adapt to the various hardware requirements for Android smartphones and Android operating system versions. Functional Suitability, which has a mean score of 4.35 and a verbal interpretation of "Excellent," has the lowest score in the

criteria results. As a result of the limited onsite access to the Planto Chick Aquatech hardware prototype, the researcher was only able to demonstrate and present the application's functionality using a prerecorded video demonstration of the app. This app can connect to, configure, control, and monitor the Planto Chick Aquatech prototype.

Comparison of Alpha and Beta Test

The results of the beta and alpha tests that were conducted are shown in Table 8. In general, the results of alpha and beta testing were rated as "Excellent," and the system complied with the needs of the users. The combined mean score for the alpha test was 4.62, which was considered "Excellent," and the mean score for the beta test was 4.56, which was also considered "Excellent." The Planto Chick Aquatech application and prototype can be used by beta testers in a pleasant and satisfying fashion, which will help with future feature upgrades made feasible by feedback from alpha testers. But the researcher can only show it to the beta testers via a prerecorded video demonstration of an app that can connect, setup, control, and monitor the Planto Chick Aquatech prototype.

Table 8. Comparison of Alpha and Beta Test Results

Criteria	Alpha	Interpretation	Beta	Interpretation
Functional	4.60		4.35	
Sustainability		Excellent		Excellent
Compatibility	4.75	Excellent	4.57	Excellent
Usability	4.70	Excellent	4.63	Excellent
Portability	4.45	Excellent	4.70	Excellent
TOTAL	4.62	Excellent	4.56	Excellent

DISCUSSIONS

These discussion and conclusions are based on the objectives of the study, completed analysis, and testing and evaluation of the developed prototype. It also covers the recommendations of the developers to further improve the prototype for future researchers.

Summary of Findings

The prototype (see Appendices I and J) and mobile application (see Appendix B) were developed using the researchers' use of the prototyping methodology. The researchers used the internet to acquire data, ensuring that it was accurate and reliable. The research team, which included a farmer, IT specialists, researchers, technical advisers, capstone

professors, and panel committees, worked together to generate ideas for capstone projects through brainstorming, planning, internet and library research. The researchers first used the internet to collect information from academic papers, journals, aquaponics websites, application development websites, electronics websites, and websites for IoT devices in order to describe the issues and evaluate the fundamental requirements for the prototype and application development.

The consultants, technical adviser, and capstone instructor were regularly updated on the progress of the documentation, prototype, and mobile application by the researchers. The study's objectives were taken into consideration while the researchers created activity plans, communicated ideas, and assigned planned activities.

The researchers frequently spoke with the team to learn how the application, prototype, and documentation development was going. The researchers devised activity plans, disseminated concepts, and carried out scheduled activities in accordance with the study's goals.

The researchers looked at the system's basic design to get a sense of what it would look like. The researchers' design and analysis tools were used to illustrate the mobile application and system prototype's functionality. The researchers employed storyboards (see Appendix A), architectural designs (see Appendix D), flowcharts (see Appendix E), tables, and block diagrams (see Figure 30) to illustrate the flow of the system prototype and mobile application.

Users can maintain and keep track of the PlantoChick AquaTech prototype via a mobile app that the researchers created (see Figure 30). The six categories on the mobile app dashboard are Chicken, Fish, Plant, Temperature, pH Level, and Water Level. With the help of the developed application and prototype, the user could activate manual or automatic system features such as fish feeders, chicken feeders, aquaponics and chicken coop lighting systems, fish tank cooling and heating systems, fish tank water refilling and draining systems, pH level monitoring systems, and fish tank water monitoring systems.

The results of the beta and alpha tests were applied. Alpha and beta testing results were generally rated as "Excellent," and the system complied with user requirements. The alpha test had an overall mean score of 4.56, which was deemed "Excellent," and the beta test had an overall mean score of 4.62, which was also deemed "Excellent." Beta testers found the PlantoChick AquaTech application and prototype to be pleasant and enjoyable to use, which is beneficial for upcoming application feature updates made feasible by feedback from alpha testers. But since the PlantoChick AquaTech hardware prototype is only partially usable on the premises, the researchers can only demonstrate and present it via a previously produced video of an app that can connect to, set up, control, and monitor the PlantoChick AquaTech prototype.

Conclusion

The researchers made the fish tank, chicken coop, and Aquaponics monitor, track, and control the condition of the water. They also made the cooling, feeding, and lighting systems for the fish tank, chicken coop, and aquaponics. This study, "PlantoChick AquaTech," was developed in accordance with its stated objectives. Users could check the status of the prototype sensor using the application. As a result, it is simpler to monitor the PlantoChick AquaTech. The prototype method helped the researcher achieve his or her goals for building the system. In order to administer and monitor the feeding system, lighting system, and water refilling system as well as to check the water level, pH level, and temperature, the researchers were successful in building a prototype system that could communicate with a mobile application.

The researchers came to the conclusion that the PlantoChick AquaTech application and prototype had been interpreted as "Excellent" and Superbly achieved the set criteria for the evaluation based on the overall mean scores of 4.62 for the alpha test evaluation and 4.56 for the beta test evaluation.

The researchers came to the conclusion that the study's overarching goal had been accomplished after considering all the available evidence.

Recommendations

Based on their knowledge of renewable energy sources and an awareness of their benefits, the researchers highly advise including solar panels in the study. It has been proven that solar energy is a trustworthy and sustainable energy source that can benefit both homes and businesses in a variety of ways. Among these benefits include cheaper energy costs, a lesser reliance on non-renewable energy sources, and a reduction in carbon emissions.

The researchers strongly advise using the study's waterer system in the chicken coop. A consistent source of clean water is necessary for a chicken's health and wellbeing as well as the caliber of the eggs they lay. Compared to traditional waterers, which are prone to filth and bacteria like open troughs or containers, it can be a significant improvement. The study might learn a lot more about the benefits and challenges of implementing cutting-edge technology to improve animal welfare and production by including a watering system for chicken coops.

Adding a mist system into the aquaponics project is highly advised by the researchers. A mist system can benefit aquaponics systems in a number of ways, such as higher humidity levels, better control of temperature, and provision of vital oxygen levels for the fish and plants. In aquaponics, a mist system can also help conserve water and promote plant growth by fostering a more humid environment around the roots of the plants. A well-planned mist system can also help stop the spread of diseases and pests, leading to healthier and more fruitful plants in the end. By including a mist system in the study, researchers can assess how effective it is in promoting plant growth and fish health, as well as how it affects water usage and overall system effectiveness.

Lastly, the researchers highly recommend the weight method used in the study for the chickens in the coop. A weight system can be beneficial to poultry farmers in a variety of ways, including by tracking the development and health of the chicks, identifying any potential health issues early on, and maximizing feed consumption. By including the weight system into the study, future researchers will be able to assess how well the hens' weights and growth rates were tracked.

Based on this information, which can also be used to identify any potential health issues, the meal's serving size can be adjusted. The information obtained from the weight system can also be utilized to do additional analysis to determine the most efficient and cost-effective feed and nutrition plan for the chickens.

REFERENCES

- [1] S. Bernstein, *Aquaponic Gardening: A Step-By-Step Guide to Raising Vegetables and Fish Together*. Books, October 11, 2011. Accessed on November 10, 2022. [Online]. Available: https://books.google.com.ph/books/about/Aquaponic_Gardening.html?id=TT30AgAAQBAJ&redir_esc=y
- [2] I. Ezzahoui et al., *Hydroponic and Aquaponic Farming: Comparative Study Based on Internet of thing IoT technologies*, ScienceDirect, Sep 8, 2021. Accessed on November 2, 2022. [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S1877050921014642>
- [3] S. Goddek, et al., *Aquaponics Food Production Systems*. Scholar, February 2019. Accessed on November 10, 2022. [Online]. Available: <file:///C:/Users/Bea%20Pinero/Downloads/1007278.pdf>
- [4] K. A. Obirikorang, et al., *Aquaponics for Improved Food Security in Africa: A Review*, Frontiersin.org., August 2022. Accessed on November 10, 2022. [Online]. Available: https://www.frontiersin.org/articles/10.3389/fsufs.2021.705549/full?fbclid=IwAR0_gSKxSoGWI0ma_fHXSGPoHo1V-uobjMOMA5YHaymW5ldkiSpwCr1vsmc
- [5] "The FAO Legislative Advisory Group-Philippines (FLAG-PH) initiative", United Nations: Department of Economic and Social Affairs Sustainable Development. Accessed on November 2, 2022. [Online]. Available: <https://sdgs.un.org/partnerships/fao-legislative-advisory-group-philippines-flag-ph-initiative#:~:text=In%20the%202020%20State%20of,of%20consistent%20access%20to%20food>
- [6] "CHAPTER 2: Advantages & Disadvantages of Aquaponics: Environmental Benefits", Philippines Aqua-Hydroponic Prime Ventures Corp, September 19, 2022. Accessed October 15, 2022. [Online]. Available: <https://philprimeventures.com/aquaponics-101/chapter-2-advantages-disadvantages-of-aquaponics/>
- [7] "Conceptual Issues: Defining Farming, Farms, Farmers, and Agriculture", National Academies of Sciences, Engineering, and Medicine, 2019. Accessed on May 2, 2022. [Online]. Available: <https://nap.nationalacademies.org/read/25260/chapter/6>
- [8] Dr. M. A. Kareem, *Farming Systems Approach*, Manage.gov. Accessed on May 2, 2022. [Online]. Available: <https://www.manage.gov.in/studymaterial/FSA-E.pdf>
- [9] N. C. Tanquilut et al., *Quantitative assessment of biosecurity in broiler farms using Biocheck*. Ugent in Central Luzon, Philippines, ScienceDirect, June 2020. Accessed on November 3, 2022. [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S003257912030136X#tbl1>
- [10] "BFAR, provincial government, promote sustainable aquaculture in Pampanga", PressReader: SunStar Pampanga, Nov 29, 2016. Accessed on November 3, 2022. [Online]. Available: https://www.pressreader.com/philippines/sunstar-pampanga/20161129/281582355239121?fbclid=IwAR04yrbSlAybufBJl4zrm5f5FVki5Hg4rr3dnk_x12-dnondTpfMTi21A8
- [11] N. Cosgrove, *Feeding Chicken: How Much, and How Often? [Feeding Chart & Guide]*, PetKeen, Jan 12, 2022. Accessed on May 3, 2022. [Online]. Available: <https://petkeen.com/feeding-chicken-how-much-how-often/#:~:text=How%20Often%20to%20Feed%20Chickens,large%20meals%20once%20a%20day>
- [12] "Feeding tips for chickens: Attention Egg Lovers", CitiFarm Kelso, 2018. Accessed on May 3, 2022. [Online]. Available: <https://www.citifarm.com.au/a/Chickens/Feeding-Tips-for-Chickens#:~:text=Chickens%20need%20to%20eat%20all,to%20encourage%20them%20back%20in>
- [13] AquaFarm News et al., *Farming Tilapia in the Philippines*, SEAFDEC Organization. Accessed on April 25, 2022. [Online]. Available: https://repository.seafdec.org.ph/bitstream/handle/10862/2558/AFNv11n03_p04.pdf?sequence=1
- [14] A. Frost, *The Sustainability of Tilapia Aquaponics: A Case Study*, Umich Edu. Accessed on March 29, 2022. [Online]. Available: https://css.umich.edu/sites/default/files/publication/CSS19-54_0.pdf
- [15] Hambrey Consulting, *Aquaponics Research Project: The relevance of aquaponics to the New Zealand aid programme, particularly in the Pacific*, MFAT. Accessed on March 27, 2022. [Online]. Available: <https://www.mfat.govt.nz/assets/Uploads/The-relevance-of-aquaponics-to-the-New-Zealand-aid-programme-particularly-in-the-Pacific.pdf>
- [16] "WWF-Philippines, Partners Introduce Aquaponics to Food Shed Systems", World Wide Fund for Nature (WWF), December 2020. Accessed on October 15, 2022. [Online]. Available: <https://wwf.org.ph/resource-center/story-archives-2020/aquaponics-to-food-shed-systems/>
- [17] A. E. Nacua et al., *Urban Farming Using Upcycling Technique of Brassica rapa L. Cv (Pechay Tagalog) in Ermita, Manila, Philippines*, Crimson Publishers, May 28, 2019. Accessed on March 31, 2022. [Online]. Available: <https://crimsonpublishers.com/mcda/pdf/MCDA.000587.pdf>
- [18] H. Hamadani et al., *Traditional Farming Practices and Its Consequences*, Springer Link, April 1, 2021. Accessed on March 29, 2022. [Online]. Available: [https://link.springer.com/chapter/10.1007/978-3-030-61010-](https://link.springer.com/chapter/10.1007/978-3-030-61010-030-61010-)

- 4_6?fbclid=IwAR1fwGKZgfvb20c0VxVKM68kZnt5CMQNFgBT5JRAz3q8FBqD_ZN8b5jYccc
- [19] PennState Extension, Hydroponics Systems and Principles Of Plant Nutrition: Essential Nutrients, Function, Deficiency, and Excess, July 10, 2020. Accessed on March 28, 2022. [Online]. Available: <https://extension.psu.edu/hydroponics-systems-and-principles-of-plant-nutrition-essential-nutrients-function-deficiency-and-excess>
- [20] PubMed Central, Temperature Preference of Nile tilapia (*Oreochromis niloticus*) Juveniles Induces Spontaneous Sex Reversal, National Library of Medicine, Feb 14, 2019. Accessed on March 28, 2022. [Online]. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6375642/>
- [21] V. Lagomarsino, Hydroponics: The power of water to grow food, SITN, Sep 26, 2019. Accessed on March 30, 2022. [Online]. Available: <https://sitn.hms.harvard.edu/flash/2019/hydroponics-the-power-of-water-to-grow-food/>
- [22] "Hydroponics: A Better Way to Grow Food", National Park Service. Accessed on March 30, 2022. [Online]. Available: <https://www.nps.gov/articles/hydroponics.htm>
- [23] J. Woodard, What Are Hydroponic Systems and How Do They Work?, Fresh Water Systems, Sep 06, 2019. Accessed on March 30, 2022. [Online]. Available: <https://www.freshwatersystems.com/blogs/blog/what-are-hydroponic-systems>
- [24] J. H. Homesteader, Chicken Manure: Turning Waste Into Quality Fertilizer, Epic Gardening, Jan 29, 2019. Accessed on March 28, 2022. [Online]. Available: <https://www.epicgardening.com/chicken-manure/>
- [25] I. Sinoya, Chicken Droppings Boost Fish Farming for Communities, World Vision International Homepage, March 29, 2021. Accessed on October 15, 2022. [Online]. Available: <https://www.wvi.org/stories/kenya/chicken-droppings-boost-fish-farming-communities#:~:text=The%20fish%20eat%20the%20chicken,%2C%20carbohydrates%2C%20vitamins%20and%20minerals>
- [26] PubMed Central, Temperature Preference of Nile tilapia (*Oreochromis niloticus*) Juveniles Induces Spontaneous Sex Reversal, National Library of Medicine, Feb 14, 2019. Accessed on March 28, 2022. [Online]. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6375642/>
- [27] Dr. R. Coffey, Chapter 7 - Air Temperature, Agriculture, Food and Environment, 2022. Accessed on March 30, 2022. [Online]. Available: <https://afs.ca.uky.edu/poultry/chapter-7-air-temperature>
- [28] N. Brooke, NFT Aquaponics – A Viable Option?, How to Aquaponic, 2018. Accessed on March 28, 2022. [Online]. Available: https://www.howtoaquaponic.com/designs/nft-aquaponics/?fbclid=IwAR1d_nyFirFCWg9_y3UqR4yQ2eKcusDAK0pGe0S8cVcgXxl7I9yUAZ2IZ10
- [29] M. R. Romana-Eguia et al., Tilapia Culture: The Basics, Aquaculture Extension Manual No. 66, July 2020. Accessed on May 1, 2022. [Online]. Available: <https://repository.seafdec.org.ph/bitstream/handle/10862/5842/5842-Romana-EguiaMRR2020-AEM66.pdf>
- [30] A. Roque, Sex reversal makes tilapia grow bigger, Punto, Jan 11, 2018. Accessed on March 31, 2022. [Online]. Available: <https://punto.com.ph/sex-reversal-makes-tilapia-grow-bigger/>
- [31] A. Akinbobola, Broiler Feeding Guide, Growth & Weight Chart, Livestocking, 2018. Accessed on March 30, 2022. [Online]. Available: <https://www.livestocking.net/standard-broiler-feed-chart-growth-weight>
- [32] C. Castelliniet al., Animal Welfare and Poultry Meat in Alternative Production Systems (and Ethics of Poultry Meat Production), Science Direct, 2017. Accessed on March 30, 2022. [Online]. Available: <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/broiler-chickens>
- [33] "Basic Feeding Programs for Small Chicken Flocks". Accessed on: March 30, 2022. [Online]. Available: <https://www.gov.mb.ca/agriculture/livestock/production/poultry/basic-feeding-programs-for-small-chicken-flocks.html#:~:text=A%20broiler%20chicken%20will%20eat,finisher%20to%20reach%20market%20weight>
- [34] "What is K1 media?", Aquapona, June 22, 2020. Accessed on October 5, 2022. [Online]. Available: https://aquapona.co.uk/k1-media/?fbclid=IwAR2FPHwjZVexJ89ja2ku__2gpMhz1T5dtgTH7AG1tgbykuK2IbZkRAGUpY
- [35] "K1 Filter Media", Gustawater. Accessed on October 5, 2022. [Online]. Available: https://www.gustawater.com/mbbr/k1-media.html?fbclid=IwAR31tgg1wsNBopn1hd136tIBaaf9EoIQ1LXlbAk0bQOyJ_-MqOK1bAct94o#:~:text=Helps%20in%20removing%20ammonia%20and,%20nitrite%20in%20the%20water
- [36] "The Importance of pH in Aquaponics", Go Green Aquaponics, March 7, 2021. Accessed on October 5, 2022. [Online]. Available: <https://gogreenaquaponics.com/blogs/news/the-importance-of-ph-in-aquaponics>
- [37] "Aquaculture Feed and Fertilizer Resources Information System: Formulated feeds", Food and Agriculture Organization of the United Nations. Accessed on April 9, 2022. [Online]. Available: <https://www.fao.org/fishery/affris/species-profiles/nile-tilapia/feed-formulation/en/>
- [38] N. Brooke, "Aquaponics Filtration System", How To Aquaponic: Learn How To Do Aquaponics!, 2015. Accessed on October 15, 2022. [Online]. Available: <https://www.howtoaquaponic.com/designs/aquaponics-filter-systems/>
- [39] "Conclusion: Do Aquaponics Systems Need Water", Go Green Aquaponics, July 9, 2022. Accessed on October 15, 2022. [Online]. Available: <https://gogreenaquaponics.com/blogs/news/do-aquaponics-systems-needs-water-filter>
- [40] "Arduino: What Does Arduino Mean?" TechoPedia, April 5, 2022. [Online]. Available: <https://www.techopedia.com/definision/27874/arduino>

- [41] "What is the Internet of Things? WIRED explains", WIRED, Feb 16, 2018. Accessed on April 5, 2022. [Online]. Available: <https://www.wired.co.uk/article/internet-of-things-what-is-explained-iot>
- [42] "What Does Mobile Application (Mobile App) Mean?", Techopedia, Aug 7, 2020. Accessed on April 5, 2022. [Online]. Available: <https://www.techopedia.com/definition/2953/mobile-application-mobile-app>
- [43] Shawn, Types of Distance Sensors and How to Select One?, Seed Studio, 2020. Accessed on April 5, 2022. [Online]. Available: <https://www.seedstudio.com/blog/2019/12/23/distance-sensors-types-and-selection-guide/>
- [44] "Types of pH Sensors: What You Need to Know", Sensorex, Sep 9, 2019. Accessed on April 5, 2022. [Online]. Available: <https://sensorex.com/2019/09/09/ph-sensors-need-to-know/>
- [45] "Temperature Sensor Waterproof DS18B20", Digi-Key. Accessed on April 5, 2022. [Online]. Available: <https://www.digikey.com/catalog/en/partgroup/temperature-sensor-waterproof-ds18b20/57171#:~:text=This%20sealed%20digital%20temperature%20probe,connected%20from%20a%20central%20microprocessor.>
- [46] "DS18B20 TEMPERATURE SENSOR WORKING, CONSTRUCTION, AND APPLICATIONS", Techatronic, April 24, 2022. Accessed on October 9, 2022. [Online]. Available: <https://techatronic.com/ds18b20-temperature-sensor-working-construction-and-applications/#:~:text=The%20main%20advantage%20of%20DS18B20,for%20the%20overall%20temperature%20sensor>
- [47] "Linear Actuators", Linak. Accessed on October 10, 2022. [Online]. Available: <https://www.linak.com/products/linear-actuators/>
- [48] M. Luciano, Pros & Cons of Hydraulic, Pneumatic, and Electric Linear Actuators, March 18, 2021. Accessed on October 12, 2022. [Online]. Available: <https://www.progressiveautomations.com/blogs/products/pros-cons-of-hydraulic-pneumatic-and-electric-linear-actuators#:~:text=Advantages%20of%20Electric%20Linear%20Actuators,-Electric%20actuators%20offer&text=They%20can%20be%20easily%20networked,than%20pneumatic%20and%20hydraulic%20actuators.>
- [49] "How to Use a Breadboard for Electronics and Circuits", Science Buddies. Accessed on October 10, 2022. [Online]. Available: <https://www.sciencebuddies.org/science-fair-projects/references/how-to-use-a-breadboard>
- [50] "What is a Stepper Motor Driver : Types and Its Applications", ELPROCUS. Accessed on October 12, 2022. [Online]. Available: <https://www.elprocus.com/what-is-a-stepper-motor-driver-types-and-its-applications/#:~:text=Definition%3A%20A%20motor%20driver%20that,well%20as%20several%20step%20resolution>
- [51] M. Yuan, "Archived | Getting to know NodeMCU and its DEVKIT board", IBM Developer, August 6, 2022. Accessed on October 12, 2022. [Online]. Available: <https://developer.ibm.com/tutorials/iot-nodemcu-open-why-use/>
- [52] Engr. Fahad, NODEMCU ESP8266 VS ARDUINO UNO, ElectroniClinic, September 27, 2020. Accessed on October 12, 2022. [Online]. Available: https://www.electronicclinic.com/nodemcu-esp8266-vs-arduino-uno/#NODEMCU_ESP8266_VS_ARDUINO_UNO_OPERATING_VOLTAGE
- [53] "Arduino vs NodeMCU", RoboCraze. Accessed on October 12, 2022. [Online]. Available: <https://robocraze.com/blogs/post/arduino-vs-nodemcu>
- [54] "DHT11 vs DHT22 - Which Temperature and Humidity Sensor Should You Use?", SeedStudio, 2019. Accessed on October 12, 2022. Available: <https://www.seedstudio.com/blog/2020/04/20/dht11-vs-dht22-am2302-which-temperature-humidity-sensor-should-you-use/>
- [55] Dejan, "DHT11 & DHT22 Sensors Temperature and Humidity Tutorial using Arduino", How to Mechatronics. Accessed on October 15, 2022. [Online]. Available: <https://howtomechatronics.com/tutorials/arduino/dht11-dht22-sensors-temperature-and-humidity-tutorial-using-arduino/>
- [56] "What is the Use of Submersible Water Pump", Hygger-Online. Accessed on October 15, 2022. [Online]. Available: <https://www.hygger-online.com/what-is-the-use-of-submersible-water-pump/>
- [57] J. Woodard, "What Is an Aquarium Water Pump and How Does It Work", Fresh Water Systems, June 17, 2022. Accessed on October 15, 2022. [Online]. Available: <https://www.freshwatersystems.com/blogs/blog/what-is-an-aquarium-water-pump-and-how-does-it-work>
- [58] "How to Use an Aquarium Air Pump (and Make It Quieter)", AquariumCoop. Accessed on October 2, 2022. [Online]. Available: <https://www.aquariumcoop.com/blogs/aquarium/aquarium-air-pump>
- [59] "L298N Motor Driver Pin Diagram, Working, Datasheet & Arduino Connection", Etechnophiles. Accessed on October 15, 2022. [Online]. Available: <https://www.etechnophiles.com/l298n-motor-driver-pin-diagram/>
- [60] D. Das, LM35 Temperature Sensor, Circuit Digest, April 13, 2022. Accessed on October 12, 2022. [Online]. Available: <https://circuitdigest.com/microcontroller-projects/interfacing-lm35-sensor-with-arduino#:~:text=The%20LM35%20sensor%20is%20moderately,155%C2%B0C%20temperature%20range.>
- [61] H. Gupta, Circuit Breaker - How it Works, Types, Applications and Advantages, Electrical Funda Blog, November 21, 2022. Accessed on October 15, 2022. [Online]. Available: <https://electricalfundablog.com/circuit-breaker-works-types-applications/>
- [62] "Surface Water Pump", Royals, 2022. Accessed on October 10, 2022. [Online]. Available:

- <https://www.royal.ps/en/sanitary-ware/products/water-pumps-and-pressure/shimge-pumps/surface-water-pump>
- [63] Chika C. Uchendu (November) What is Visual Studio? Accessed on April 22, 2023. [Online] Available: <https://www.geeksforgeeks.org/introduction-to-visual-studio/>
- [64] Computer Hope. Accessed on June 7, 2019 [Online] Available: <https://www.computerhope.com/jargon/v/visual-studio.htm>
- [65] E. Shoemaker. (2021, Aug. 03). 8 Reasons Why Every Product Design Team Needs to Use Figma — Or Get Left Behind [Online]. Availability: <https://webuild.io/why-use-figma-for-digital-product-design>
- [66] M. Arora. (2022, Jan. 19). Advantages of Python programming language in the world of big data: poster poster abstract [Online]. Availability: <https://dl.acm.org/doi/abs/10.5555/3512489.3512520>
- [67] Serdar. (2021, Nov. 27). Blender vs Cinema4D - Advantages & Disadvantages [Online]. Availability: <https://vagon.io/blog/blender-vs-cinema4d/>
- [68] J. Sykutera. (2020, Aug 07). Pros and Cons of Firebase [Online]. Availability: <https://redvike.com/article/pros-and-cons-of-firebase/>
- [69] Pascal Francis-Mezger (2018) Raspberry Pi Operating System. Availability: https://web.eece.maine.edu/~vweaver/projects/vmwos/2018_memsys_os.pdf
- [70] A. Kurniawan. (2018, Nov. 29). Programming on Raspbian OS [Online]. Availability: https://link.springer.com/chapter/10.1007/978-1-4842-4212-4_3
- [71] L. Jia, Y. Ren, D. Yang, Q. Feng, B. Sun and C. Qian. (2019, Nov). Reliability analysis of dynamic reliability block diagram based on dynamic uncertain causality graph [Online]. Availability: <https://www.sciencedirect.com/science/article/abs/pii/S0950423019304322>
- [72] Z. Kazi and L. Kazi (2022, Jul). Software Project Duration Estimation Based on COSMIC Method Applied to Data Flow Diagram [Online]. Availability: <https://iajit.org/portal/images/Year2022/No.4/20030.pdf>
- [73] T. Zhiri, Z. Ruoha, L. Peng, W. Hao, H. Qijun, C. Sheng and M. Qiming. (2019, Mar. 09). A hardware friendly unsupervised memristive neural network with weight sharing mechanism [Online]. Availability: <https://www.sciencedirect.com/science/article/abs/pii/S0925231218315078>
- [74] a. sulha (2019, july 3). the effectiveness of using storyboard animation on students' writing achievement on recount text in the first grade of vocational high school 1 boyolangu [Online]. Available: <http://repo.uinsatu.ac.id/11935/5/CHAPTER%20II.pdf>
- [75] V.Nageim (2018, July 16). Understanding Steel Design [Online]. Available: <https://www.fao.org/3/i2433e/i2433e04.pdf>
- [76] J. Britton. (2021, May. 06). What Is ISO 25010? [Online]. Available: <https://www.perforce.com/blog/qac/what-is-iso-25010>
- [77] S. Lewis. (2019, Sep). Prototyping Model [Online]. Available: <https://www.techtarget.com/searchcio/definition/P-prototyping-Model>
- [78] Nikolopoulou, K. (2022, December 1). What is purposive sampling?: Definition & examples. Scribbr. Retrieved April 3, 2023, from <https://www.scribbr.com/methodology/purposive-sampling/>
- [79] Thomas, L. (2022, December 5). Simple random sampling: Definition, steps & examples. Scribbr. Retrieved April 3, 2023, from <https://www.scribbr.com/methodology/simple-random-sampling/>
- [80] Written by: Ferdinando Santacroce Ferdinando Santacroce Ferdinando has been a developer for a long time. Today he works with teams as an indep. (2022, January 12). 20 types of tests every developer should know. Semaphore. Retrieved April 3, 2023, from <https://semaphoreci.com/blog/20-types-of-testing-developers-should-know>
- [81] Hermans, K. (2022, November 22). What is alpha testing? definition and process with examples. LogRocket Blog. Retrieved April 3, 2023, from <https://blog.logrocket.com/product-management/what-is-alpha-testing-definition-process-examples/>
- [82] Beta test. What is a Beta Test? | Definition | Product Management Glossary. (2021, September 2). Retrieved April 3, 2023, from <https://www.productplan.com/glossary/beta-test/>
- [83] Turney, S. (2022, November 10). Frequency distribution: Tables, Types & Examples. Scribbr. Retrieved April 3, 2023, from <https://www.scribbr.com/statistics/frequency-distributions/>
- [84] Weighted mean: Formula: How to find weighted mean. Statistics How To. (2023, March 3). Retrieved April 3, 2023, from <https://www.statisticshowto.com/probability-and-statistics/statistics-definitions/weighted-mean/>
- [85] Bhandari, P. (2023, January 16). What is a Likert scale?: Guide & examples. Scribbr. Retrieved April 3, 2023, from <https://www.scribbr.com/methodology/likert-scale/>

prodScout: A Multi-Platform Application for Parental Monitoring

Khyle L. Alegre
Rachelle C. Corcuera
Christian Paul D. Dayag
Jan Humphrey M. Salangsang
Moises C. Yumul
Dessa Lyn J. De Castro (Technical Adviser)

ABSTRACT

The current generation of youth is growing up in a rapidly changing world and the way in which children are guided and supervised is evolving. Studies have shown the importance of collaboration between schools and families for positive child development. Parental monitoring, including parental knowledge, watchfulness, and supervision, is crucial for positive outcomes. Parental involvement in a child's education leads to high expectations, higher academic performance, and positive behavior. In online education, parental monitoring can help students' progress by allowing parents to observe or be informed of their performance, activities, and websites visited. To address challenges such as short attention spans and multitasking during online classes, the researchers propose "prodScout: A MULTI-PLATFORM APPLICATION FOR PARENTAL MONITORING." The application will notify parents and teachers if students have unnecessary web activities during class sessions, promoting productivity and attentiveness. Parental involvement in education has been present since early childcare programs and homeschooling. The involvement of both parents and teachers is crucial for a child's education and development. The study is now ready for implementation and usage by parents and families of students taking online classes.

INTRODUCTION

Today's youth are growing up in a vastly different world from past generations [1]. The method of how each child is guided and supervised is gradually changing. Many studies on parental monitoring emphasize the importance of collaborations between schools and families to improve children's development [2].

Parental monitoring usually involves knowing where children are, what they do in their free time, and who their friends are. Parental monitoring involves knowing, watching, and supervising a child's activities across several domains (e.g., friends, school, and home conduct) and signaling to the adolescent that the parent is worried [3].

Parental involvement in a child's education improves outcomes. Positive behavior, strong academic performance, and high expectations for children are examples. Parental participation includes monitoring children's time and choices [4].

Online class monitoring could improve student performance. The student's performance, activities, and websites can be monitored by the parents. Monitoring helps pupils learn.

Parents can relax knowing their child is learning in class. The child's major source of information is the parents. Research shows that monitoring a child's activities can lower the risk of their engaging in harmful or unapproved activities. Parental involvement validates the child's hobbies and helps spot behavioral changes that may indicate a problem. It's crucial to monitor children's surroundings to prevent harm. More adults now interact with children daily [5].

Online education's longevity depends on parents. Parents, guidance instructors, and caregivers assist school-aged children in completing a certain academic curriculum [6]. Most parents are at work and cannot oversee children, especially during online sessions, but with the internet, parents may monitor the child's state and attentiveness.

Scope and limitations

The study developed a parental monitoring app for children, parents, and teachers. The multi-platform parental monitoring tool will watch children throughout lessons and prevent playtime disruptions and web activities. However, for online, desktop, and mobile

application deployment, the minimum hardware and software requirements was used. User registration on online (including web extensions), mobile, and desktop platforms depends on role. Users chose between parents and teachers. After logging in, parents and teachers can control student and child profiles, screenshot captures, app and site limits, tab and site changes detection (exclusively for web platform), SMS notifications, in-app and online notification alerts. Parents and instructors can check the child's screen at any moment in the screenshot gallery. Most pupils were distracted by mobile, desktop, and browser games and apps. Parents can block apps on desktop, mobile, and web platforms, whereas the web platform only controls webpages in web browsers. Sometimes the child cheats or surfs the web during class or tests. Tab and site change detection might alert pupils that their browser tabs are being monitored. The notification and alert inform parents of their child's session activity. Logs are also visible and updated to show the child's activities. Enabling modes (Strict and Holiday) lets parents use parental monitoring control in their accounts. A watchlist will also monitor desktop programs children can utilize during online class sessions. Only web application users can get managed profile logs in PDF format. Webby, the browser add-on to login watched youngsters. For mobile-only users, the mobile app offers the same features and functionality as the online app. Mobile app users can sign up and log in (depending on their job), control screenshots from the child's devices, receive SMS notifications (exclusively for parents), and block apps and sites. Users choose between parents and teachers. Each multi-platform application user role has distinct permissions or functions. The instructor function has an unlimited number of students, but the parent role has a limit based on the number of children. Strict mode and holiday mode can be used to monitor a youngster while or outside online classes. Parents can view all logs and web activity in strict mode. Holiday mode allows screenshots, blacklist and watchlist sites, and parental supervision while removing stringent mode restrictions. If parents consent, the teacher's user account can have these modes if they are

(1) unable to use the application due to physical and psychological constraints (PWD, Clinical Mental Illness, etc.), (2) technologically illiterate, or (3) other reasons. The teacher and parent roles can "nudge" children or students during online class sessions, sending a reminder to keep engaged. The researchers can't accommodate this application's requirements. The system monitors parents, not controls them. The program is web-dependent, therefore most features and functions require an internet connection.

This study also considers privacy restrictions. The researchers recognize that the Data Privacy Act of the Philippines allows only first-level monitoring and consent monitoring, therefore they opted out features that may gather and contain sensitive information, especially because majority of the target end-users are minors.

The mobile app can screenshot the desktop but not control it. It can't control the mobile screen like the desktop app.

Due to unusable features, the mobile app and mobile scouter are only compatible with Android OS 4.4 (Kitkat) and higher. Web, web extension, and desktop apps require Microsoft Windows 10 or later. Due to the broad number of browsers produced and versions used by different users, the researchers have focused on chromium-based browsers, notably Google Chrome, as the top platform for usage. Using a chromium-based browser allows for more system development features. Non-Chromium browsers require different syntax and algorithms, which complicates development.

Researchers want to add web and desktop software features to a mobile APK. However, Android has been updated continuously to secure content and data protection due to an overwhelming security risk to its platforms, which resulted in having this functionality be accessed only over the shell layer of any Android apps being released, which is currently a knowledge roadblock to researchers due to the complexity of accessing the shell layer of Android devices and a lack of deeper understanding of shell layers, including network control. Researchers must also match every permission control and access for each manufacturer and verify whether Android devices use the native launcher or their OS

launchers. Given that Realme has a large number of mobile phones, creating OS Launchers for each device is difficult. Since permissions must be checked every time the foreground app listens, high-end manufacturers like Samsung and Google will prohibit or compromise the program. With the recent updates to google and android platforms, the researchers encountered additional knowledge blocks to the development of a mobile app. Ongoing library updates to match Google's security policy have hindered some of the open source libraries for parental monitoring and security management from functioning anymore as their respective sources, such as node package libraries, are still being updated at the duration of this study until further notice by packa Researchers want robust screen recording and streaming options. Since cloud storage is expensive, students and children's gadgets cannot store data. Screen recording and streaming were complicated, resource-intensive, integrated, and patented, therefore information was scarce. Different devices and operating systems have multi-level restrictions based on how they were pre-configured during manufacture and if they have a specified security setup. Antivirus software may potentially impact monitoring application performance. Security patch updates on mobile or desktop devices can also change how the software operates.

Webby! prodScout can detect URL change, tab detection, and blacklisted websites. The Deskty! prodScout desktop watcher logs shell layer events and processes like program name and timestamp. The mobilo! prodScout mobile observer can log notifications and screen orientation in real time.

This study is limited by internet connectivity because each device uses a different service provider, which might delay communication and lose data.

Alpha testing of researcher-made test cases will use user-defined criteria. The ISO 25010-based criterion checks system stability, beta test cases for beta testing.

SYSTEM DEVELOPMENT METHODOLOGY

This section explains the study's methodology and software development processes. SDLC

verifies project programs. SDLC improves apps [7].

The modified waterfall technique is a systematic research method with procedures. [8] Documentation and design review ensure research dependability and maintainability in this procedure. It suits complicated, technology-intensive research undertakings.

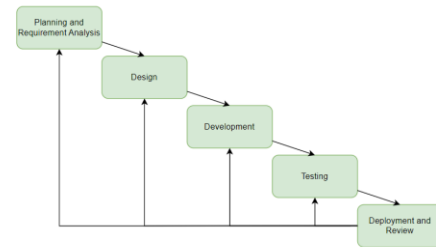


Figure 1. Modified Waterfall Model

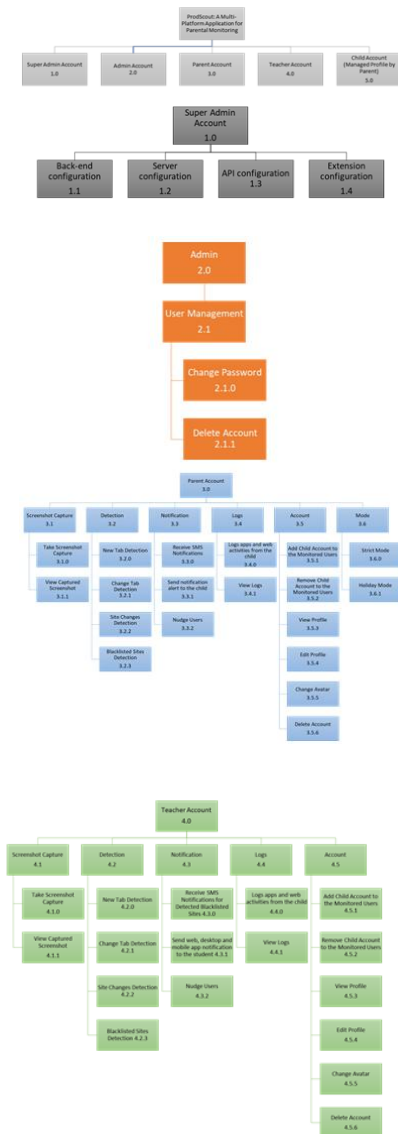
The application was based in modified waterfall process, which ensures system stability and quality over a succession of phases. Plan, design, build, test, deploy, and review. Each phase has a separate system creation procedure. The modified waterfall method prioritizes documentation and design review to ensure product reliability and maintainability. Complex technology-intensive projects benefit from this strategy.

In planning and requirement analysis, the researchers' data was examined and merged to construct the application's principles, including those described in the first chapter. Researchers brainstormed all study concepts. The team's visual chronology, the Gantt chart will list and organize all tasks. Work break structure will list system development works. Scoping and planning will assess study limits. Project costing estimated the current system's entire cost. After that, the researchers collected data from linked literature and studies.

In the design phase, researchers focused on the multi-platform application's aesthetics. This phase focused on UI, buttons, functions (depending on platform), and colors. To satisfy target users, all system requirements was met. In this phase, researchers produce Visual Table of Contents (VTOC), Entity Relationship Diagram (ERD), and Use Case Diagram (UCD) UML diagrams (UCD). The Visual Table of Contents (VTOC) illustrates the application's capabilities and features in a simple form. This

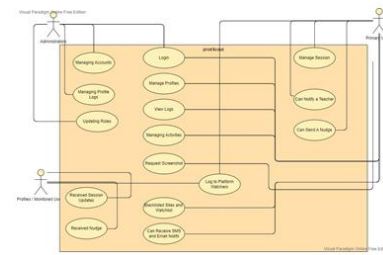
APPENDIX D

VISUAL TABLE OF CONTENTS



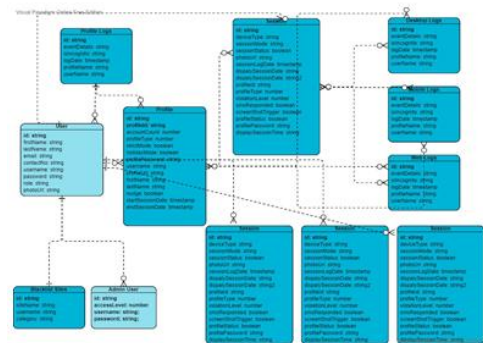
APPENDIX E

USE CASE DIAGRAM



APPENDIX F

ENTITY RELATIONSHIP DIAGRAM



In development phase, the researchers will follow the researchers' conceptual framework and methodological model's application criteria. This phase includes introductory and core coding. During initial coding, the three multi-platform applications' body was developed. The core code concentrates on each multi-platform application's features and functions. Application development will use Javascript, Typescript, AngularJS, IonicJS (with Java), and ElectronJS. After serious bugs in testing and deployment, development will resume. The researchers will use a machine with Microsoft Windows 10, Intel Core i5 8th Gen processor, 8 GB RAM, 240 GB storage, NVIDIA GTX 1050ti graphics card, and 1920 x 1080 screen resolution for system development. Windows 10, Visual Studio Code, and Android Studio was used for software development. Vercel will host the website utilizing Github for the system repository and Google Firebase SDK for back-end communication. Google Chrome will use chromium. Chrome Extension API creates browser extensions.

In testing phase, the researchers will verify all possible errors in the developed application. This step will use researchers-made test case criteria and beta test cases. The researchers must complete all of the requirements before the testing is initiated. In some cases, all possible bugs and glitches listed down to give actions for that particular issue. For initial and final testing, researchers will test those features and functions. There are two (2) sets of alpha testing and beta testing. The IT experts will take the alpha testing to know if there are possible bugs, errors, and other issues that may help the deployment of the system with the help of researchers-made test case criteria. In beta testing, random thirty (30) users will examine the system based on the beta test cases given by the researchers. After the assessment will fix all of the possible issues accordingly. And will show the system requirements for the testing and deployment for the users during the deployment phase.

During the deployment and review, web hosting will launch the multi-application initial release after testing and fixing all bugs. After the initial release, researchers will use target user feedback when analyzing concerns and adjustments. The website's homepage offers the multi-platform app. The desktop software was included in the desktop button, while the mobile app can be downloaded from Google Play. If the multi-platform program requires more debugging, the researchers will do so after reading the feedback. The multi-platform application's stability depends on end users' minimum hardware and software requirements.

RESULTS AND OUTCOMES

Thesis archives, libraries, and the internet helped researchers obtain system-appropriate data. The researchers brainstormed the multi-platform application's roles and features using related literature and studies. Visualization was the first idea for system uniformity. The researchers used the following graphics to show how the VTOC or Visual Table of Contents system lists functions and features hierarchically. UCD or Use Case Diagram to show actor/s and their actions and event phases on the system, and ERD or Entity Relationship Diagram to provide a graphical entry platform for database design and

information system requirements. The researchers wrote a user manual for the multi-platform program.

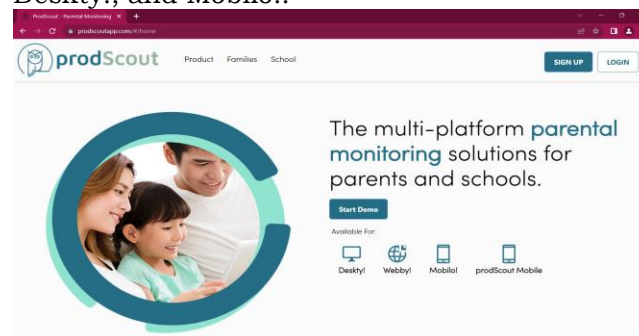
After the system's design phase, the researchers made all of the following functions and features in the development phase.

Functions and Features

Web Application Side

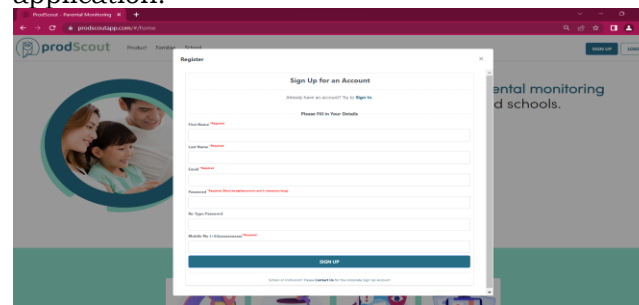
Landing Page

On this page, the users can view the system's functions and features in graphical information. Also, the users can download the installer to access the system. The users can download the following watchers and versions of the application - prodScout mobile, Webby!, Deskty!, and Mobilo!.



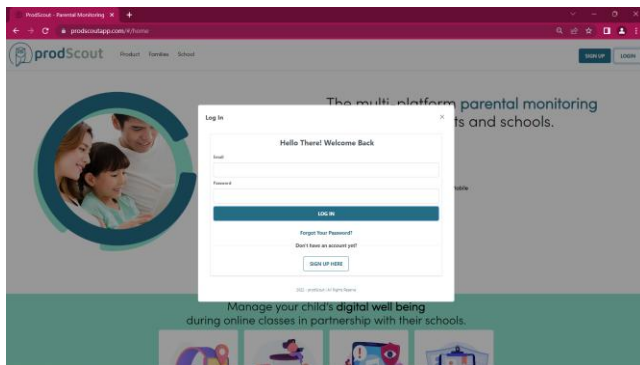
Sign up Page

On this module, the users can sign up for an account based on their preferences and role. Personal information will be needed to have an account to access the multi-platform application.



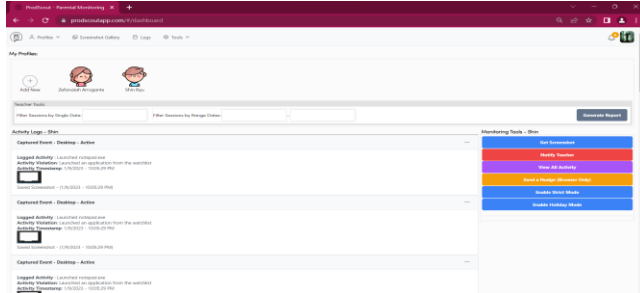
Login Page

On this module, users can log in to the system to have full access to the functions and features of the system. If the users forget their password from this system, users will be given temporary password tokens to have a chance to change their passwords. Once the login credentials are correct, it will automatically proceed to the dashboard interface.



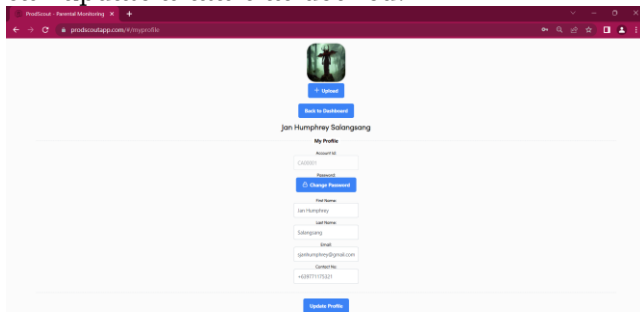
Dashboard

The dashboard will appear on this page if the users successfully log on. The objects presented on this page were the monitoring tools section, navigation bar, “My Profiles” section, activity logs section, and user profile section.



My Profile

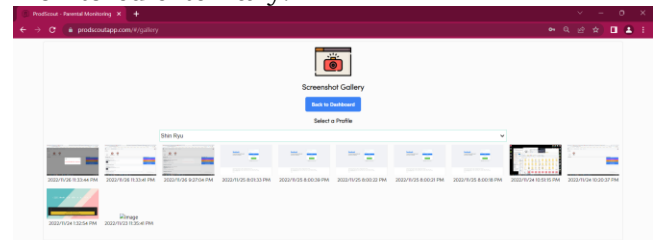
On this page, users can view all of the details and information of their profile. The users can edit their details, change passwords by clicking the “Change Password” button, and email. Saving all of the changes from the details by clicking the “Update Profile” button. The users can update avatars as desired.



Screenshot Gallery

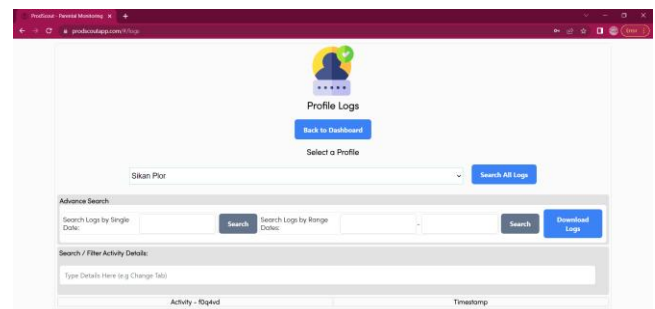
On this page, all of the screenshots come from certain users that the parents and teachers monitor. The users can sort out all of the

screenshots by profile. Parents and teachers can view, rotate and zoom each profile monitored externally.



Profile Logs

On this page, profile logs created by the researchers are presented and can be viewed by parents and teachers from web, desktop and mobile applications. The same concept from the screenshot gallery, each profile has a set of logs detected from the children's devices with advanced log management features such as searching logs by single date, searching logs by range date, downloading logs in pdf format and searching/filtering activity details which provide specificity of the activity you want to find. The ability to search logs by single date allows parents and teachers to quickly find and view logs from a specific date. Searching logs by range date enables them to view logs within a specific time frame, making it easier to track activity over a period of time. The feature of downloading logs in pdf format allows the parents and teachers to easily share or archive the logs for future reference. Additionally, searching/filtering activity details provides specificity in finding the activity of interest, making it easier to find specific information in the logs.



Manage Site Restrictions

On this page, the users can manage websites blacklisted. The children can't access a website/s coming from the blacklist of parents and teachers. Users can add website/s to be blacklisted from the side of the children, set on what category the users wished to be assigned. Adding a website/s from the list by clicking the "Add to Blacklist" button.

Website URL	Category	Actions
https://www.facebook.com/	Social Media	
https://twitter.com/	Social Media	
https://www.youtube.com/	Social Media	

Manage Desktop Watchlist

On this page, this feature aids in managing desktop applications that will be monitored in the watchlist. The users will avoid all watchlisted desktop applications, like games and other software, which the parents and teachers added. Adding avoided programs just by clicking the "Add to Watchlist" button.

Application Extension Name	Category	Actions
.exe	Games	
.com	Entertainment	
.bat	Games	

Monitoring Tools

On this section of the dashboard webpage, monitoring tools were displayed beside the webpage. The users can grab screenshots using "Get Screenshot" in all added children by parents and teachers in their profiles that will be monitored. The "Notify Teacher" button allows parents to send notifications to a teacher regarding a specific activity or progress of their child. Parents and teachers can see all of the activity logs from each profile by the

children from the "View All Activity" button. The users can nudge children only for web browsers by clicking "Send a Nudge." Strict mode and Holiday mode are also presented and displayed in this section.

Monitoring Tools

Get Screenshot

Notify Teacher

View All Activity

Send a Nudge (Browser Only)

Enable Strict Mode

Enable Holiday Mode

Administrator Login Page Login Page Interface

On this page, administrator login was intended for administrator privileges only. Once the administrator is successfully logged on, it will be redirected to the administrator dashboard.

Hello There! The Rabbit Hole is Open

Username

admin1

Password

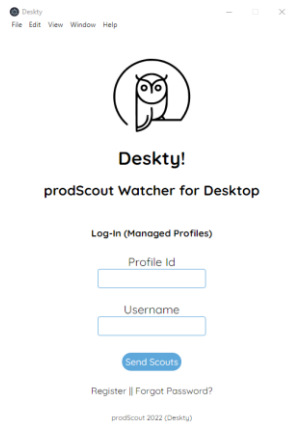
12345678

LOG IN

© 2020 - profitcloud All Rights Reserved

Administrator Dashboard

On this page, the administrator dashboard will appear after successful login. An administrator can view a list of accounts created in the client-side application, the total number of user accounts and profiles managed by the users, and edit and update user account details. The administrator can easily search for details to identify the user/s registered on the application.

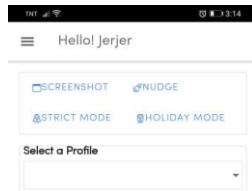


Mobile Application Version Side Login Screen Interface

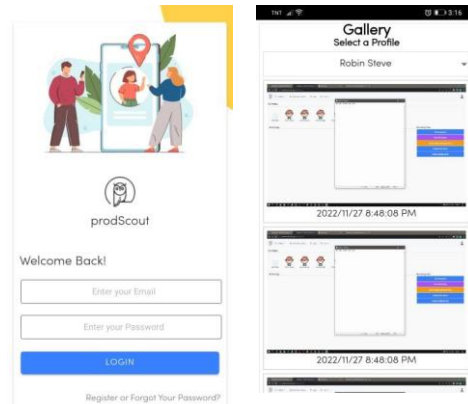
On this screen, the login interface will appear once the users launch the mobile application version of the system. Once the login details are correct, it will automatically redirect to the dashboard interface. On the other hand, once the login credentials inserted by the users are incorrect, a login error prompt will appear on the screen. If the user has no account, registration will proceed into the web application (which runs on the mobile web browser). Users can also change their password if forgotten.

Dashboard Screen Interface

On this screen, a dashboard will appear after the login is successful. The user can screenshot a specific profile from the drop-down option. Users can also nudge specific profiles to notify them to focus on their studies. Also, strict and holiday modes are presented and displayed on this screen. The hamburger



menu has different options for the users, the same as the web application side.



Screenshot Gallery Screen Interface

The screenshot gallery will appear on this screen after tapping the “Gallery” tab below. The users can view screenshots in specific profiles. Each profile has a list of screenshots after the monitoring of the system. Also, each screenshot has details such as the date and time the image was captured.

Logs Interface

On this screen, activity logs will appear after tapping the “Logs” tab below. Each profile has activity logs sorted in descending order. Each log contains the log date and time and activity done by the profiles owned by the children.

Log Date	Activity
2022/11/21 2:26:24 PM	StartMenuExperienceHost.exe / Start is currently active
2022/11/21 2:25:24 PM	explorer.exe / is currently active
2022/11/21 2:25:24 PM	explorer.exe / is currently active
2022/11/21 2:25:24 PM	explorer.exe / is currently active
2022/11/21 2:25:24 PM	explorer.exe / is currently active
2022/11/21 2:25:24 PM	explorer.exe / is currently active
2022/11/21 2:25:24 PM	explorer.exe / is currently active
2022/11/21 2:25:24 PM	explorer.exe / is currently active
2022/11/21 2:25:24 PM	explorer.exe / is currently active
2022/11/21 2:25:24 PM	explorer.exe / is currently active

“My Account Profile” Interface

Users can edit their profile details based on their preferences on this screen. Also, the user

My Profile

To change your Profile Image please access our mobile / desktop app

Jerjer Thomas

My Profile

My User Id
ngomas66758

First Name
Jerjer

Last Name
Thomas

can change the password under the profile editing.

“Manage Profiles” Screen Interface

On this screen, users can edit all of the profiles that belong to them. Each profile can edit based on the preferences of the users. Default avatars will be assigned depending on the gender of the monitored child. Users can also add another profile as monitored children and delete profiles on this screen.

Profiles

Select a Profile

Profile Id

First Name

Last Name

Password

UPDATE

Please select an avatar

BENNY

LAURA

ADD

DELETE

BACK

“Manage Blacklist Sites” Screen Interface

On this screen, users can add websites and set a category to the blacklist. The children can’t access blacklisted websites that users wish to avoid to be used. Adding and removing websites from the blacklist were the functions in this interface.

Manage Blacklist Sites

Enter Site / Url

ADD

BACK

Category	Site Name / Url	Actions
Pornography	https://www.pornhub.com/	X
Others	https://www.google.com/	X
Others	https://1337x.to/	X
Others	https://mail.google.com/mail/u/0/#inbox	X
Social Media	https://www.facebook.com/	X

“Manage Watchlist Applications” Screen Interface

On this screen, the users can add applications to the watchlist. Watchlisted applications were the programs or software that can’t allow being used by the monitored children. Once the children access a watchlisted application, it will notify parents and teachers. Also, users can remove the watchlisted application from the list.

Manage Watchlist Sites

Application Name

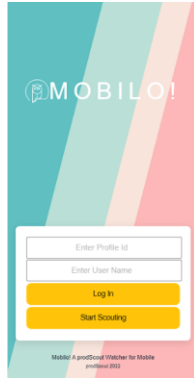
ADD

BACK

Category	Application Name	Actions
Games	CoDWaW.exe	X
Office Productivity	notepad.exe	X

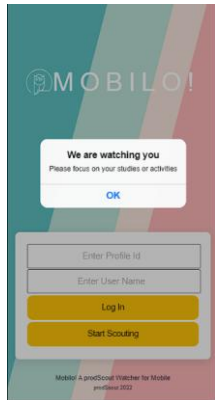
Mobile Watcher for Children Access Mobilo! - prodScout Mobile Watcher Application for Android

On this screen, Mobilo! - the prodScout watcher mobile application was intended to monitor children through mobile devices. The administrator managed profiles created by the parents and teachers to the children to monitor their mobile activities during online class sessions. A login error prompt will appear if the user's credentials are incorrect.



Nudge Notification Alert for Children

On this screen, once the parents and teachers nudge the profiles administered for the children, they will be notified and shown in the image.



Summary of Alpha Testing

The result from the test cases aims to check the stability of the system evaluated by IT experts as the alpha testing has been conducted. All the test cases used by the researchers were divided into seven (3) sections based on ISO 25010 model - functionality suitability, compatibility and usability. Each test case ID has some steps to be followed by the testers if it's working as part of the evaluation.

The test cases were used by the alpha testers and the results was completely functional. From the functionality suitability, compatibility and usability, the system passed on this characteristics based on the presented ISO 25010 standards.

Summary of Beta Testing Result

The results gathered by the researchers who conducted the beta test were successful. The application was tested on thirty (30) respondents, who are parents and teachers.

Parents were chosen as the sample since parents are the ones who assign the devices to their children. The researchers used the beta test cases for this testing phase.

The system's functionality was assessed by beta testers, with 86% of participants indicating they were satisfied with the system. The system's features, including the landing page, software installers, login/sign-up form, dashboard, and password recovery option, were all considered suitable by testers. This suggests that the system functions well overall and is easy to use and navigate.

In this evaluation, the compatibility of the system was thoroughly examined by beta testers. The results of the evaluation revealed that a significant proportion of respondents, 78.00% to be exact, answered positively to all the questions concerning compatibility, which indicates a high level of satisfaction with the system developed by the researchers. The testers found the system's compatibility and accessibility to be suitable and adequate, indicating that the system is able to function seamlessly across a variety of devices and platforms. The beta testers were able to navigate and utilize the features of the system with ease and efficiency, which suggests that the system is user-friendly and easy to use. Additionally, the respondents were able to access and utilize the application on various web browsers installed on their personal devices such as laptops and smartphones, as well as on the devices provided by the researchers. This demonstrates that the system is compatible with a wide range of devices and can be easily accessed by users regardless of the type of device they are using.

The usability of the system was evaluated by beta testers with 76.67% of respondents indicating satisfaction. The testers found the system's usability including navigation bar, monitoring tools, "My profile" section, logs section, and notification tab suitable and easy to use. The system was found to be user-friendly and easily accessible across different devices and web browsers, making it suitable for the target user group.

86.67% of beta testers were satisfied with the system's security, finding the secure connection, credentials, password policy, verifications, account recovery, and

authentications suitable and easy to use. The system is deemed secure and user-friendly across different devices, providing enough security features to protect users' data and information.

Comparison of Alpha and Beta Testing

The results of the alpha and beta testing conducted by the researchers indicate that the system performed well, with high scores in several key areas. Specifically, the functionality suitability received a score of 87.27%, indicating that the testers were highly satisfied with the functionalities and features of the system. Additionally, the compatibility of the system received a score of 80.00%, indicating that the system was able to work well across a variety of devices. The usability of the system also received a score of 78.79%, indicating that the system was easy to use and served its intended purpose. Finally, the security of the system received a score of 87.88%, indicating that the system provided a high level of protection for its users. Overall, these results suggest that the system was well-designed and performed well in all areas, meeting the expectations of the testers.

DISCUSSIONS

The researchers reached these conclusions after analyzing, testing, and evaluating the web app. The proposed multi-platform application met research goals. Thesis archives, libraries, and the internet helped researchers find study aids. The parental monitoring system's Visual Table of Contents, Use Case Diagram, and Entity Relationship Diagram were effective.

Front-end and back-end technologies work together to provide responsive multi-platform application designs and functions. Researchers created client-server systems for each platform (web, desktop, and mobile application). The platform also has key characteristics. Registration page with built-in code authentication. Each platform uses token-based account password authentication. Profile and account maintenance are simple on the dashboard (for web and mobile versions). Web and smartphone screenshots enable users create galleries. The T-test demonstrates statistical significance, indicating that the beta testers liked the system.

Mobile and web log viewing for blacklisted websites, watchlisted desktop programs, and site and tab detection works well. The multi-platform software includes child, parent, and teacher notifications. With each access level connected, SMS and email notifications operate well. Digital nudging (mini-push notifications on the browser) alerts pupils of monitoring on the web and mobile versions. Web and mobile watchlists reflect other desktop programs. Web and mobile websites were blacklisted effectively.

The researchers included all web app-specific functionalities. For system background, a landing page shows users. Registration and password change emails worked well. The independent chromium-based browser plugin for parental monitoring was also designed and deployed.

Researchers created unique features for the desktop. The children's activity profile login interface worked well. The researchers implemented basic app launch detection, background program detection, local event logging, watchlisted desktop application detection, and notification loop.

Mobile features including profile login interface for monitoring minors, background mode, orientation recognition (tilting the phone), and app activity tracking on basic authorization are incorporated.

The researchers released the multi-platform app for web browsers and the Google Play Store. To assess functionality, compatibility, usability and security the researchers created test case criteria.

The researchers beta-tested the system utilizing the beta test cases. From web to mobile, this encompasses customer satisfaction and interest.

Study objectives were attained. Administrators, Profiles/Monitored Users, and Primary Users had access controls. To protect data and information, each account had particular system access control. A multi-platform parental monitoring app was created. The Parental Monitoring System is developed efficiently using modified waterfall. Researchers follow a modified waterfall methodology life cycle to track progress.

All test cases were thoroughly tested in alpha and beta testing, and the findings

satisfied study requirements. The system's performance during the alpha and beta testing, as evaluated by the researchers, was found to be high across several key areas. Particularly, the functionality suitability received a score of 87.27%, signifying that the testers were highly pleased with the system's functionalities and features. Furthermore, the system's compatibility was scored at 80.00%, revealing that it functioned well on a variety of devices. The usability of the system also received a score of 78.79%, indicating that it was easy to use and served its intended purpose. Lastly, the security of the system was rated at 87.88%, showing that it provided a high level of protection for its users. All in all, these results indicate that the system was well-designed and performed well in all areas, meeting the expectations of the testers.

REFERENCES

- [1] H. Telecom, "The vital importance of parental controls in today's day and age," Homesc.com, 07-Jul-2021. [Online]. Available: <https://www.homesc.com/Blog/361189/The-Vital-Importance-of-Parental-Controls-in-Today-s-Day-and-Age>. [Accessed: 28-Mar-2022].
- [2] M. M. Makokha, P. Raburu, and A. M. Onditi, "Effects of parental monitoring on academic achievement of secondary school students in Busia sub-county, Busia county, Kenya."
- [3] D. P. Witherspoon, E. M. May, A. McDonald, S. Boggs, and M. Bámaca-Colbert, "Parenting within residential neighborhoods: A pluralistic approach with African American and Latino families at the center," *Adv. Child Dev. Behav.*, vol. 57, pp. 235–279, 2019.
- [4] K. Gyamfi and M. A. Pobbi, "Parental Monitoring and Child Performance in Ghana," *Eric.ed.gov*. [Online]. Available: <https://files.eric.ed.gov/fulltext/EJ1109409.pdf>. [Accessed: 28-Mar-2022].
- [5] Scanfamilies.org. [Online]. Available: [yourhttps://scanfamilies.org/resource/monitoring-your-child/#:~:text=As%20a%20parent%2C%20you%20are,those%20that%20can%20be%20harmful](https://scanfamilies.org/resource/monitoring-your-child/#:~:text=As%20a%20parent%2C%20you%20are,those%20that%20can%20be%20harmful). [Accessed: 14-Jul-2022].
- [6] "View of Parental involvement, learning participation and online learning commitment of adolescent learners during the COVID-19 lockdown," *Alt.ac.uk*. [Online]. Available: <https://journal.alt.ac.uk/index.php/rlt/article/view/2544/2878>. [Accessed: 28-Mar-2022].
- [7] "What is SDLC? Understand the Software Development Life Cycle," *Stackify*, 08-Apr-2020. [Online]. Available: <https://stackify.com/what-is-sdlc/>. [Accessed: 28-Mar-2022].
- [8] E. Conrad, "Domain 8," in *Eleventh Hour CISSP*, Elsevier, 2011, pp. 129–145.

Puzzyalan Jigsaw Battle: A 3D Android Based Jigsaw Puzzle with Trivia

Robert J. Dagyagnao Jr.

Joner P. Lalu

Justine S. Maaño

Darlon B. Resuello

Lance O. Salunga

Dennis L. Tacadena, PCpE, DIT (Technical Adviser)

ABSTRACT

In the Philippines, nine of the country's top tourist attractions have received recognition on a global scale and are now listed as UNESCO World Heritage Sites. Jigsaw puzzles have been found in studies to enhance cognition and visual-spatial reasoning. The general aim of the study is to develop a casual mobile game titled "Puzzyalan Jigsaw Battle; A 3D android based puzzle with trivia" that intends to promote the tourism of the Philippines in a form of an interactive presentation of media and 3D with the core game-play of a Jigsaw Puzzle Game which focuses on presenting the tourist spots, wildlife and food native to the country. The researchers utilized and used the Modified Waterfall Model methodology as a guide in the application development. The game has been made using a PC and software development tools such as Unity, Blender 3D, Wavepad Audio and Photoshop. The design and analysis tools such as storyboard, game tree menus, and character model was used. Evidently, the researcher created a game single or multiplayer, level of difficulty, trivia's of Philippine foods, animals and tourist spots and puzzle assembly. The researchers have used statistical formulas such as frequency distribution, mean score and Likert scale. The survey questionnaires are based on the standard criteria specified in MEEGA+ specifically: Player Experience and Usability. The researchers came to the final conclusion that the game had been regarded as having satisfactorily met the predetermined criteria for the evaluation based on the beta test evaluation's overall mean score of 3.94.

CCS Concepts: • Information Technology → Game Applications;

Keywords

Android Game, Android Application, Mobile Application, Puzzle Game

INTRODUCTION

Spending time away from home in search of leisure, relaxation, and pleasure while utilizing the commercial provision of services is known as tourism. As a result, although it has roots in Classical antiquity, tourism is a byproduct of contemporary social structures that emerged in Western Europe in the 17th century.

The history of tourism is consequently very interesting and significant since by the early 21st century, international tourism had become one of the most significant economic activities in the world, and its impact [1] was becoming more and more obvious from the Arctic to Antarctica. Before the term "tourist" was first used at the end of the 18th century, there was a lengthy history of travel. Ancient

Greece and Rome, which can lay claim to the origins of both "heritage tourism" (aimed at the celebration and appreciation of historic sites of recognized cultural importance) and beach resorts, are the places where organized travel with supporting infrastructure sightseeing and an emphasis on essential destinations an experiences can be found. According to (UNESCO) United Nations Educational, Scientific and Cultural Organization, UNESCO names places as World Heritage Sites when they are considered to be of significant cultural, historical, scientific, or other value.

Cultural and natural heritage around the world considered to be of extraordinary importance to humanity" is said to be present at these locations As of August 2022, a total of 1,154 World Heritage Sites (897 cultural, 218 natural, and 39 mixed properties) exist across 167 countries. With 58 selected areas, Italy is the country with the most sites on the list.

In the Philippines, nine of the country's top tourist attractions [2] have received recognition on a global scale and are now listed as

UNESCO World Heritage Sites. These include significant protected areas like the Puerto Princesa Underground River or the Subterranean River National Park in Palawan Island, the beautifully preserved Historic City of Vigan from the Spanish era in Ilocos Sur, and the Rice Terraces of the Philippines in the Cordillera region of North Luzon.

The Philippines, which have over 7,000 islands, are culturally and biologically diverse. There are numerous attractions and tourist destinations on its islands that draw tourists in with their allure. The Philippines has developed its own identity through its native cuisine and art despite centuries of foreign occupation. Along with its stunning scenery and animals, the warmth of the Filipino people is seen by many as a distinctive quality. But this nation is much more than just the home of adobo and amiable people. These facts about the Philippines can help you learn more about this nation's wonders.

Filipinos [3] are known for positive values, hospitality, being hard-working, and ability to face whatever challenges that life brings – with a smile in face. On top of that, Filipinos also known to have a great passion for food – to the point of considering eating as a hobby.

The food in the Philippines is a mixture of sweet, salty, and sour flavours. Filipino cuisine has been influenced by Spanish, American, and Chinese traditions due to its rich colonial history. Similar to other Asian countries, rice is a staple food in the Philippines. Filipinos rarely eat a meal without steamed rice and it's usually eaten with meat and vegetable dishes.

The same way that people come in a variety of shapes and sizes, so do animals. Since the beginning of civilization, they have been around and have supported mankind in their quest for advancement. All animals have rights that should and should be safeguarded and upheld, regardless of where they may originate. Since the 17th century, when Europe approved its first animal protection law outlawing the removal of sheep's wool and the tying of horses' to devoted farm workers like carabaos.

The importance of animals in Filipino culture has never changed. The animals that have stayed by our sides to keep us company and aid us in our daily activities range from loyal

pets like cats and dogs to devoted farm workers like carabaos.

Puzzles are beneficial to the brain as well. Jigsaw puzzles have been found in studies to enhance cognition and visual-spatial reasoning. Concentration is needed while putting puzzle pieces together, which enhances short-term memory and problem-solving skills. Using the puzzle as a mental workout can boost creativity and productivity and inspire imaginative thinking.

Background of the study

Tourism is one of the most important economic industries in the world. The main benefits of tourism are income creation and generation of jobs. Tourism can also help in building a country's image and identity. The Philippines is a country with great possession of various beautiful natural resources that create a great impact on tourism and also the Philippines is perceived as a destination with beautiful nature and beaches and delicious food and native wildlife. [4]

Puzzyalan is derived from the word "Puzzle" and "Pasyalan" in English Sightseeing. The researchers came up with this name because our game is a 3D puzzle and its subject is Philippine tourism.

Two years ago, the whole world is experiencing the effects of the pandemic and the Philippine government previously declared a state of emergency because of a virus called COVID19 implementing guidelines for and health protocol as more countries report increasing reports of infections as many people are dying and need to keep on distancing and staying at home all the time all time due to the implementation of lockdowns, halt of industry related functions, economic operations, leisure and the state of tourism of the country is affected due to pandemic [1] [5]. Currently, the Philippine government approved the easing of stringent travel restrictions [6]. The overarching goal of the Marcos Administration is to enable our nation to project to the outside world that the country are open and prepared to receive investments and tourists in order to give the fellow Filipinos a chance to recover all of the losses in terms of livelihood and property that were sustained during the pandemic.

Despite of the current situation the resilience of the Filipinos now includes searching for new

type of activities and entertainment to get rid of boredom aside from watching television and listening to radio or music. Some are engaged in social media websites, streaming platforms and gaming through the use of computers and mobile devices.

Mobile gaming is one of the contributors of entertainment these days not only in this state of the pandemic but also through the history before this began. Moreover, the market for mobile games and devices now is rapidly increasing as not only for entertainment purposes but also due to its necessity in the field of education through flexible and online classes. [7]

One genre that is most sought of on the app market by casual players are Puzzle games. There are different types of successful puzzle games in the app store including new game genres with hyper casual mechanics and even genres as old as dice games and Jigsaw Puzzle are well received by the gaming community. [8] In line with the situation of tourism and taking advantage of the growing demands of mobile games and rise of mobile device use, the researchers are planning to create a casual mobile game titled "Puzzzyalan Jigsaw Battle".

Objectives of the study

The general aim of the study is to develop a casual mobile game titled "Puzzzyalan Jigsaw Battle; A 3D android based puzzle with trivia" that intends to promote the tourism of the Philippines in a form of an interactive presentation of media and 3D with the core game-play of a Jigsaw Puzzle Game which focuses on presenting the tourist spots, wildlife and food native to the country.

In line with this, the study aims to achieve the following specific objectives:

- To gather needed information through collaboration and internet research
- To identify hardware and software needed in the game application development.
- To design a game application using appropriate design and analysis tools.
- To create a jigsaw puzzle game application.
- To develop a multiplayer battle game application.
- To test the quality of game application using MEEGA+ in terms of player

experience and usability from the viewpoint of gamers.

- To deploy the game application in the free game application site.

Scope and limitation of the study

The study was focused primarily on the design, development, testing, and evaluation of the mobile game titled "Puzzzyalan Jigsaw Battle: A 3D android based puzzle with trivia".

The researchers would conduct data gathering through internet research and ensure that the integrity and accuracy of the collected data. The researchers collaborated to create capstone project ideas through brainstorming, planning, and internet and library research. The researchers started with gathering information from scholarly articles, journals, and government sites, application store sites via the internet to define the problems and identify the initial requirements for the application development. The researchers regularly checked in with their technical and capstone mentor to see how the documentation and application development were progressing. Based on the scope of the investigation, the researchers devised activity schedules, shared ideas, and dispersed individual tasks.

The researcher would be using a desktop computer powered by Microsoft Operating System in the game application development. The development tools that the researchers would be use in creating the game are Unity3D, Adobe Photoshop, and Blender. The Unity 3D engine would be use because it enabled the game to be developed for a wide range of platforms, including computers, gaming consoles, augmented reality environments, and mobile devices. In addition to a free version, there is a pro version with more advanced features that may be of interest to researchers. Furthermore, it is used to test all of the game's features and functions. Blender, on the other hand, would be use by researchers because it has all of the features found in any 3D application which is required for the game's development. For the logo and other written elements in the game, the Adobe Photoshop would be use as graphic enhancement. A WavePad Audio editor would be used to control the volume and sound effects of the game. Researchers would be using an Android SDK to

build, test, and debug applications on the Android platform.

The development team would use the designing tools to illustrate the functions of the developed game. The designing tools would be use were Storyboard, Game Menu Tree, Character Model and Logo Design. The Storyboard serves as a manual for the reader to understand the game flow and functionality of the game. The researcher would be able to design the initial draft of the mobile game using Storyboard and Game Menu Tree as guide throughout the game development process. Using Blender as a tool, the researcher would able to draft games 3D object models.

The study focused on the creation and development of mobile game which enables the user or gamer, to have fun and get knowledge about Philippines animals, foods, and places while playing the game. At the beginning of the game, when the player launch the application and start to play, the splash screen would be displayed. The Main Menu would consist of three sections: Play, Options, and Quit.

By clicking Play button, the player would be able to choose option either Single Player or Multiplayer game. One of the main features of this project is the creation of a single player. The player can choose one of three categories: Animals, Foods, and Places. In each category, there are 10 stages of puzzles to be solved, and each puzzle has three levels of difficulty to choose from easy to hard. The player's life is symbolized by three stars. If the player fails to complete the puzzle before time expires, the player would lose a star. The number of pieces and the time required to complete the puzzle would depend on its difficulty. For the easy puzzle (3x3), there are nine pieces, for the medium puzzle (4x4), there are 16 pieces, and for the hard puzzle (5x6) there are 30 pieces. An easy puzzle has a time limit of 120 seconds, a medium puzzle has a time limit of 150 seconds, and a hard puzzle has a time limit of 180 seconds.

It is necessary for the player to complete the first stage puzzle in order to proceed to the next stage, regardless of the category they choose. The player's screen would display a 3D model and trivia once they have completed one puzzle. Additionally, the Almanac section of the game provides information about each puzzle that

has been solved. During each stage, there would be a viewable trivia about foods, animals, and places in the Philippines.

In multiplayer game, there would be four sections. An "i" button can be view in the upper right corner of the screen which indicates the instruction of the game. Clicking it would prompt the player an option to choose an avatar character. There would be four different characters that available for the player to be chosen. In the third instance, the player would be able to find an available match player for them to play the battle game. The battle game would be one player versus one player game. An opponent would be identified once the press the FIND MATCH button was clicked. Once the application have identified and paired with the opponent device, the player should choose an avatar character then battle would begin. In this game battle, players would race against each other to locate the puzzle sphere in the forest and solve it. If both players found the same puzzle sphere, the first player who have click the play button would have the chance to solve the puzzle to gain points. The puzzle sphere would be disappearing in the view of second player. In this game, each puzzle is worth one point, and the first player to accumulate five points would wins.

By clicking "Back to Main" button, the player would be able to return to the Main Menu. The volume of the background music could be adjusted by clicking the Options button. Clicking Quit button would cause exit and closure of the game application.

The game would be undergone a preliminary developers application test conducted by the researcher to detect bugs that have miss detected during other tests like unit and integration testing, and it is considered more important before it would be release for beta test. Application testing would be done once the application was converted to APK file, installed and launched in mobile device to test for possible defects. The purpose of this test is to refine the software product by identifying and fixing bugs that were miss discovered during previous testing.

Once the game application would pass the developers test, the researchers would release the software to a limited number of external beta users for testing. The application would be

evaluated using MEEGA + tool survey questionnaire. This is an application model designed to evaluate the quality of educational application used to teach computing/software engineering in terms of player experience and perceived learning from the viewpoint of the learners. Using the statistical mean formula; frequency distribution; and Likert scale, the researcher would be able to come up with a result. With this, the interpretations from the sub-criteria and criteria results are justified with valid information. Homogeneous purposive sampling would be used in the study because the researcher needs to reach a targeted sample quickly. In the beta testing, the researchers would approach thirty (30) tourists to test and evaluate the game. A major advantage of beta testing is the direct feedback provided by users. The purpose of this testing is to test the project in a real-time environment.

Once the game would pass the acceptance testing of the beta users, the researchers would deploy and upload the game in the free application hosting site

Significance of the study

Global context - The study will offer a good platform for people to use in their own time while learning new strategies to avoid or prevent illnesses in the global setting.

Environmental Context – time, place(venue), awareness that can influence to the gamer, discuss benefit to a gamer using the game application would provide trivia's about the Philippines.

Economic Context – business influence, discuss the benefit to gamer using game application would promote tourism and attracts tourist. Tourist attractions nearby business establishments will financially gain.

Societal Context – social interaction, discussing cooperative multi-player game would have great impact people engagement and support gaming industry.

SYSTEM DEVELOPMENT METHODOLOGY

Application Development Methodology

This chapter presents methods used in developing the Android application game and to illustrate the functions of the game, contains methods, design and data that were used in the game development. It also shows the

methodologies and research instruments to collect data used by the researchers. There are also different kinds of diagrams to further explain the flow and the design of the study

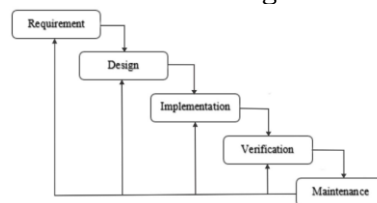


Figure 1: The Modified Waterfall Model, Software Development Methodology of Puzzylayan
(Source: <https://i.stack.imgur.com/3U4LR.jpg>)

In this study, the researchers utilized the Modified Waterfall Model software development methodology. This methodology (see Fig. 1) consists of different phases that include requirement gathering and analysis, design, implementation, verification, and maintenance.

Requirement

In this phase, the researchers collected all the needed hardware and software requirements and supporting articles and academic published research for requirement specification document (SRS). The researchers' plan is to define the gaming application's needs, scope, and development platform at this point. Together, the researchers engaged brainstorming, planning, and internet and library research to conceptualize potential project ideas. The researchers routinely checked on the status of both the documentation and application development by communicating with their technical and capstone mentor. The researchers developed an idea and expertise on how they would develop the gaming application by gathering information from the internet, library materials, and study on prior capstone projects. The researchers created schedules of activities, communicated ideas, and distributed individual workloads based on the study coverage. They also planned and analyzed the application development flow. Technical and capstone advisers closely monitor project progress while determining the project's needs, scope, and priorities.

It should be required when developing the game to have a listing of hardware and software requirements with descriptions and specs. The researchers worked together to create a game

via programming, designing, or editing. The researchers used a desktop PC (see Table 1) and installed software applications such Unity 3D [12], Blender [13], Wavepad Sound Editor, and Adobe Photoshop [14] utilizing the Windows operating system in order to build or design the program. The researchers write and outline the main object of the game using Adobe Photoshop and Blender. The game developers would use Blender to create a variety of objects that will be included in the game and loaded into Unity.

Table 1: Hardware Specification Requirements for Application Development

Components	Specification
CPU	i7- 7th Generation Ryzen 3 2200g
Hard drive	500GB STORAGE
RAM	16 GB RAM
Graphics Card	Intel HD Graphic 5500 / Radeon Graphics

Design

In this phase, the application design was created using the requirement specification documents (SRS). The researchers or the development team used some analysis tools to illustrate the functions of the developed game. The analysis tools are: Storyboard, Game Menu Tree Model and Character Model.

Storyboard [20] [21] used by the researcher is a sketch of how to organize a game story flows and a list of its detailed contents. Storyboard is a graphic organizer in the form of illustrations or images displayed in sequence for organizing the motion, animation and images of the game. A storyboard helps to define the parameters of a project within available resources and time, organize and focus a project, and figure out what medium to use for each part of the project. The researchers used this tool because it would help developers to quickly get a sense of what work still needs to be completed. It will also help the team to visualize the sequence and interconnectedness of project output (See Fig. 2). The researchers created a storyboard that would display the game's characters, plot points, tone, actions, gameplay features, and other factors in a logical sequence.

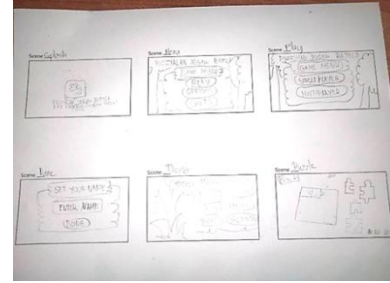


Figure 2: The design and analysis tool - Storyboard

Game Menu Tree [22] presents ways of letting the player select clickable button menus. The researchers used this analysis tool to show the overview the executable buttons that controls the flow of the game and to understand how the game works (See Fig. 3). This would able the researchers to see any gaps in the gameplay and plot and create plot components to fill in the gaps or make the game more interesting. It assisted the researchers in structuring the main ideas of the plot into a logical sequence and perfecting the pacing for maximum impact.

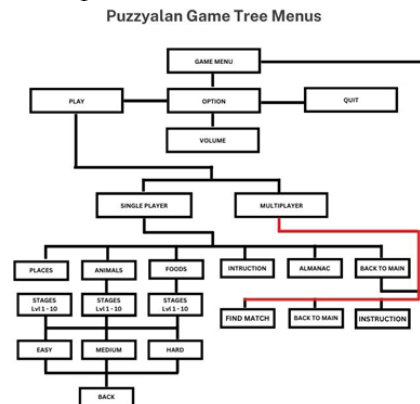


Figure 3: The design and analysis tool – Menu Tree

Character Modeling [23] was the tool used that shows the evolution of the game 3D character designs as the development progresses. This model shows character designs of a 3D avatar that the player may choose from the multiplayer game. (See Fig. 4)



Figure 4: The design and analysis tool – Character Model

One of the numerous things a skilled graphic designer can offer to a business that wants to stand out in the industry is logo design. The researchers used this tool to create a logo for this study. In creating the game logo, the developers used Adobe Photo Shop in designing and lay-outing of the logo or bran image of “Puzzylan Jigsaw Battle: A 3D android based puzzle with trivia”. (See Fig. 5)



Figure 5: The design and analysis tool - Logo

Implementation

Application programming, problem-solving, and series of testing are all part of the implementation phase. This involves

interpretation of design phase into action. The software design such as storyboard, game menu tree, character modeling and logo design would put into practice in the desired game programming language during the development phase. The game's developers decided to develop a single and multiplayer mode.

The creation of a single player is one of this project's key characteristics. Animals [18], foods [19], and places [17] are the player's three options. There are ten stages of puzzles in each category, with three varying levels of difficulty to pick from (easy, medium, and hard). Three stars represent the player's life. A star would be taken away from the player if they are unable to complete the task in the allotted time.

There would be four sections in a multiplayer game. In the top right corner of the screen, there is a "i" button that displays the game's instructions. The player would be given the choice to select an avatar character upon clicking it. The player would have the option of selecting one of four characters. In the third instance, the player would be able to locate a match player who was available to play the battle game with them.

The researchers use the Unity 3D [12] Software tool to create the game's functionality in action. This is the most challenging and important stage of development because it takes a lot of time and work to complete fully functional game. The team's developer built the codes for each button to specify the action once it was pressed by the player, starting with the Main Menu. After completing the project, the team tested the game application by launching it on a real Android device to check for flaws and immediately correct those before releasing it to the beta testers (see Table 2).

Table 2: Smartphone specification during Application Testing

Components	Capacity
Android Version	Android 8
RAM	6GB RAM
Internal Memory	64GB ROM

Verification

In this phase, the testing team would deploy the application for beta testing to see if it would provide the researchers with the successful

objectives or not. The application's integration into the desired target environment was part of the testing phase. Typically, beta versions of application items are first distributed to a limited number of end users (beta tests). The team tester can check whether the program complies with the requirements by using the acceptance tests created during the analysis phase. A piece of application that has successfully passed beta testing is prepared for public consumption.

The testing phase covers the evaluation of the whole study if the application performs as specified by the requirements. The tester team conducted the beta testing using adopted MEEGA+ tool [16] to review and correct any application glitch or defects.

The researchers' testing team used the Educational Game Quality Model MEEGA+ questionnaire to evaluate the game. The test questionnaires that would be given by the researchers are based on the standard criteria specified in MEEGA+ specifically: Player Experience and Usability.

Through beta testing tools, the researchers carried out the simple random and purposive sampling. Because the target population was very homogeneous and each member of the population has an equal and independent chance of being selected in a single sample, simple random sampling, without replacement, was used in the study.

The judgment sampling method, also known as purposive sampling [24], involves carefully selecting a participant based on the characteristics they possess. This nonrandom technique does not require underlying theories or a predetermined number of participants. Simply put, the researcher selects what information is necessary to have and then searches for groups that are able and are willing to provide it due to their knowledge or experience. Because the study needed to swiftly obtain a targeted sample and sampling proportionality was not the key issue, homogeneous purposive sampling [24] was adopted.

Instrumentation

The researchers adopted a questionnaire based on the MEEGA+ checklist to know if the game application has met the objectives needed. The

researchers' game was installed on the researchers' smartphone (see table 3).

In the beta testing, the researchers approached thirty (30) tourists in Angeles City, Pampanga who loves to travel to other provinces in the Philippines to test and evaluate the game.

Table 3: Smartphone specification during Beta Testing

Components	Capacity
Android Version	Android 8 to 12
RAM	6GB RAM
Internal Memory	64GB ROM

4.5.1 Questionnaire Administration

In Angeles City tourist areas, the questionnaire was handed out between December 6 and December 7, 2022. A brief explanation of how the respondent would complete the checklist based on their game experience would be given during the distribution and administration of the questionnaire.

Data gathering

The beta questionnaires were administered, distributed, and collected by the researchers. Within ten (10) minutes of playing and using the developed gaming application, respondents complete the survey. During December 6, 2022, researchers begin beta testing and data collection until December 7, 2022.

Data Analysis

Descriptive statistics was used in this study. Descriptive statistics summarized the data in order to identify the points around which the data are located, and the spread and dispersion of the data.

The following statistical treatments were used for data reduction:

Frequency Distribution

The study employed a frequency distribution to show how many cases fell into each score range. The demographic profile of the respondents' scores was divided into step interval-defined groups, each of which was a collection of contiguous potential scores. There are various types for a variable that contains values that represent the cases' order. The frequency was measured by the total number of cases for each group.

Mean Score

The mean score is used in the study to determine if the average score (or mean value) of the respondents' set of data is equivalent to

the sum of all the values in the data set (divided by the total number of values). The formula for the mean (or average) is:

$$A = N/S$$

Where:

A = average (or mean),

N = number of terms (the number of items or numbers being averaged, and

S = sum of the numbers in the set of interest (e.g., the sum of the numbers being averaged).

Likert scale

The Likert scale is a rating system that used in questionnaires and is designed to measure respondent's attitudes, opinions, or perceptions. After the calculations each mean score of each survey tool sub-criteria and criteria, the researcher used the Likert scale (see Table 4) to interpret the result into its corresponding verbal interpretation.

Table 4: Percentage range for results verbal interpretation

Response	Value	Range	Verbal Interpretation
Strongly Agree	5	4.21 – 5.00	Excellent
Agree	4	3.41 – 4.20	Good
Neutral	3	2.41 – 3.40	Acceptable
Disagree	2	1.41 – 2.40	Marginal
Strongly Disagree	1	1.00 – 1.40	Poor

Data processing

Data processing was done using tally sheets. The tally summary was finalized as the respondents completed the beta questionnaires. The researchers would work on the data entry using tally sheets form.

Maintenance

The maintenance phase is done after the verification phase. In this phase, the game application was deployed and released into the game industry market repository site. This would be an avenue where user or gamer may able to report glitch or needs improvement for the betterment of the developed application. In the course of project deployment, the potential gamers could able to download the game by accessing the repository hosting site and

marking as it is only available for Android devices. The program has been advertised and disseminated for deployment with the aid of the repository hosting website. A summary statistic on the website hosting the repository could assist the researchers in figuring out the precise numbers related to application installations, uninstalls, and ratings. Additionally, tracking the various Android versions that the application is compatible with could be useful to the researchers.

RESULTS AND OUTCOMES

The results and outcomes were based on the objectives of the study. These discussions and conclusions are based on the objectives of the study, completed analysis, and testing of the developed application prototype. It also presents the analysis and the interpretation of the beta testing made by the researchers. The results and outcomes have been computed carefully by the researchers. It is important that the research output be presented in an organized, coherent and understandable manner.

Data Gathering

The researchers used online research to acquire data and made sure the information was accurate and of high integrity. The researchers brainstormed, planned, and conducted online and library research in order to develop capstone project ideas. To describe the issues and determine the basic needs for the application development, the researchers first began to gather data online from academic articles, journals, government websites, and application store sites. The researchers communicated with their technical and capstone adviser frequently to learn how the application development and documentation were going. The researchers created activity schedules, communicated ideas, and distributed specific tasks depending on the breadth of the investigation.

Identifying Hardware and Software Requirements

For the creation of the mobile game, the researchers acquired and utilized a desktop PC running the Microsoft Operating System (see Fig. 6). The researcher created a game application on a desktop PC with an i7 7th generation processor, 16 GB of RAM, 500 GB of

hard drive storage, and a graphics card. The researchers turned the designed diagrams into an operational application by using software development tools. A mobile game was successfully created and developed by the researchers.

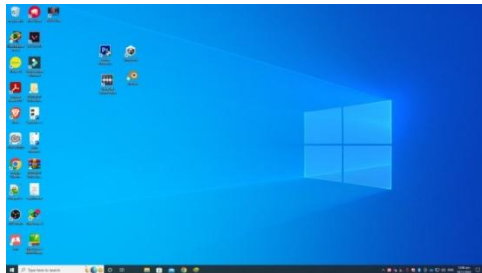


Figure 6. Desktop PC Installed Software Development tools during Application Development

Design, Creation and Development of Application

The researcher created a game application sub-menu (see Fig. 7) and then added a prompt to the game. The prompt contained six buttons such as Places, Animals, Foods, Instructions, Almanac, and Back to Main. Animals, foods, and places are the player's three options. The created game has three level of difficulty. It has an Easy, Medium and Hard mode. There are 10 stages of puzzles in each category, with three varying levels of difficulty to pick from (easy, medium, and hard).



Figure 7. Game Application Sub Menu and Level of Difficulty

A player's life is symbolized by three stars. If the player does not solve the puzzle before the time runs out, he loses a star. Number of

pieces and the time it takes to solve a puzzle depends on its difficulty. The easy puzzle (3x3) has nine pieces, the medium puzzle (4x4) has 16 pieces and the hard puzzle (5x6) has 30 pieces.

The game can be played with a single player or multiplayer. The gamer can choose from a variety of different characters. There would be four sections in a multiplayer game (see Fig. 8). In the top right corner of the screen, there is a "i" button that displays the game's instructions. The player will be given the choice to select an avatar character upon clicking it. The player would have the option of selecting one of four characters. In the third case, the player would be able to locate a match player who was available to play the battle game with them. One player versus one player would be the format of the fight game. Once the FIND MATCH button was pressed, an opponent would be located. The player must select an avatar character before the battle starts once the application has located and associated with the opponent's device.



Figure 8. Selection of Avatar and Application Paired Matching

Regardless of the category they select, the player must finish the first stage's puzzles in order to move on to the next. After solving one puzzle, the player's screen would show a 3D model and trivia (see Fig. 9). Additionally, the Almanac section of the game provides information about each puzzle that has been solved. There would be a viewable fact about a food, an animal, or a place in the Philippines during each stage.

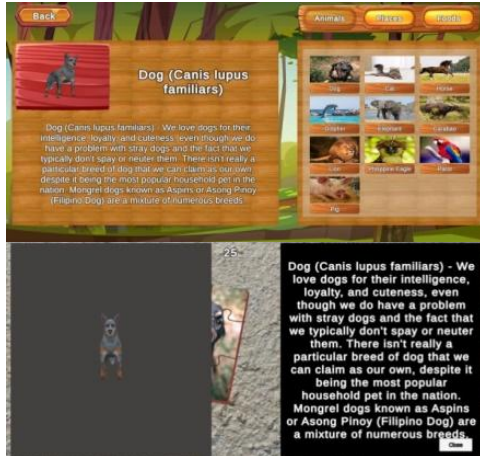


Figure 9. Jigsaw Puzzle 3D Trivia and Description

Beta Test

The survey was distributed in Angeles City tourist area between December 6 and December 7, 2022. In the beta testing, the researchers approached thirty (30) tourists to test and evaluate the game. During the distribution and presentation of the questionnaire, a brief explanation of how the respondent would complete the checklist based on their game experience would be provided. The researchers disseminated, collected, and administered the beta surveys. Respondents finished the survey within ten (10) minutes of utilizing and playing the created game application.

Table 5. Summary of MEEGA+ in terms of Player Experience criteria

Player Experience Sub-criteria	Mean	Verbal Interpretation
Focused Attention	3.62	Good
Entertainment / Fun	3.52	Good
Challenge	3.67	Good
Social Interaction	3.78	Good
Confidence	4.15	Good
Satisfaction	3.81	Good
Perceive Learning	4.44	Excellent
Error prevention and recovery	3.77	Good
Total Mean	3.84	Good

Table 5 shows the summary of beta test results of the game in terms of MEEGA+ Player Experience test. The highest in the sub-criteria result is the Perceive Learning that has a mean

score of 4.44 and has a verbal description of "Excellent". This means that the game assisted in the player's improvement of their tactical strategy. Additionally, the game assisted in sharpening their judgment and critical thinking. Another, the Confidence garnered a mean score of 4.15 with a verbal interpretation of "Good". This means that the player initially thought the game would be simple to them when they first looked at it. The structure and contents gave the player the confidence they needed to finish the game.

The lowest in the sub-criteria result is the Entertainment / Fun that has a mean score of 3.52 with a verbal interpretation of "Good". This means that the gamer satisfyingly entertained by anything that occurred in the game within a short period of gaming time.

Table 6. Summary of MEEGA+ in terms of Usability criteria

Usability criteria	Sub-Mean	Verbal Interpretation
Aesthetic	3.37	Good
Learnability	3.98	Good
Operability	4.70	Excellent
Accessibility	4.12	Good
Total Mean	4.04	Good

Table 6 shows the summary of beta test results of the game in terms of MEEGA+ Usability test. The highest in the sub-criteria result is the Operability that has a mean score of 4.70 with a verbal interpretation of "Excellent". This means that the respondent believes that the game is simple to play. The game's rules are unambiguous and simple to grasp. In the usability criteria, the lowest in the sub-criteria result is the Aesthetics. It garnered a mean score of 3.37 with a verbal interpretation of "Good". This means that the respondents find the game's interface to be somewhat appealing.

Table 7. Summary of MEEGA+

MEEGA+ Criteria	Mean	Verbal Interpretation
Player Experience	3.84	Good
Usability	4.04	Good
Total Mean	3.94	Good

Table 7 shows that the researchers came to the conclusion that the game had been regarded as

having very satisfactorily met the predetermined criteria for the evaluation based on the beta test evaluation's overall mean score of 3.94 and verbal interpretation of "Good."

5.5 Deployment of Application

The researchers deployed and published the game [25], and it is now easily accessible at Google Play after passing the acceptance testing of beta users and a board of panelists.

DISCUSSION

The study was focused primarily on the design, development, testing, and evaluation of the mobile game titled "Puzzylan Jigsaw Battle: A 3D android based puzzle with trivia".

The researchers have used a desktop computer powered by Microsoft Operating System in the game application development. The development tools that the researchers used in creation of game are Unity3D [15], Adobe Photoshop [14], and Blender [13]. The Unity 3D engine was used because it enabled the game to be developed for a wide range of platforms. Blender, on the other hand, was used by researchers for it support features for 3D application game development. For the game logo was designed using Adobe Photoshop as a graphic enhancement tools. A WavePad Audio editor was used to control the volume and sound effects of the game. Researchers used an Android SDK to build, test, and debug applications on the Android platform.

The design and analysis tools used by the developers were Storyboard [20] [21], Game Menu Tree [22], Character Model [23] and Logo Design. The Storyboard served as a manual for the reader to understand the game flow and functionality of the game. The Game Menu Tree reflects on the produced application as user interface navigation and control keys. Using Blender as a tool, the researchers have abled to create a 3D object models.

The developed game is a puzzle [9] solving game [10] with trivia's of Philippines animals [18], foods [19], and place [17]. When the player launched the android [11] application, a user friendly splash screen would be displayed. The Main Menu would consist of three sections: Play, Options, and Quit. The developed game supports both single and multiplayer 3D game [12].

The developed game have undergone a preliminary developers application test conducted by the researcher to detect bugs that have miss detected during other tests like unit and integration testing. Once the game application has passed the developers test, the researchers have released the software to a limited number of external beta users for testing. The researchers' have adopted the MEEGA + [16] as the evaluation tool. This application model was created to assess the effectiveness of educational applications used to educate software engineering and computer science in terms of player experience and perceived learning. The statistical mean formula, frequency distribution, and Likert scale are used in this study. With this, the interpretations from the sub-criteria and criteria results are justified with valid information. Homogeneous purposive sampling [24] was used in the study in order for the researcher to reach a targeted sample quickly. The beta tester respondents were the thirty (30) random tourists at Angeles City. The researchers assumed that the game had been judged to be very satisfactory and had met the evaluation criteria based on the beta test evaluation's overall score of 3.94

Finally, the "PUZZYALAN" game application has been deployed and published by the researchers to the Google Play site [25]. With the support provided by the evidence in the summary of findings, the researcher came to the conclusion that the study's general objective and scope were completely achieved.

REFERENCES

- [1] "Tourism And Covid-19 – Unprecedented Economic Impacts". (n.d) . World Tourism Organization. Retrieved from <https://www.unwto.org/tourism-and-covid-19-unprecedented-economic-impacts>. (accessed August 14, 2022).
- [2] "Tourism industry in the Philippines - statistics & facts". (n.d) Statista. Retrieved from <https://www.statista.com/topics/6012/tourism-industry-in-the-philippines/>. (accessed August 14, 2022).
- [3] J. Tek-Ing. (n.d). "13 Reasons Why You Should Travel to The Philippines Now". Guide To The Philippines. Retrieved from <https://guidetothephilippines.ph/articles/ultimate-guides/why-travel-the-philippines>. (accessed August 14, 2022).
- [4] Y. Yehia. (March 26,2019). "The Importance of Tourism on Economies and Businesses". Global EDGE. Retrieved from

- <https://globaledge.msu.edu/blog/post/55748/the-importance-of-tourism-on-economies-a>. (accessed August 14, 2022).
- [5] "COVID-19: Protecting people and societies". (n.d). Organisation for Economic Co-operation and Development. Retrieved from <https://www.oecd.org/coronavirus/policy-responses/covid-19-protecting-people-and-societies-e5c9de1a/> (accessed August 14, 2022).
- [6] PBBM oks easing of stringent travel restrictions. Be part of the fun! Welcome to the DOT Corporate Site. (2022, October 26). Retrieved January 18, 2023, from https://beta.tourism.gov.ph/news_and_updates/pb-bm-oks-easing-of-stringent-travel-restrictions/
- [7] O. Fernandez et al. (January 8, 2018). "Mobile gaming and problematic smartphone use: A comparative study between Belgium and Finland". National Library of Medicine National Center for Biotechnology Information. Retrieved from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6035026/> (accessed August 14, 2022).
- [8] I. Frid. (October 22, 2020). "Why a new game classification in the app stores is in order". Appsflyer. Retrieved from <https://www.appsflyer.com/blog/mobile-marketing/game-classification-app-stores/> (accessed August 14, 2022).
- [9] S. Raikar. (November 10, 2022) "Puzzle". Britannica. Retrieved from <https://www.britannica.com/topic/puzzle> (accessed August 14, 2022).
- [10] "10 Reasons Why Playing Video Games is Good for Your Brain". (n.d). Record Head. Retrieved from <http://recordhead.biz/10-reasons-video-games-is-good-for-you> (accessed August 14, 2022).
- [11] A. Talathi. (April 23, 2018). "Strengths and Weaknesses of Android Based Applications". Medium. Retrieved from <https://medium.com/@anujatalathi82/strengths-and-weaknesses-of-android-based-applications-298b9fb46af9>. (accessed August 14, 2022).
- [12] J. Brodtkin. (June 3, 2013). "How Unity3D Became a Game-Development Beast". Dice. Retrieved from <https://insights.dice.com/2013/06/03/how-unity3d-become-a-game-development-beast/>
- [13] Blender. (December 1, 2019). Computer Hope. Retrieved from <https://www.computerhope.com/jargon/b/blender.htm> (accessed August 14, 2022).
- [14] K. Rockwell et al. (n.d). "Adobe Photoshop CS6 (2012)". kenrockwell. Retrieved from <https://kenrockwell.com/adobe/photoshop-cs6.htm> (accessed August 14, 2022).
- [15] "Android environment setup".(n.d) Unity Documentation. Retrieved from <https://docs.unity3d.com/Manual/android-sdksetup.html>. (accessed August 14, 2022)
- [16] "MEEGA+ A model for evaluating educational games".(n.d) Grupo de Qualidade de Software. Retrieved from <https://docs.unity3d.com/Manual/android-sdksetup.html>. (accessed August 14, 2022)
- [17] "10 Best Places to Visit in the Philippines".(n.d) Touropia. Retrieved from <https://www.touropia.com/best-places-to-visit-in-the-philippines/>(accessed August 14, 2022)
- [18] N. Indy. (April 29, 2016). "Top 10 Most Famous Animals in the Philippines". Pinoytopens. Retrieved from <https://topten.ph/2016/04/29/top-10-famous-animals-philippines/> (accessed August 14, 2022)
- [19] M. Radhakrishnan. (n.d). "Philippines Food: 10 Traditional Dishes That Every Traveler Must-Try At Least Once". Travel Triangle. Retrieved from <https://traveltriangle.com/blog/philippines-food/>(accessed August 14, 2022)
- [20] Zeng, W., Dong, A., Chen, X. et al. ViStory: interactive storyboard for exploring visual information in scientific publications. J Vis 24, 69–84 (2021). <https://doi.org/10.1007/s12650-020-00688-1>
- [21] Taylor, C.L., Kaufman, J.C. and Barbot, B. (2021), Measuring Creative Writing with the Storyboard Task: The Role of Effort and Story Length. J Creat Behav, 55: 476-488. <https://doi.org/10.1002/jocb.467>
- [22] Arora, V. (2022, August 29). What is a tree menu? Planet Crust. Retrieved January 20, 2023, from https://www.planetcrust.com/what-is-a-tree-menu?utm_campaign=blog
- [23] Steven Murdoch (2016) Agent-oriented modelling in the production of 3D character animation, Studies in Australasian Cinema, 10:1, 35-52, DOI: 10.1080/17503175.2015.1133486
- [24] Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. American journal of theoretical and applied statistics, 5(1), 1-4.
- [25] Google. (2023). Puzzyalan - Android apps on Google Play. Google. Retrieved January 25, 2023, from <https://play.google.com/store/search?q=puzzyalan&c=apps&hl=en&gl=US>

Smart Home: A Solar Powered Automated Door-lock, Lighting, and Plant Watering System using Arduino Mega

Justine V. Borja
Arvin T. Castillo
Allen B. Montoya
Earl John A. Reyes
Elgine, L. Salazar
Jose C. Santos
Jaypee B. Patdu, MIT (Technical Adviser)

Technology and solar energy usage have significantly improved over the years, a proof of that is the continuous advancement of technological devices invented that helped people in the daily living especially at home, appliances are being automated such as smart light devices using light level sensors and voice or sound activation. While the usage of solar energy gathered from the sun has also dramatically improved to the point that it can be used as a source of electrical supply to power up and operate all kinds of devices that requires electricity. By combining the concept of technological automation, solar energy, and use of microcontrollers, the researchers have come up with a study that aimed to develop a “Smart Home: A Solar Powered Automated Door-lock, Lighting, and Plant Watering System using Arduino Mega” that would benefit the users by providing a system that can help in preventing unwanted accidents like fire and burglary at home, while experiencing a convenient way of cost saving and managing the lighting, watering, and door locking system at home by automation, radio frequency remote controlling, manual tactile switches, and a mobile application to control all three (3) home devices. The use of prototyping methodology has greatly helped the researchers in gathering all the related studies and literatures that helped in identifying the required hardware components for the prototype and software applications for coding the programs installed into the microcontrollers and, in developing the mobile application of the study. By following the designed schematic diagram of the prototype, the researchers are able to build an actual prototype made of solar gathering components and microcontrollers with the help of connecting of electrical wires. While the storyboard helped the researchers in developing the mobile application using the MIT app inventor software and the arduino IDE software was the platform used in coding the programs that would then be installed to the arduino mega and nodemcu mini-Wi-Fi module. The researchers also created a series of test cases separately for the prototype and mobile application to ensure the functionalities of the two (2) are all working. Additional features on the mobile application are made during the refinement phase of the study before the integration of the prototype and mobile application, as well the installation of the prototype system into the wooden miniature model house. The researchers concluded that the “Smart Home: A Solar Powered Automated Door-lock, Lighting, and Plant Watering System using Arduino Mega” met all the requirements stated in the study’s objectives and scope. With the evidence made by the researchers, the research project was successfully achieved. With this, a certain recommendation includes the feature to use the mobile application to conveniently connect to a Wi-Fi connection without having to manually include the said and password into the Wi-Fi module’s program, as well including additional home devices to control and automate, such as an electric fan.

INTRODUCTION

As stated by Fox M. A. (2016), home has always been a gathering place, a safe haven, and a refuge from the busyness and intrusiveness of the outside world. Home has been the subject of numerous written works and other cultural products because it has been much thought about, treasured, and longed for as an anchor of our existence. It carries many and varied

symbolic meanings embedded in the physical design of houses and projected onto them by the belief systems within which our lives play out, as an ideal that exists in the imagination, dreams, and wish fulfillment [1].

According to Swap (2022), with the advancement of technology, society’s way of living has been significantly changed; this is because nowadays, living had become difficult,

and daily duties had taken up too much of our time to the point where people have to choose what things or responsibilities should be prioritized. Due to this, technology has become an essential part of human life. Living have substantially improved as a result of the convenience and efficiency offered by the modern devices that had been invented [2].

Giles A. et. al. (2017) mentioned that, due to the continued improvements in of the technological capabilities, people are able to discover a new source of energy called solar energy which is collected from the Sun and then can become as an alternative to the use of electrical energy to supply power to electrical devices to operate [3].

As reported by Umali T. (2018), today here in the Philippines, the government is starting to make programs that indicate the plan to adapt and use advanced technological devices and machines to further improve the economy and make daily living comfortable and convenient [4].

Confirming to Ronquillio (2022), every aspect of a person's life is now infused with technology to the point where it is impossible to function without it. Even homes now have a place for it. Air conditioners followed by remote-controlled televisions are the first. Currently, technology is advancing by automating nearly every aspect of a home [5].

Background of the study

People are now living in a modern era where almost everything that are used is installed with technological features, and people nowadays are getting busier, work schedules are getting more complex. With the aid of automation, users can now concentrate more and handle more duties, this study would undoubtedly assist users in making daily house chores like plant watering and switching the lights more manageable and easier to complete. Additionally, the study would also help prevent unwanted accidents at home such as fire outbreaks caused short-circuited electric wires and break-ins from uninvited strangers which can help lessen the worries of the user, especially the elderly people that tends to become forgetful of things due to the developed mental health problems that comes from old age and people with physical disabilities (PWDs) that requires extra effort in performing

certain task like reaching for the light switch or door lock, that could result in the event of forgetting or being unable to turn off or on the lights and lock the door at home that could lead to accidents.

As described in CompTIA's IoT ecosystem framework in Sections 1 and 2 (2016), Internet of things is more than a product or service, or even a collection of a few products or services. Many elements must come together for Internet of Things to deliver expected benefits. Strong majorities of business and IT executives view IoT more positively today compared to a year ago, suggesting these elements are starting to fall into place. Furthermore, with 6 in 10 organizations claiming to have some type of IoT initiative underway, this certainly seems to be the case. [9]

This is why the researchers decided to create an Internet Of Things-based study and develop a device prototype that can utilize the use of three (3) basic home devices which can be powered by solar energy and controlled wirelessly with the use of a mobile application and radio frequency remote controller that can help the user on the daily living by automating and conserving the energy consumption efficiently at home.

Objectives of the study

The general objective of the study was to develop and design an IOTs-based solar-powered automated home devices system titled "Smart Home: A Solar Powered Automated Door-lock, Lighting, and Plant Watering System using Arduino Mega."

To gather and review related literature, studies, and tutorials from the internet to construct a multifunction smart blind using raspberry pi with the essential IoT devices.

To identify the required hardware and software needed for the study.

To design the flow process of the study using conceptual framework.

To build the IOTs-based prototype by following the designed Schematic diagram.

To test the following using Test cases created by the researchers and validated by an IT expert.

To integrate the Finalized IOTs-based Prototype system and mobile application that are tested using test cases.

Scope and limitation of the study

The development of the study entitled “Smart Home: A Solar Powered Automated Door-lock, Lighting, and Plant Watering System using Arduino Mega” started after the researchers studied and reviewed all the gathered related information needed to identify the required hardware components for the prototype and software applications for the codes used in the mobile application. By following the flow process designs for the study, the researchers first built the prototype by connecting the micro-controllers, sensors, solar gathering components, and electrical wirings altogether based on the schematic diagram. Using the arduino IDE, the codes needed for the arduino mega and Wi-Fi module was created. The researchers used an application called MIT app inventor for coding and developing the mobile application that was based on the storyboard created.

The study would develop a smart home prototype not only to provide comfort and security for the users’ especially elderly people and PWDs, but also to help people understand and become aware of the effectiveness of solar energy as a substitute electrical power source and the unlimited potential of using technology to automate devices not only at home, also anyplace that can be installed with smart devices.

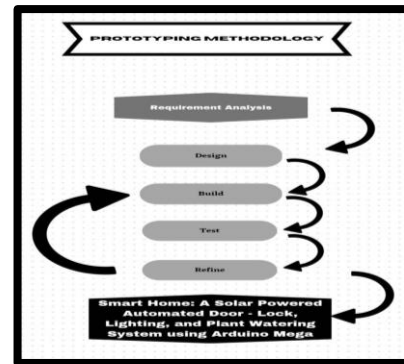
In the economic context, home automation using solar energy will definitely increase the value of the property, aside from the fact that using solar energy is very useful to cut utility costs over time, for instance, the smart lights save energy and the watering system will definitely prevent exorbitant water bills, safety is also a major concern that will be addressed since automated door and lightings thwart would-be burglars, it also provides convenience because home automation technology performs routine tasks on regular home processes automatically which is a great convenience to the end-users, in this case, this project is a promising business venture in the future that will surely attract people that will want to experience the benefit and the convenience of having a smart home.

In the environmental context, solar-powered smart home devices when implemented on a large scale has the potential to significantly

affect the pace of climate change because among the energy sources we use today, solar energy has the least negative impact on the environment. It does not provide ozone-harming substances and does not pollute water and one of the major benefits on the environment is that it does not create any sound, the fact that solar energy production produces no noise is a significant advantage.

SYSTEM DEVELOPMENT METHODOLOGY

The section includes a lot of techniques, generalizations, or findings, finished theses, and closely connected ideas. It talks about pertinent study and works that helped the researchers create the suggested system.



Prototype Model

Requirements

In this Phase, the researchers had brainstormed ideas, conducted interviews to people living in Mabalacat City that are familiar and uses solar energy gathering panels, as well as automated home devices such as automated lights that turn on during nighttime, by the researchers to gain a better understanding on the beneficial effects of using solar energy and home automation. The researchers also searched the internet, studied related studies, and watched video tutorials that could help in gaining additional insights of the process and principles of solar energy usage, home automation using IOTs-based technology, and software applications. After analyzing and reviewing all the gathered information, the researchers were able to identify what IOT based hardware components will be needed in building a prototype model for the study. As well as the various software applications

required in creating programs and database for both the prototype and application.

APPENDIX G

Smart Home Software and Hardware Requirements

Software Requirements

Software Application	Function
Arduino IDE	Coding/Programmer
MIT App Inventor	Mobile Application blocks
MIT App Companion	Application tester
Google Firebase	Database Account

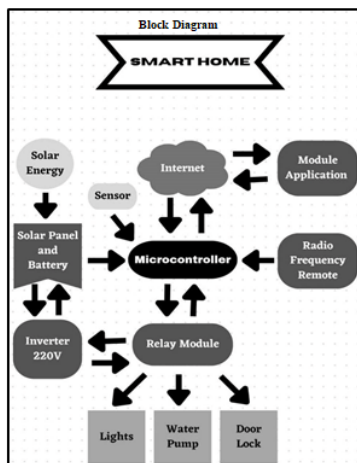
Hardware Requirements

Micro Controllers and Sensors	Functions
Arduino Mega 2560	Micro controller Board
NodeMCU Mini	Wi-Fi Module
Moisture Sensors	Detects Moisture Content
Mini Water Pump	Watering System
Light Sensors	Detects Light level
Solenoid Lock and RF Remote	Door Lock system
Tactile Switches and PCB	Manual Override

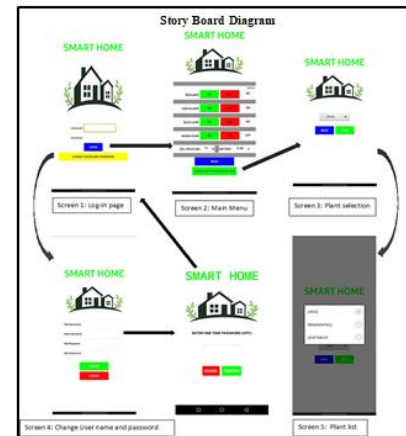
Quick Design

After the review and study of all the collected related information, as well the identification of required hardware and software components. The researchers were able to obtain the essential knowledge and ideas to proceed in the creation of the prototype and mobile application's designs. This is achieved by creating a sketch of a quick or simple design of both the planned prototype and application based on the specified objectives for the study. The use of conceptual framework helped the researchers in planning the phases of the study.

APPENDIX E



APPENDIX F

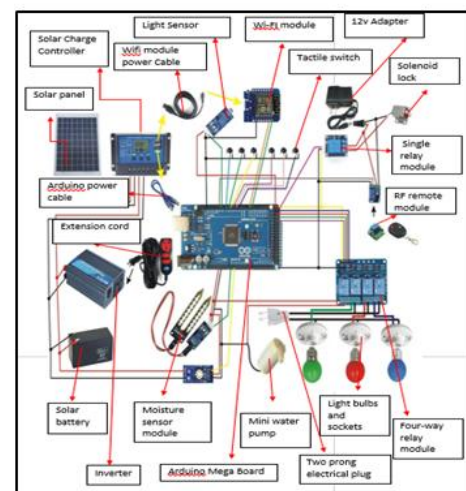


Build Prototype

The researchers had begun building the actual experimental prototype and mobile application in this phase. By following the designed schematic and block diagrams, they were able to create a working prototype by connecting all the needed home devices like light bulbs, receptacles, micro controllers, and sensors with the help of linking them to the bread board and electrical wires. The arduino IDE was used in coding the programs and was installed on both the arduino mega board and ESP8266 Wi-Fi module respectively, which were all needed for the prototype's features such as lighting, watering, door lock, and Wi-Fi connectivity. These functions were all successfully activated by the researchers thru the use of the solar energy collecting panel, battery, charge controller, and a 220 volts inverter that powered up the experimental prototype. A miniature house model made of wood materials was also built during this phase.

APPENDIX D

Schematic Diagram



Refining Prototype

The researchers would proceed to the refining phase if there are any changes and adjustments that are needed for the experimental prototype and mobile application. This is done by reflecting to the suggestions and recommendations of the three (3) experts that tested the prototype and mobile application, the researchers would have to rebuild and re-examine the positions of the installed microcontrollers, hardware components and, electrical wirings of the prototype to ensure all electrical wirings are connected to the correct hardware components base on the schematic diagram to avoid possible malfunction that could occur to the prototype.

Refining the Mobile Application's User Interface
Mobile application user interface refinements.



Figure 1.

Figure 2.

The figure 1 shown above was the first user interface design for the username and password log-in for the mobile application, while figure 2 shows was the refined user interface. The researchers included a background image and title text that can be seen in the mobile application.



Figure 3.

Figure 4.

The figures 3 and 4 shown above are the additional feature included by the researchers, the option for the user to change username and password authentication using a one-time pin (OTP) code sent to the registered cellular number.



Figure 5.

Figure 6.

The researchers also refined the main control user interface of the mobile application shown by the figure 5 & 6, a text "STATUS" is included in the right side to label the status monitoring of the lights and water pump switches. Also, the icon of the option to change plant and soil moisture level was replaced by a bar with a text labeled "CHANGE PLANT TYPE AND MOISTURE LEVEL".



Figure 7.

Figure 8.

The figure 7 & 8 shows the background image and title text was also included and can be seen in the plant type and moisture level option.

RESULTS AND OUTCOMES

Testing Of Prototype's Features Final smart home prototype



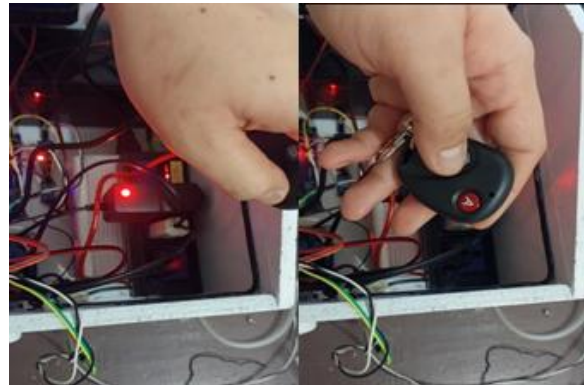
The upper-left figure shows the manual tactile buttons installed at the side of the prototype. The upper-right figure shows a top view and solar panel of the prototype. The lower -left figure shows the front view of the prototype. Lastly, the lower – right figure shows the inside of the prototype, the microcontrollers, electrical wirings, solar battery and charge controller are placed inside.

Automated mode using light sensors for the lighting system of the prototype



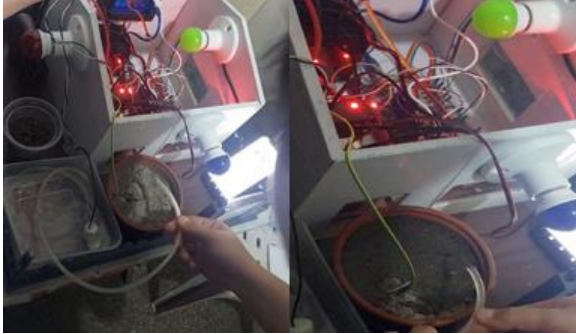
The figures show one of the researchers holding the light sensor of the prototype to make sure the sensor would properly operate. The left figure shows the three (3) light bulbs are still turned off due to the reason of the light sensor still detects the required brightness level. While the right figure shows the researcher turned off the light, the light sensor detected the low light level that is why the light bulbs are turned on.

Door lock system using radio frequency (RF) remote control

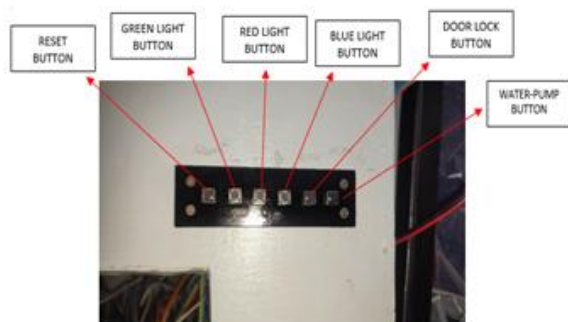


The figures shown above are one of the researchers testing the door lock system of the prototype using the radio frequency remote connected to the solenoid lock's radio antenna installed in the relay module. The left figure shows one of the researchers pressing the red button with a letter "A" to unlock the solenoid door lock system installed in the prototype. The right figure shows the researcher pressed the gray button with letter "B" to activate and lock the solenoid of the door lock system.

Automated plant- watering system using mini water pump and moisture level sensor



The researcher planted the moisture level sensor into a plant vase with dry soil to see if the sensor would detect the lack of water. The water pump was activated due to lack of water to the plant vase, it began watering the plant pot and stopped watering upon reaching the set maximum moisture level required.



Manual switches using tactile buttons installed in printed circuit boards (PCB)

The tactile manual button switches installed in the prototype. The tactile buttons can be turn on or off the lighting, watering, and door lock system of the prototype by pressing the assigned buttons for each feature. While tactile button labeled above as the reset button can be pressed to return all the prototype's features to automated mode using light and moisture sensors for the lighting and watering system. As well, the ability to lock and unlock the solenoid of the door lock system.

Lighting system



Manually turning on the green light bulb by pressing the assigned tactile button.



Manually turning on the red-light bulb by pressing the assigned tactile button.



Manually turning on the blue light bulb by pressing the assigned tactile button.

Door lock system



Manually unlocking the solenoid lock by pressing the assigned tactile button.

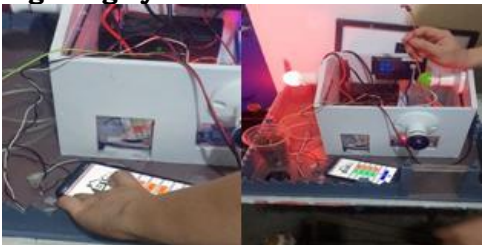
Reset prototype back to automated mode for lighting, watering, and radio frequency controlled locking system

Controlling the lighting and watering system using the mobile application user interface

The developed mobile application can remotely turn on and off the lighting and watering system using WI-FI connection and the

installed Wi-Fi module of the Smart Home prototype.

Lighting system



Turning ON the red light bulb using the assigned virtual button in the mobile application.



Turning ON the green light bulb using the assigned virtual button in the mobile application.

Watering System

The developed mobile application for the Smart Home prototype can also remotely activate the pump installed in the prototype. the application also has a monitoring feature of the moisture level of the soil where the moisture sensor is placed and, the option to choose from three plant type with set amount of required moisture level content was also included the mobile application’s features. Plant type feature of the mobile application, the user can choose from grass, ornamentals, and vegetable plant with individual moisture level content requirement set for each plant type selection. Monitoring the moisture level content of the soil where the moisture sensor is placed on. The soil moisture content changed from 11% to 37 % after the soil was watered using the mini water pump. By pressing the assigned virtual button of the water pump in the mobile application. The mini water pump was activated and began to pour water taken from the plastic container.



Testing Results

Table no. 1 Prototype Test Case

Step	Action	Expected Findings	Number of trials conducted	Successful trials	Result
1	Check if the solar battery charges when the solar panel exposes to the sun.	The battery indicator must show that the battery charges successfully.	1		
2	Check if all the lights turn on when the sensor detects darkness.	All lights must turn on when the sensor detects darkness.	10		
3	Check if all the override switches in each light	Each light must successfully turn on or off using the	10		

	success fully turn them on or off.	tactile switches of each light.	
4	Check if the solenoi d lock respon ds when the remote control clicks.	The remote control must success fully open or close the door lock within its range.	10
5	Check if the manual button in the tactile switch will success fully lock or unlock the door.	The door lock must respond accordi ngly when controll ed by its manual switch.	10
6	Check if the water pump will pour water if the soil moistur e sensor detects below the set temper ature level.	The water pump must success fully release water if the soil moistur e sensor detects below the set tempera ture level.	10

7	Check if the water pump will turn off when reaches the maxim um soil temper ature sets for the certain plant	The water pump must turn off and stop pouring water upon reachin g the maximu m tempera ture sets.	10
8	Check the manual switch of the water pump if it is success fully workin g.	The water can be poured into the soil using the manual switch.	10

The table 3 shown above are tables containing a series of test case questions created by the researchers for the actual testing conducted and validated during this phase by two (2) electrical engineering and one (1) mobile application developer, in order to ensure the Schematic diagram of the experimental prototype is followed as well, the story board for the mobile application. The two (2) experts in electrical engineering will examine whether the microcontrollers and hardware components are all properly installed and connected with the electrical wirings, as well the features are functioning correctly to produce outputs based on the design of the prototype.

DISCUSSIONS

This section consists of the summary of findings, conclusions and recommendations based on the results of the study entitled “Smart Home: A Solar Powered Automated Door-lock, Lighting, and Plant Watering System using Arduino Mega.

Summary of Findings

The researchers were able to achieve the stated objectives in the study entitled “SmartHome: A Solar Powered Automated Door-lock, Lighting, and Plant Watering System using Arduino Mega” by gathering and reviewing all the related information, which helped the researchers in better understanding the concept of solar energy as an alternative power source at home and the use of automated home devices.

With the researchers gaining the required knowledge needed for the study, identifying the hardware components essential in building the prototype and the various software to use for coding the programs and setting up of the database were achieved.

The researchers were able to clearly visualize and create a quick design of a conceptual framework for the study, while the prototype and application features are developed with the help of designing tools like block diagram for the operating process of the prototype and mobile application. A schematic diagram is created for guiding the researchers in assembling the microcontrollers and hardware devices with electrical wiring connections, with a story board for designing the layout of the mobile application’s user interface which helped greatly in ensuring that all the planned features and recommendations were applied and achieved when the finalized prototype is made.

The researchers were able to build the actual prototype that has all the planned functionalities of automated lights, watering system, and a radiofrequency (RF) remote controlled door lock which can be controlled by a mobile application (except for the locking system), and manual tactile switches which are able to communicate to the prototype and database with the use of internet access or Wi-Fi connection.

The researchers were assisted by two (2) electrical engineers and one (1) mobile application developer to conduct and validate a series of test cases to examine and suggest if additional refinements were needed for both the prototype and mobile application. Also, the three (3) testers verified that all the functions are working properly while also communicating to each other with the use of a Wi-Fi

connection. These were also the reason researchers were able to confirm that usage of solar energy is possible and can become beneficial due to the energy used is not from the electrical supply but instead, came from the gathered solar energy. This means that using solar energy gathered from the sun can lessen energy consumption when used as an alternative source of electric supply at home, while automation of home devices could help users especially the elderly and people with disabilities (PWDs) in doing daily chores like reaching for the light switches, watering the plants, and locking the door, since most elderly people are forgetful due to old age and PWDs would have difficulties of performing the tasks mentioned.

The researchers were also able to fulfill the requested adjustment of Mr. Pineda, one of the panel members of the study, by including the username and password change in the mobile application. The researchers also adjusted the text title seen in the log-in screen of the mobile application as well, add a text “status” in the status display bar and remove the icon button for plant type and moisture level option of the mobile application.

Finally, the researchers were able to integrate the prototype system to the miniature model house and were able to successfully establish connections wirelessly between the finalized prototype and mobile application with use of a Wi-Fi or internet access. With this, the researchers were able to produce a finalized prototype of lighting, watering, and RF controlled door lock systems which are all able to be set as automated, manually used by override switches, and controlled with the use of a mobile application (except for the door lock) while being powered by solar energy.

Conclusions

The researchers concluded that the “SmartHome: A Solar Powered Automated Door-lock, Lighting, and Plant Watering System using Arduino Mega” met all the requirements set forth in the study’s objectives and scope.

The researchers used test cases to test the hardware and software functionalities. Based on the test case responses from the testers, both hardware and software worked properly.

The developers created a working mobile application, which included a username and

password that can be change by the user as well, a one time pin (OTP) code sent to the registered cellular sim card in case the user wanted to change credentials.

The researchers were also able to double-check with the assistance of Engineer Santos and Engineer Montoya, the jump wire and electrical wires used in various modules to ensure proper wiring.

Researchers guarantee that all the prototype's features the users utilized are in perfect functioning order. The researchers put the prototype and mobile application through a testing process. The testers could determine and validate whether the prototype and mobile application are in good working order.

For a better appearance, the researcher placed the hardware components and wirings inside the miniature model house, while the solar panel, inverter, mini water pump, light and moisture sensors were placed outside the miniature model house. The researchers also added a manual tactile switch at the side of the model house that the user could use in case the mobile application is not usable.

Recommendations:

The researchers considered the following recommendations for future improvements of the developed smart home prototype and mobile application.

1. Additional smart devices to include to the prototype. Future researchers can include a smart electric fan, window blinds, and device that can be automated or controlled using microcontrollers.
2. Include scheduled activation timer for lighting and watering system in the mobile application.
3. Improve the graphical user interface (GUI) of the mobile application based on the additional smart devices to be included by the future researchers.
4. Develop a version of the mobile application that is compatible to IOS mobile devices.
5. Include a feature to use the mobile application to conveniently connect to a Wi-Fi connection without having to manually include the SSID and password into the Wi-Fi module's program.
6. Upgrade the battery to a larger capacity to store solar energy that could extend the

operating hours of the prototype. Also, to accommodate higher wattage of bigger light bulbs for the lighting system of the prototype.

REFERENCE

- [1] Fox M. A. (2016). Importance of home to us. Retrieved from <https://blog.oup.com/2016/12/home-place-environment/>
- [2] Swap (2022). Importance of technology. From <https://slidingmotion.com/why-technology-is-important/>
- [3] Giles A. et. al. (2017). The importance of solar energy. Retrieved: <https://venturesolar.com/blog/the-importance-of-solar-energy/>
- [4] Umali T. (2018). Philippine economy to grow faster with technology. Retrieved from <https://opengovasia.com/philippine-economy-to-grow-faster-with-technology/>
- [5] Ronquillo (2022). Smart homes. From <https://www.manilatimes.net/2022/10/04/business/real-estate-and-property/smart-homes/1860805>
- [6] Solaric Philippines (2022). Solar energy in the Philippines. Retrieved: <https://solaric.com.ph/solar-energy-philippines/#:~:text=In%20our%20country%2C%20solar%20energy%20is%20harvested%20from,sun%20is%20definitely%20important%20to%20Earth%20and%20mankind.>
- [7] Citicore Energy (REIT) Corp. (2022). Clark solar plant. From <https://creit.com.ph/our-portfolio/power-generation/clark-solar-plant/>
- [8] Ghaza B. and Al-Khatib K. (2016). Smart Home Automation System for Elderly, and Handicapped People using XBee. Retrieved: https://www.researchgate.net/profile/Bilal-Ghazal/publication/283232425_Smart_Home_Automation_System_for_Elderly_and_Handicapped_People_using_XBee/links/56a4932608ae1b6511325349/Smart-Home-Automation-System-for-Elderly-and-Handicapped-People-using-XBee.pdf
- [9] CompTIA. (2016). Internet of Thing. Retrived from <https://www.comptia.org/content/research/internet-of-things-insights-and-opportunities>
- [10] Singh U. (2021). Home Automation. Retrieved: <https://www.geeksforgeeks.org/what-is-home-automation/>
- [11] Kundariya H. (2019). Exploring the benefits of smart home automation on a global scale. Retrieved: <https://www.iotcentral.io/blog/exploring-the-benefits-of-smart-home-automation-on-a-global-scale>
- [12] U. S. Energy Information Administration (2022). Solar energy and the environment. Retrieved from <https://www.eia.gov/energyexplained/solar/solar-energy-and-the-environment.php>
- [13] Wardini J. (2019). How smart homes impact our lives. Retrieved from <https://www.bbntimes.com/technology/how-smart-homes-impact-our-lives>
- [14] Brown S. (2022). What is Android? Here's everything you need to know. Available:

- <https://www.androidauthority.com/what-is-android-328076/>.
- [15] Arduino Mega. <https://robu.in/what-is-arduino-mega/>
- [16] Arduino Integrated Deveopment Environment. <https://www.arduino.cc/en/Guide/Environment>
- [17] Automation. Retrieved from <https://www.servicenow.com/now-platform/what-is-automation.html#:~:text=Simply%20put%2C%20automation%20is%20the%20ability%20to%20use,up%20human%20workers%20to%20focus%20on%20other%20responsibilities>
- [18] Stevenson D. (2018). What is Firebase? Available: <https://medium.com/firebase-developers/what-is-firebase-the-complete-story-abridged-bcc730c5f2c0>]
- [19] Hope C. (2019). Graphical User Interface. Available: <https://www.computerhope.com/jargon/g/gui.htm>
- [20] Ranger S. (2019). What is the IoT? Everything you need to know about the Internet of Things right now. Available: <https://www.zdnet.com/article/what-is-the-internet-of-things-everything-you-need-to-know-about-the-iot-right-now/>.
- [21] Microcontroller. <https://www.techopedia.com/definition/3641/microcontroller>.
- [22] Mobile Application. <https://www.techopedia.com/definition/2953/mobile-application-mobile-app>.
- [23] Old age. <https://www.britannica.com/science/old-age>
- [24] Person with Disability (PWDs). <https://wecapable.com/persons-with-disabilities-definition-rights-states-and-more/>
- [25] Smart Home. <https://www.investopedia.com/terms/s/smart-home.asp#you-need-to-know-about-the-iot-right-now/>.
- [26] Solar Energy. <https://education.nationalgeographic.org/resource/solar-energy>
- [27] Martindale J. (2019). What is wifi? Available: <https://www.digitaltrends.com/computing/what-is-wi-fi/>.
- [28] Banzi M. et. al. Arduino Mega 2560. From <https://store.arduino.cc/products/arduino-mega-2560-rev3>
- [29] Marketlab Electronics. Relay 5V 4 Channel. Retrieved from <https://www.makerlab-electronics.com/product/4-channel-relay-module-spdt/>
- [30] Rhudolabz Embedding Intelligence. Breadboard Mini appliances. From <https://www.rhydolabz.com/prototyping-c-126/mini-breadboard-selfadhesive-blue-p-537.html>
- [31] Storr W. (2022). Light Sensor. retrieved from https://www.electronics-tutorials.ws/io/io_4.html
- [32] Robotic Technology Center (2015). 200mm M/F Jumper Wires. From <https://www.robotpark.com/200mm-F-M-40-Pin-Jumper-Wire>
- [33] Robotic Technology Center (2015). 200 M/M jumper wires. From <https://www.robotpark.com/200mm-M-M-40-Pin-Jumper-Wire>
- [34] Elecrow. Remote control RF 1 channel. Retrieved from <https://www.elecrow.com/1-channel-rf-remote-control-module-ac-110v-220v-p-1399.html>
- [35] Takigen MFG Co., LTD. Door lock solenoid. From <https://www.takigen.com/products/list/L-002>
- [36] William and Wang (2015). Relay 5V 1 channel. Retrieved: <https://www.bananarobotics.com/shop/1-Channel-5V-Relay-Module#:~:text=The%201%20Channel%205V%20Relay,the%20status%20of%20the%20relay>
- [37] Marketlabs Electronic (2020). Adaptor 12V 3.2A. From <https://www.makerlab-electronics.com/product/12v-2a-power-adapter/>
- [38] Omron Corporation (2022). Tact medium switch. Retrieved from https://components.omron.com/sg-en/products/switches/tactile-switches/tactile-switch_features
- [39] John (2015). Mini-water pump and tube. From <https://www.ourpcb.com/mini-water-pump.html#:~:text=As%20the%20name%20suggests%2C%20a,using%20a%20battery%20or%20solar>
- [40] University of Minnesota Extension (2019). Soil moisture sensor. Retrieved from <https://extension.umn.edu/irrigation/soil-moisture-sensors-irrigation-scheduling>
- [41] Gannon M. (2018). What are the flat cables? Retrieved from <https://www.wireandcabletips.com/what-are-flat-cables/>
- [42] Sharariar (2016). Inverter 500w. From https://create.arduino.cc/projecthub/PSoC_Rocks/integrated-solar-chargecontroller-inverter-powerbank-lamp-e4c1d6?offset=4&ref=tag&ref_id=solar
- [43] Cafemedia Publisher (2022). Battery. From <https://www.batteryequivalents.com/12v-7ah-rechargeable-batteries.html>
- [44] Ohl R. 9 (2015). History of Solar Panel. Retrieved from <https://www.mrsolar.com/what-is-a-solar-panel/>
- [45] Shahariar (2016). Solar Charge Controller. From https://create.arduino.cc/projecthub/PSoC_Rocks/integrated-solar-chargecontroller-inverter-powerbank-lamp-e4c1d6?offset=4&ref=tag&ref_id=solar
- [46] TechTarget Contributor (2013). Printed circuit board. From <https://www.techtarget.com/whatis/definition/printed-circuit-board-PCB>
- [47] Markerfabs (2021). Nodemcu mini wi-fi module. <https://www.makerfabs.com/nodemcu-mini.html>
- [48] Nitin (2020). What is electrical wire color coding. Retrieved from <https://www.contractorbhai.com/what-is-electrical-wire-color-coding/>
- [49] David (2022). Standard wire. Retrieved from <https://www.pcmag.com/encyclopedia/term/stranded-wire>
- [50] Collins (2020). What is electrical wire color coding? From <https://www.collinsdictionary.com/dictionary/english/bulb#:~:text=countable%20noun,2>.

- [51] Petersen C. (2022). What is bulb socket? From <https://www.easytechjunkie.com/what-is-a-bulb-socket.htm>
- [52] Massachusetts Institute of Technology (2022). MIT app companion. From <https://appinventor.mit.edu/explore/ai2/setup-device-wifi.html>
- [53] Jones C. "What is the voltage of Household electricity?" <https://homesteady.com/12566975/what-is-the-voltage-of-household-electricity>
- [54] Arduino Integrated Development Environment. From <https://docs.arduino.cc/software/ide-v1/tutorials/arduino-ide-v1-basics>
- [55] Omisola I. (2021). What is Google Firebase?. <https://www.makeuseof.com/what-is-google-firebase-why-use-it/>
- [56] Massachusetts Institute of Technology (2022). MIT App inventor. Retrieved from <https://appinventor.mit.edu/explore/about-us.html>
- [57] Patton E. et. al. (2019). MIT app Inventor: Objectives, design and development. From https://link.springer.com/chapter/10.1007/978-981-13-6528-7_3
- [58] AndreasB81 (2022). Create a small wood house. Retrieved: <https://www.instructables.com/Create-a-Small-Wood-House/>
- [59] Hackster.io (2021). Integrate Solar Charge Controller. Form https://create.arduino.cc/projecthub/PSoC_Rocks/integrated-solar-chargecontroller-inverter-powerbank-lamp-e4c1d6?offset=4&ref=tag&ref_id=solar
- [60] Mr. X (2021). Automatic Irrigation System using a adruino Uno. From <https://circuitdigest.com/microcontroller-projects/automatic-irrigation-system-using-arduino-uno>
- [61] Engr. Fahad (2019). Remote controlled door lock using Arduino and electronic lock. Retrieved from <https://www.electronicclinic.com/remote-controlled-door-lock-using-arduino-electronic-lock/>
- [62] Rodenburg J. (2021). How does solar power work? from <https://www.literoflightusa.org/solar-panel-diagrams/>
- [63] The coding bus (2020). How to create login and signup MIT app inventor using firebase? From https://www.youtube.com/watch?v=_boq4iZKucs&t=2s
- [64] The coding bus (2020). How to connect firebase with MIT App Inventor 2? From https://www.youtube.com/watch?v=ES26E4r_uEU&t=73s
- [65] Santos R. (2022). Tutorial of Installing ESP8266 Board in Arduino IDE. Retrieved: https://randomnerdtutorials.com/how-to-install-esp8266-board-arduino-ide/?fbclid=IwAROpI32Kz96M_NPZEI9EdwduhqLJIHkO4VC0UVr1IFC9oaRUUnfbFYQw8kmo
- [66] Logs A, (2022). Home automation using nodemcu esp32. From <https://www.youtube.com/watch?v=tOKTNex2wwA&t=16s>
- [67] Wang S. Technology to Support Aging in Place: Older Adults' Perspectives. <https://www.mdpi.com/2227-9032/7/2/60/htm>
- [68] Smart Home Automation System for Elderly, and Handicapped People using XBee. https://www.researchgate.net/profile/Bilal-Ghazal/publication/283232425_Smart_Home_Automation_System_for_Elderly_and_Handicapped_People_using_XBee/links/56a4932608ae1b6511325349/Smart-Home-Automation-System-for-Elderly-and-Handicapped-People-using-XBee.pdf
- [69] Smart Door Lock System. https://www.researchgate.net/publication/332538718_Smart_Door_Lock_System
- [70] Automatic lighting and security system design using pir motion sensor. https://www.researchgate.net/publication/303314563_AUTOMATIC_LIGHTING_AND_SECURITY_SYSTEM_DESIGN_USING_PIR_MOTION_SENSOR
- [71] Smart Irrigation Technology: Controllers and Sensors. <https://extension.okstate.edu/fact-sheets/smart-irrigation-technology-controllers-and-sensors.html>
- [72] Brush B. et. al. (2016). Home Automation in the Wild: Challenges and Opportunities. https://www.microsoft.com/en-us/research/wp-content/uploads/2016/02/HomeOSCHI_cameraready_Final.pdf
- [73] Bhavna and Dr. Sharma (2018). Smart Home Automation Using IOT
- [74] Aniley A. (2018). Soil Moisture Sensors in Agriculture and The Possible Application of Nanomaterials In Soil Moisture Sensors Fabrication. https://www.researchgate.net/publication/328539067_SOIL_MOISTURE_SENSORS_IN_AGRICULTURE_AND_THE_POSSIBLE_APPLICATION_OF_NANOMATERIALS_IN_SOIL_MOISTURE_SENSORS_FABRICATION
- [75] Albertus B. (2021). Solar Features Study. From <https://energy.mit.edu/wp-content/uploads/2015/05/MITEI-The-Future-of-Solar-Energy.pdf> <https://www.energy.gov/sites/default/files/2021-09/Solar%20Futures%20Study.pdf>
- [76] Khawas and Shah (2018). Application of Firebase in Android App Development – A Study. https://www.researchgate.net/publication/325791990_Application_of_Firebase_in_Android_App
- [77] Regionel P. (2015). Conceptual Framework: A step by step guide on how to make one. Retrieved from <https://simplyeducate.me/2015/01/05/conceptual-framework-guide/>
- [78] Lewis S. (2019). Prototyping model. Retrieved from <https://www.techtarget.com/searchcio/definition/P-rototyping-Model#:~:text=The%20prototyping%20model%20is%20a,or%20product%20can%20be%20developed>
- [79] Soil moisture level chart. <https://www.acurite.com/blog/soil-moisture-guide-for-plants-and-vegetables.html>

SPOTIHOUSE: A 3D Simulation Model of Online Fiesta Communities House Listing with Site Map

Enjelyn T. Cordero
Nathaniel P. Corvera
Rosando T. Elli
Aljay B. Francisco
Rail Justin L. Ibanez
Ace E. Mallari
Marilou B. Cabuñag (Technical Adviser)

ABSTRACT

The online House listing industry is competing to offer more detailed accessibility and improved search choices, which helps tenants as a tap of a finger offers more valuable information. FIESTA Communities, Inc. was created with the intention of providing the working class in the Philippines with inexpensive housing and improving lives. The general objective of the study is to develop a system entitled "A 3D Simulation Model of Online Fiesta Communities House Listing with Site Map " that can make it easier for people looking for a place to live and people who wants to visit the Communities without having to go directly to fiesta communities. The researchers utilized and used the Modified Waterfall Model methodology as a guide in the system development. The researchers create a 3D simulation model of an online Fiesta Communities house listing with a site map that is web-based. Based on the client's design, this website provides a unique 3D house design as well as specifics about the home, such as the property type, sale type, house sizes, bathroom, kitchen, bedrooms, and the number of rooms. The system was evaluated based on its functionality, reliability, portability, usability, performance, security, compatibility, and maintainability. The alpha test garnered an overall mean score of 4.6 and the beta test garnered an overall mean score of 4.98, both tests had been verbally interpreted as "Strongly Satisfied". After considering all the data, the researchers concluded that the overall objective of the study had been met.

INTRODUCTION

The online House listing industry is competing to offer more detailed accessibility and improved search choices, which helps tenants as a tap of a finger offers more valuable information. As rental applications grow, they not only make it easier to locate available apartments but also provide prospective landlords with financial details from renters and allow tenants to pay rent after a lease has been signed [1].

There will be a website to be made exclusively for the researchers' consumers on the exterior design for various house models. The website will contain unique features such as the menu, about the researchers, contact details, and list of products for them to choose from. It comes with assorted options from Normal, Suite and Deluxe.

Several interrelated factors, including facility, price, reference, location, operation, protection, reputation, and advertisement, mainly account for the difficulty of boarding searches. The

rental price, for instance, would be influenced by the distance from the campus of the boarding house, the facilities, and the services offered at the boarding house. Although there are many suggested applications for boarding houses, most of them only show pictures, prices, and other facilities defined by the owner. The popularity of smart mobile devices is growing fast [2].

The "Spotihouse" was created to overcome the shortcomings of the existing manual approach. This program is supported in order to eliminate and, in certain situations, decrease the difficulties encountered by the current system. Furthermore, this system is tailored to the company's specific requirements for smooth and efficient operations. The program is kept as simple as possible to prevent data entry mistakes. It also displays an error notice when inputting incorrect data. The user does not require any formal expertise to utilize this system. Hence, all of this demonstrates that it is user-friendly. As previously explained, the

Fiesta House Management System may result in an error-free, secure, dependable, and rapid management system. It might help the user focus on their other tasks rather than record keeping. As a result, it will assist organizations in making better use of their resources.

Every firm, large or small, faces issues in handling information about Property Type, Property, Flats, Facilities, and Location. Because each Real Estate Management System has unique property requirements, they provide custom personnel management systems that are tailored to their managerial demands. This is intended to aid in strategic planning and will assist them in ensuring that their business has the appropriate degree of knowledge and specifics for their future goals. Furthermore, for those busy executives who are constantly on the road, our systems have remote access tools that will allow them to manage their staff at any time and from any location. These solutions will eventually enable them to better manage their resources [3].

Background of the study

FIESTA Communities, Inc. was created with the intention of providing the working class in the Philippines with inexpensive housing and improving lives. Clients who want to visit Fiesta Communities do not need to go to the location itself because it can be seen in greater detail on the internet while they are lying down. Clients can also see the appearance of the houses and see the house more precisely, as if it were already there in the exact place where it is located. Fiesta communities is a real estate, it has a total of 14 communities, and they have a total of 11 models of houses [4].

It has become crucial to find a house, condo, apartment, etc. Owing to the pandemic, many, particularly today, do not want to leave their houses, and even browsing the internet is challenging due to the lack of clear information on a residence. The website features distinctive home designs along with cost calculations that vary according to the plan. And if they wish to include properties that they sell, such designs are specifically designed to be showcases. The contact information on the researcher's website will allow visitors to schedule an appointment and inquire about the home they want to view or explore. The contact information on the website will allow visitors to schedule an

appointment and inquire about the property they want to view or tour. In addition, the researcher's website offers a 3D house design that perfectly captures the ideal design of what the researchers' clients' dream homes should look like, as well as information about the house based on the client's design, such as the property type, sale type, sizes of the house, bathroom, and bedrooms, as well as the number of rooms. Additionally, the clients will provide five photographs of the house they intend to sell and based on those images [5].

Objective of the study

The general objective of the study is to develop a system entitled "A 3D Simulation Model of Online Fiesta Communities House Listing with Site Map " That can make it easier for people looking for a place to live to find one and people who wants to visit the Communities without having to go directly to fiesta communities. and it was developed to further expand or clarify the appearance of the house in the fiesta using a 3D model. because, as researchers, the researchers discovered that the website does not describe the overall appearance of the house they are selling. On the SpotiHouse website, clients can view the entire house, whether it is outside or inside, via a web-based 3D model. The 3D model can rotate the house 360 degrees, and there are also buttons that show the entire interior designs. The appearance of the bathroom, kitchen, and bedroom is included, and there is an interactive map if want to visit the Fiesta Communities right away. If clients want to buy, they can contact the provided admin information, and the admin and seller will talk about what should be done, and when it is agreed upon, the admin will transfer the conversation from seller to buyer. A main goal of this project for homeowners in the Fiesta Communities is that it will accelerate the purchase of the property they are selling because it is an advanced system that can be displayed online. The 3D model allows for a better understanding of the precise appearance of the houses in the Fiesta from the inside to outside, in addition to five various photographs of the same house. Therefore, there is a good chance that more individuals will rent or buy their properties.

This study aims to achieve the following specific objectives:

1. To plan and gather information
 - a. Collaborative brainstorming
 - b. Gather related literature
 - c. Gather related Studies
 - d. Gather related System
2. To identify hardware and software developmental tools
 - a. Desktop Computer with installed Microsoft Operating System
 - b. Smartphone
 - c. XAMPP Web Server System
 - d. Notepad++
 - e. Google Chrome Browser
3. To design the system using analysis tools
 - a. Gantt Chart
 - b. Costing plan
 - c. Flowchart
 - d. Visual Table of Contents
4. To create a user-level access
 - a. Admin
 - b. Seller
 - c. User
5. To develop a Front-end and Back-end System of 3D Simulation Model of Online Fiesta Communities House Listing with Site Map
 - a. Front-end System
 - b. Create an user Interface for Admin, Seller, and User
 - c. Create a Web interface blended with Color schemes and Navigations
 - d. Back-end System
 - e. Create an Admin account for Owners and Management User
 - f. Create a user-level access
 - g. Update user-level access security password
 - h. CRUD function for the available community house inventory
 - i. Update and archive 3D model house
 - j. Approve seller request site advertisement of owner's house and lot for sale information
 - k. Create a Seller account
 - l. Create a navigation and controls dashboard for posting house and lot for sale information
 - m. Create a navigation and controls dashboard for
 - i. Viewing 3D model house
 - ii. Viewing Advertise available unit House Listing

- iii. Viewing Interactive Map of available unit House Listing
 - n. Create Feedback and listing
6. To test the develop system
 - a. Developer test
 - b. Alpha test
 - c. Beta test
 7. To evaluate the system using Software Product Quality Standards of ISO 25010 in terms of:
 - a. Functional Suitability
 - b. Performance Efficiency
 - c. Compatibility
 - d. Usability
 - e. Reliability
 - f. Security
 - g. Maintainability and
 - h. Portability
 8. To deploy the system in the domain web-hosting site

Scope and limitation of the study

The objective is to provide a seamless and efficient platform for individuals seeking to explore available properties in the market. To gather the necessary information, the researchers conducted field research by visiting fiesta communities. Through surveys and interviews with homeowners, researcher collected valuable insights about their preferences, requirements, and experiences related to buying and selling homes. This data will serve as a foundation for designing a system that aligns with the needs of homeowners, ensuring a comprehensive and user-centric platform for real estate transactions.

To fulfill the requirements for the system software, the researchers employed a range of tools and technologies. The researchers relied on Google for research, collaboration, and information gathering. The Blender application played a significant role in creating and editing visual elements. XAMPP served as our local server solution, enabling us to develop and test the web application effectively. Notepad++ was the researcher's preferred code editor, facilitating efficient coding and scripting. The researchers utilized PHP as the backend programming language and JavaScript for client-side interactivity and functionality. In terms of hardware, the researchers utilized both desktop computers and mobile phones to

ensure versatility and accessibility. Desktop computers provided the necessary processing power and screen real estate for development, testing, and more resource-intensive tasks. Mobile phones were employed to assess the responsiveness and user experience of the system on smaller screens, ensuring optimal usability for users on mobile devices. By utilizing this combination of software tools and hardware devices, were able to successfully develop a user-friendly system, accessible across different platforms and devices.

The design and analysis phase of the system used a range of tools and techniques to ensure effective planning, organization, and documentation. These tools included a Gantt chart, costing plan, flow chart, and visual table of contents to streamline the design process and conduct a comprehensive analysis. The Gantt chart provided a visual representation of the project timeline, the costing plan estimated and allocated resources, the flow chart visualized the flow of information and processes, and the visual table of contents provided a clear overview and easy navigation of the project documentation. These tools enabled the team to effectively plan and manage project activities, analyze critical aspects, and maintain comprehensive project documentation.

The Front-end and Back-end system for the 3D simulation of online fiesta communities' house listings implemented a robust user-level access control mechanism to cater to the specific roles of administrators, sellers, and regular users. Administrators have full control and oversight over the entire system, while sellers have restricted access to sensitive administrative functions. Regular users have access to search and browse available house listings, view property details, explore the 3D simulation of the fiesta communities, and interact with the sellers through inquiry or booking functionality.

To implement this user-level access control, various techniques such as role-based authentication and authorization were employed. Regular audits and monitoring were conducted to ensure the system's security and adherence to best practices.

The researchers have successfully designed and implemented a sophisticated Front-end

and Back-end system for an immersive 3D simulation platform, specifically tailored for online fiesta communities. This dynamic system seamlessly integrates advanced house listing functionalities, allowing users to explore and interact with virtual houses within a visually stunning environment.

On the Front-end side, the researchers focused on creating an intuitive and user-friendly interface. Users can effortlessly navigate through the virtual fiesta communities, browse and search for available houses, and access detailed information about each property. The immersive 3D experience provides a realistic representation of the houses, enabling potential buyers or renters to visualize themselves in their future homes.

To complement the interactive experience, our Back-end system efficiently handles data management, ensuring accurate and up-to-date house listings. The system incorporates robust database management techniques to store and retrieve information about available properties, including images, descriptions, pricing, and amenities. Seamless integration with the site map feature further enhances the user experience, as it enables users to view the entire fiesta community layout and easily locate specific houses of interest.

The development process involved leveraging cutting-edge technologies and frameworks such as blender for rendering realistic 3D visuals, JavaScript for interactive functionality, and backend frameworks to handle server-side operations. Researcher employed a scalable architecture to accommodate growing user bases and ensure optimal performance even during peak usage periods.

The Front-end and Back-end system for the 3D simulation of online fiesta communities' house listings with site map features offers a groundbreaking platform for users to explore and make informed decisions when searching for their dream homes. The combination of immersive visuals, intuitive navigation, and comprehensive data management sets a new standard in online real estate experiences, revolutionizing the way people engage with property listings in virtual environments.

The researchers employed a multi-stage testing approach to ensure the quality and functionality of the developed system.

Developer testing involved testing individual components, modules, or functions of the system to verify their correctness and functionality. Alpha testing involved an internal testing phase where the system was evaluated by a select group of individuals within the development team or organization. Beta testing involved a larger group of external users who provided feedback on its usability, performance, and overall user experience. Bug tracking systems and issue management tools were utilized to capture and document identified issues. The testing process involved a combination of manual and automated testing techniques to ensure thorough coverage and reliability.

The system was evaluated according to the software product quality standards outlined in ISO 25010, the researchers followed a comprehensive assessment process that covered various aspects of quality criteria. ISO 25010 provides a framework for evaluating software quality attributes across eight key characteristics: functionality, reliability, usability, efficiency, maintainability, portability, compatibility, and security.

The deployment process of the 3D simulation model of the online Fiesta community house listing with a site map at the domain site involved setting up the necessary infrastructure, configuring the hosting environment to support 3D rendering and interactivity, and ensuring compatibility with web-based technologies. Testing was conducted to verify the functionality and compatibility of the 3D simulation model across different web browsers, devices, and operating systems. Security measures were implemented to safeguard the integrity and confidentiality of user data.

The scope of this study focuses on an advanced visual of how to find or sell house properties. Detailed corners of a house can be accessed through technology, and 3D houses here are the exact house that exists in a place; for example, it can be made of concrete, steel, masonry, mechanical, electrical, and parts of plumbing.

Front end interface should have the following Registration/Log-in, Property Details, 3D Showroom and Contact Details, Backend Dashboards.

It will show the full admin side of the website and the layers of the website; it has major access to the website. Users can have the option that register or login on the website will show to the user backend if they are online or offline. As well to have the CRUD option for the property and all models.

Admin Portal

The admin manages all the properties that clients want to sell and the admin has an account by logging in the Login Portal which can be accessed on the website. The admin can navigate different parts of the 3D house model, whether interior, exterior, bathrooms, kitchens, and bedrooms.

In the "User" tab, all the records of the clients composed of the image, name, contact number, email address and verified status are shown.

Forgot Password

Once the username or password of the client is forgotten, a "Forgot password?" can be clicked located at the "Login" form. The user will be redirected on a form asking for

the current e-mail. The client will then receive an email containing the username and a "Reset Password" link, if the client clicked the link, the client will be redirected to a page asking for a new password and confirm password, the newly entered password will now be the user's current password. If the user is simply mistaken or no longer needs to know the username or password, the e-mail can simply be ignored.

The limitation of this study is that the installation calculator entails determining the exact cost of a substantial number of the properties listed on the website. Estimating is difficult because this is a visual method using a 3D house model.

A user is limited to have a 3rd party communication with the admin when creating a new listing for the Website where the can upload a 3d models. Reservation for appointment: Since admin is not providing an appointment schedule for engineers, if they want to have an appointment with an engineer, their client must contact them.

SYSTEM DEVELOPMENT METHODOLOGY

The researchers created the conceptual framework based on the actual project and organize aligned it with the Software

Development Life Cycle. The researchers visited the Fiesta Community in Tabun Mabalacat and used staff interviews and site visits to collect information regarding the services, costs, and commercial operations of the subdivision. To give the viewer a better perspective of the model house, researchers used a 3D model of the exterior and interior of a house

System design specification the current technology that is used in the system is Augmented Reality, AR technology was mostly utilized in the gaming and entertainment industries. And the market is still expanding. However, augmented, and virtual reality applications are no longer limited to gaming. One example is, Engineers and designers from a variety of industries (automotive, construction, and others) produce digital prototypes and test them to find the optimum solution. This is a lot less expensive than making a lot of physical prototypes that do not work.

SDLC is a procedure used inside a software company to complete a software project. It is a thorough strategy that describes how to build, maintain, replace, and change or improve certain software. The life cycle outlines an approach for enhancing software quality and the development process as a whole [58].

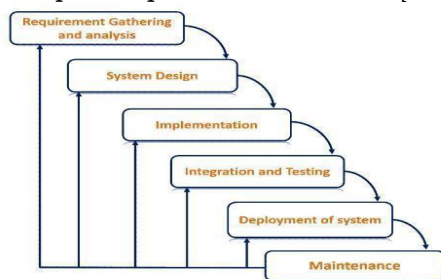


Figure 21: Modified Waterfall Model

The section presents methods used in developing the website and to illustrate the function of the website, contains methods, design and data that were used in the website development [59].

The researchers opted to utilize a modified waterfall model to meet their research project's specific needs and requirements. Recognizing the benefits of a structured and sequential approach, they incorporated modifications to enhance research outcomes. The modified approach allowed for iterations and feedback

loops, allowing for the refinement of research design, methodology, and analysis. It also emphasized stakeholder involvement and collaboration by incorporating checkpoints and milestones throughout the process. This increased collaboration enriched the research process and aligned outcomes with stakeholders' needs and expectations.

The modified waterfall model also enabled effective risk management by breaking down the project into distinct stages, assessing and mitigating risks at each step, and allowing for validation, reevaluating assumptions, and design adjustments. Overall, the modified waterfall model demonstrated a thoughtful and strategic approach to conducting research, introducing flexibility, fostering stakeholder collaboration, managing risks, and ultimately enhancing the quality and impact of the research outcomes.

Planning and Analysis

The most crucial and fundamental stage in SDLC is requirement analysis. It is carried out by senior members of the team with input from the client, the sales department, market surveys, and industry domain specialists. This data is then utilized to establish the main project strategy and undertake product feasibility studies in economic, operational, and technical aspects.

The researchers gathered all the needed information to conceptualize the research. This phase was about research and brainstorming to build ideas. The proponents used all the resources that could be utilized just like books, magazines, and the internet.

The researchers also conducted interviews (see Interview photos) with a homeowner in Fiesta Communities in Pampanga. The interview was all about the needs and problems that the homeowner was facing nowadays. Also, the proponents asked the said interviewees about the traditional methods used which could be innovated with technology.

Gathering those data gave the proponents the idea of what kind of system was needed to be integrated and presented with the said medical practitioners to give solutions to the problems and to make the daily lives of the target users much better. The researchers collected the required information regarding the system

requirements. After the information was gathered, the proponents analyzed those data which served as the guidelines regarding the application development and process.

The planning step also includes the preparation for quality assurance needs and the identification of project hazards. The technical feasibility study will describe the various technical techniques that may be used to effectively perform the project while minimizing risks.

Designing

SRS serves as a resource for product architects in developing the optimum architecture for the product under development. Typically, many design approaches for the product architecture are presented and documented in a DDS - Design Document Specification based on the requirements given in SRS.

This DDS is evaluated by all essential stakeholders, and the optimal design strategy for the product is chosen based on many characteristics such as risk assessment, product robustness, design modularity, budget, and time restrictions.

A design approach explicitly outlines all of the product's architectural modules, as well as its communication and data flow representation with external and third-party modules (if any). The internal design of all modules of the proposed architecture should be explicitly documented in DDS down to the smallest detail.

Implementing

The real development of the product begins at this level of the SDLC. During this stage, the programming code is generated in accordance with DDS. Code generation may be conducted without much difficulty if the design is detailed and structured.

Developers must adhere to their organization's coding rules, and programming tools such as compilers, interpreters, debuggers, and so on are used to create code. For coding, many high-level programming languages such as C, C++, Pascal, Java, and PHP are utilized. The programming language is chosen based on the sort of software being created.

Testing the Product

As in contemporary SDLC models, testing activities are mainly included in all SDLC stages, this stage is usually a subset of all

phases. However, this stage solely relates to the product testing stage, during which product faults are reported, monitored, repaired, and retested until the product meets the quality criteria stated in the SRS.

The Likert scale was used as a statistical treatment by the researcher to collect and quantify participants' views, attitudes, opinions, or preferences in a standardized and quantitative manner. This structured framework enabled statistical analysis, allowing valid inferences to be drawn from the responses. The Likert scale enabled response standardization and comparability, allowing for the identification of trends, patterns, and group differences. It also enabled the quantification of subjective constructs with no direct numerical values, translating qualitative data into quantitative data. The scale was designed to accommodate a wide range of responses, capturing subtle differences in participants' opinions or impressions.

In addition, the Likert scale assisted in the interpretation and presentation of findings in a short and straightforward manner, making the results more accessible and understood to a wider audience. Overall, the Likert scale provided a viable and adaptable tool for capturing and quantifying subjective components, so improving the rigor and interpretability of study results.

The System will undergo to set of tests an Alpha test which include a 3 Alpha testers and Beta test with 3 respondents from Fiesta Communities. Testing Parameters for both type of test will use an ISO 25010 to Test the different categories of Websites

Deployment in the Market and Maintenance

Once the product has been thoroughly tested and is ready for deployment, it is formally released in the relevant market. Product deployment may occur in stages depending on the organization's business plan. The product may first be introduced in a small market sector and tested in a real-world business setting (UAT- User acceptance testing).

The product may then be released as is or with proposed enhancements in the targeted market niche depending on the feedback. Following the product's release to the market, it is maintained for the current client base.

RESULT AND OUTCOMES

The chapter discusses and shows how the project's primary goals, which are to develop a web-based a 3D Simulation Model of Online Fiesta Communities House Listing with Site Map

Requirements

Through online research and interviews with experts, the researchers have learned more about the topic. The researchers thus identified and completed the system's criteria.

Table 1: Hardware and Software Requirements

Hardware Requirements	Software Requirements	Function
Desktop	Windows	7
Mobile Phone	(minimum)	Operating System
	4GB	RAM
	(minimum)	Memory
	Google Chrome	Browser

Software Process Screen Shots

The researchers finished the criteria for the system. After data collection and analysis, the researchers designed the web-based system.

Client User Process

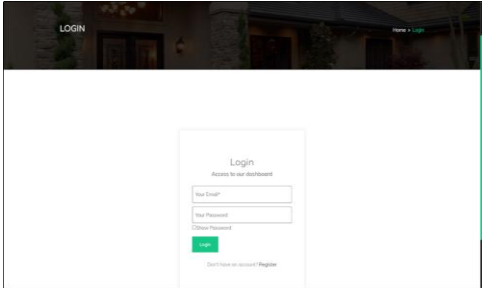


Figure 22: Login Page

Figure 22 shows the website's login page. The client inputs their existing Email account and password, and a verification Email code will be sent to the email inbox or spam folder after the password and email have been provided in order to login.

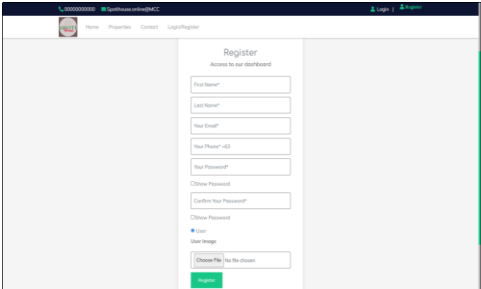


Figure 23: Registration Page

The "Register" button can be used by new users to set up an account. The customer can browse the home of the website and the different house listings of Fiesta Communities properties with precise details, the 3D model Section, and My Account after logging in.

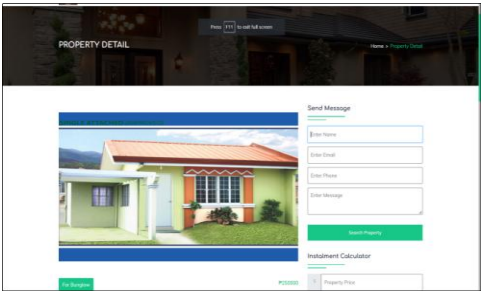


Figure 24: Clients Message

Clients can message the admin if they have questions about the house that is on the website.

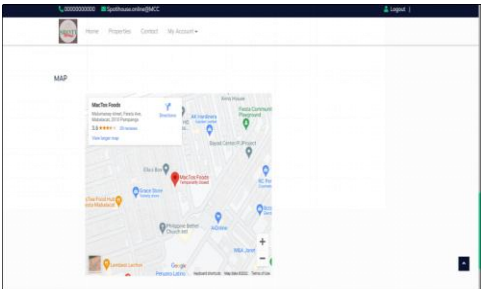


Figure 25: Site Map

Clients can see the interactive site map and the exact place where the house is located. Just click the direction button and it will automatically go to google map.

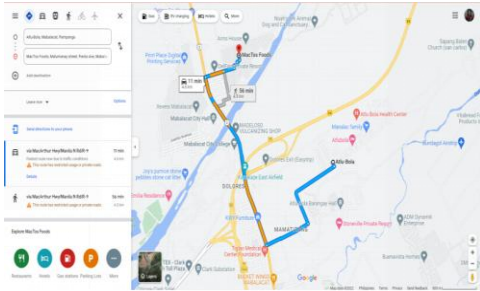


Figure 26: Search Location

After clicking the “direction” clients can search their exact location on the map and there will be a path or route that they will follow.

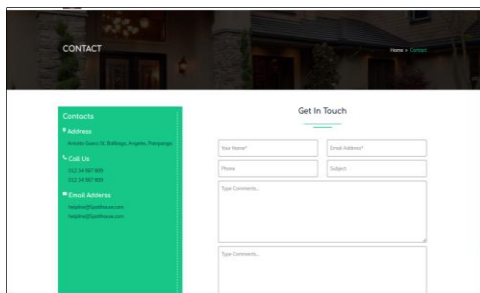


Figure 27: Contact Details

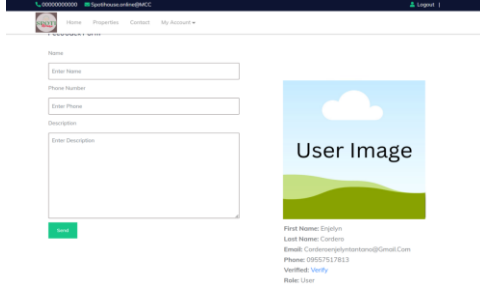


Figure 28: Clients Profile

Admin Process

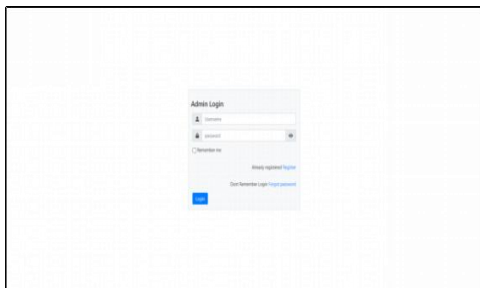


Figure 29: Admin Login

To access the website, the admin must submit a valid username and password. The admin can access all customer accounts, messages, and feedback after logging in. The account can be deactivated, and the administrator can access the details. Each account also has a search bar, making it simple to look for specific information.

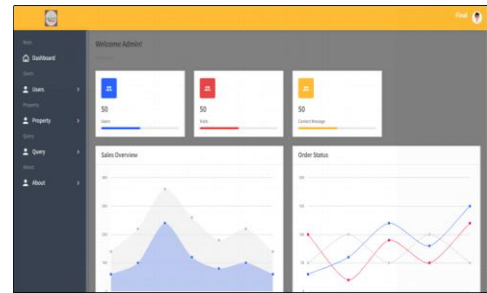


Figure 30: Dashboard

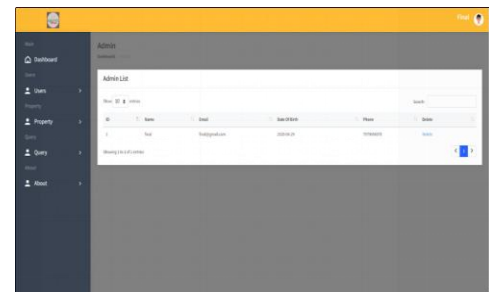


Figure 31: Admin List
Here are the admin contact details.

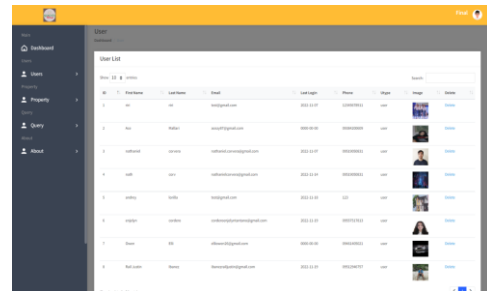


Figure 32: User List

The account can be deactivated, and the administrator can access the details of all users. Each account also has a search bar,

making it simple to look for specific information.

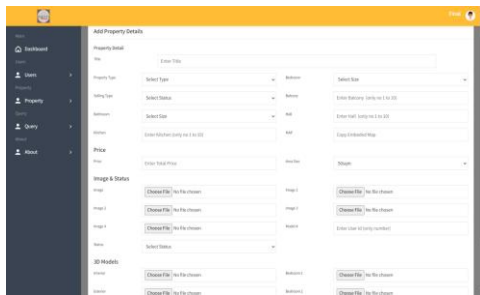


Figure 33: Add Property Details

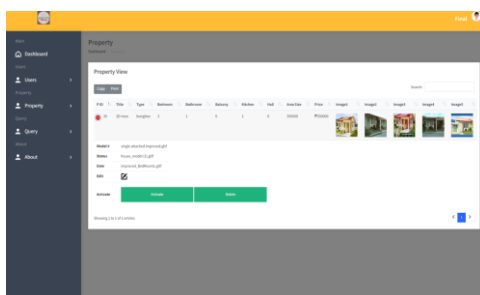


Figure 34: Active Property View

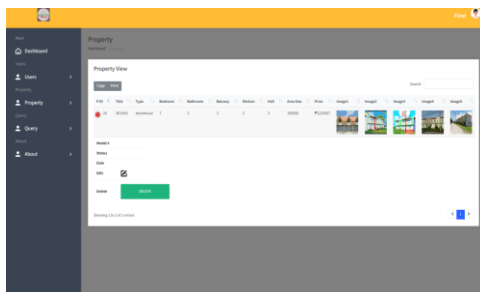


Figure 35: Pending Property View

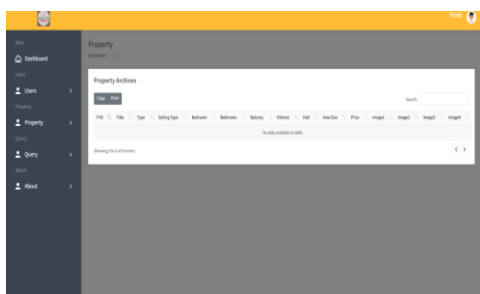


Figure 36: Archived Property View

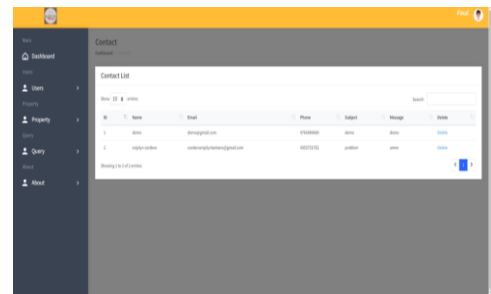


Figure 37: Contact List

This page lists users who have provided feedback, sent messages, and provided contact information.

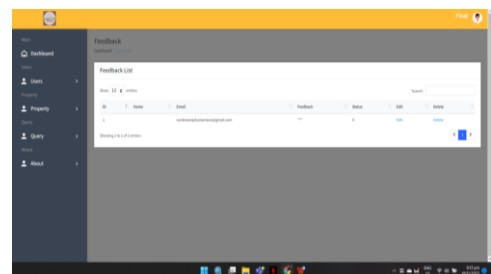
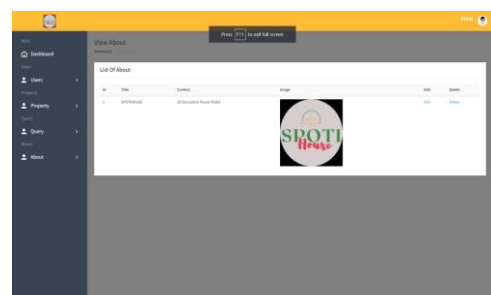


Figure 38: Feedback List

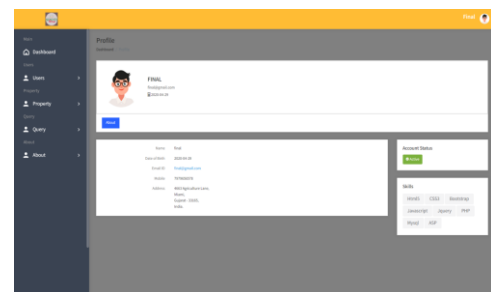


Figure 39: Admin Personal Details

Testing and Implementation

The system was evaluated based on its functionality, reliability, portability, usability, performance, security, compatibility, and maintainability. For the test, two sets of categories Alpha and Beta Testing were employed. Each test received three responses. The average alpha testing score was 4.6, or Strongly Satisfied. While the beta version's running test earned a mean of 4.986111, it was practically faultless. The ISO testing obtains a mean score of 4.820139, or 96.4 percent, in terms of total testing.

Table 2; Alpha Test

Category	Score	Descriptive
Functionality	4.56	Strongly Satisfied
Reliability	4.56	Strongly Satisfied
Portability	4.66	Strongly Satisfied
Usability	4.77	Strongly Satisfied
Performance	4.66	Strongly Satisfied
Security	4.46	Strongly Satisfied
Compatibility	5.00	Strongly Satisfied
Maintainability	4.66	Strongly Satisfied
Mean	4.66	Strongly Satisfied

Functionality, interoperability, usability, portability, and overall system performance are all important considerations. With a verbal interpretation of "Strongly Satisfied," security achieved a score of 4.6.

This percentage only shows that the system's four (4) primary user levels were approved by the three (3) alpha testers. Inventory, billing, payment, and notification systems have all been properly integrated. The testers also discovered that the system is completely functional and compatible with a variety of browsers, databases, operating systems (OS), mobile devices, networks, and additionally, the database infiltration is examined, and the tester was provided access to the hardware. the system's complete safety.

The ISO 25010 was used by the researchers to test Spotihouse for beta and construct it as an all-encompassing integrated solution. During the testing procedure, this ISO employs a number of categories. A system is subjected to a sequence of operations known as a system test case to see whether it genuinely meets

system requirements and functions as intended. Its purpose is to determine whether or not various system components are working as expected and to validate that the system meets all applicable standards, recommendations, and client demands. The Web application is tested in line with ISO/IEC 25010, an international software engineering standard.

Table 3; Beta Test

Category	Score	Descriptive
Functionality	4.88	Strongly Satisfied
Reliability	4.56	Strongly Satisfied
Portability	5.00	Strongly Satisfied
Usability	5.00	Strongly Satisfied
Performance	5.00	Strongly Satisfied
Security	5.00	Strongly Satisfied
Compatibility	5.00	Strongly Satisfied
Maintainability	5.00	Strongly Satisfied
Mean	4.98	Strongly Satisfied

This demonstrated that the web application satisfied all of the standards and was suitable for its intended use. The functionality, features, and competency of the program were reviewed by three users or Beta users. Security is one of the most critical aspects that an application should have in order to protect both the program and its users. This is done to ensure that the application's data and networking security requirements are met. According to the Iso result of the beta Test of overall category 4.986111 or equivalent to "Strongly Satisfied".

Table 4; Grand Mean

Category	Score	Descriptive
Functionality	4.72	Strongly Satisfied
Reliability	4.75	Strongly Satisfied
Portability	4.84	Strongly Satisfied
Usability	4.88	Strongly Satisfied
Performance	4.84	Strongly Satisfied
Security	4.73	Strongly Satisfied
Compatibility	5.00	Strongly Satisfied
Maintainability	4.88	Strongly Satisfied
Mean	4.83	Strongly Satisfied

The system's functionality received a "Strongly Satisfied" grade, suggesting that it can effectively and efficiently adapt to a wide range

of operating or use circumstances, as well as hardware and software.

Furthermore, the system's dependability score was "Strongly Satisfied," indicating that it regularly makes completing the aims and objectives outlined in each module or panel simpler. The planned system was operational and usable when required, achieving the highest overall score among the several sub-criteria in the dependability area. The portability criteria for the built system obtained a "Strongly Satisfied" rating.

Because it achieved the highest overall score among the five indicators under the portability criteria, the system may adapt to various hardware, software, or other operational standards.

The system's usability also obtained a "Strongly Satisfied" grade. Because the system allows users more freedom over how they may execute a job in a particular use situation, the accessibility indicator received the highest score of the several sub-indicators under usability.

During system testing, users had constant bandwidth access to at least a 10 to 15Mbps Internet connection. When the system is up and running, a larger bandwidth will improve responsiveness, processing, and throughput. Furthermore, the type of resources required to access the system will influence how effectively it runs.

The system's security rating was also very high, with good scores for the sub-factors of secrecy, accountability, and integrity. It provides a variety of security log-in access options for all user types, ensuring that only those with access privileges may access the data. It also protects against unwanted data alteration and maintains auditable logs of all actions.

Furthermore, the system's compatibility function obtained an overall "Very Strongly Satisfied" rating. It illustrates that the system successfully completed the required tasks while using shared resources and an environment with other things without negatively impacting resource consumption. The portability and compatibility of the system are linked. It indicates that another device linked to a network may gain access to the system, allowing for data consumption and exchange.

Furthermore, the Maintainability rating was "Strongly Satisfied," and Testability had the highest mean score among the sub-indicators. The system enables the user to modify the settings without introducing mistakes or diminishing the system's quality.

Profile of Respondents

The results of the respondents' personal profile in terms of age, gender, access to administration, and selling their house property in Fiesta Communities.

In terms of age, it appears that most of the respondents are at the age of 19-21 years old with a frequency of 33 or 33 percent and the least are at the age of 18 below with a frequency of 9 or 9 percent of the total population of respondents.

Moreover, the table indicates that the study was male dominated with 58 percent of the total population, while female and other genders were only 42 percent.

This demonstrates that most respondents were men.

It can also be gleaned from the survey that the majority of the respondents or 96 percent answered that having a website is beneficial in 3D house model viewing and the location of the house in Site Map. This means that most of the respondents would benefit from knowing the exact appearance of the house in Fiesta Communities.

Furthermore, most of the respondents or 80 percent preferred a personal visit by an engineer rather than an online consultation. Whereas the 20 percent of the respondents due to safety and privacy would prefer to have an online consultation. Preferences of the respondents on consultation regarding 3D house model viewing and the location of the house in Site Map.

DISCUSSIONS

This section contains a summary of the findings, conclusions, and suggestions from the research SPOTIHOUSE: A 3D Simulation Model Of Online Fiesta Communities House Listing With Site Map.

Summary of the study

The researchers create a 3D simulation model of an online Fiesta Communities house listing with a site map that is web-based. Based on the client's design, this website provides a

unique 3D house design as well as specifics about the home, such as the property type, sale type, house sizes, bathroom, kitchen, bedrooms, and the number of rooms.

The customers will also provide five pictures of the property they wish to sell, and the admin will develop a 3D model of the house based on the images provided by the clients. Furthermore, those designs are only examples; if customers want to include the property they are selling, they can contact the website's contact information to set up a meeting and discuss their options.

This website seeks to offer a more realistic assessment of the size, cost, and size of the land itself. To assist buyers, comprehend the showroom, researchers created a 3D model of the house, showing every single corner. The website's goal is to help people of all socioeconomic and demographic backgrounds find their dream house.

Conclusions

If changes are possible, the 3D model's windows and doors, for example, can be modified. In addition, management will be managed for the management that will be made available for use in the estimating system. What sort of report will be written?

The initial proposal from this research is to customize the sqm and the room, however those sqm have a predetermined selection based on the engineer's counsel for a fundamental basis of the project. The same may be said for the room number and the bathroom. Management will not just remove it from their title and related information. Furthermore, the report is created based on the cost of the raw materials.

The researchers were successful in achieving the study's goal. The program performed admirably on the supported Hosting and domain system, and users were able to attain the Website's intended performance. The website's user interface design operated well on a different browser used during the testing process. Users may easily comprehend and utilize the framework components; however, developers have gotten insufficient guidance.

Recommendation

Based on the observations and conclusions reached, the researchers would like to make the following recommendations:

Implement a direct phase to seller and customer interaction.

Categorize type of listing for Sale, Rent or Lease.

Include Real estate like condo, transient and ETC

Add some API to link it to other Real Estate listing

Online Transaction for uploading requirement and Payments.

User interface upgrade for Commercials and Boosting

REFERENCES

- [1] May 2019. [Online]. Available: <https://realestate.usnews.com/real-estate/articles/the-10-best-apps-for-finding-your-next-apartment>.
- [2] P. S, K. M, S. E and V. N, "Access moodle using smart mobile phones. A case study in a Greek University," In *interactivity, Game, Creation, Design, Learning, and Innovation*, Springer, pp. 376-385, 2017.
- [3] [Online]. Available: <https://corporatefinanceinstitute.com/resources/commercial-real-estate/real-estate/>.
- [4] [Online]. Available: <https://www.oecd.org/coronavirus/policy-responses/housing-amid-covid-19-policy-responses-and-challenges-cfdc08a8/>.
- [5] Y. S. Maarek, "Webcutter," A system for dynamic and tailorable site mapping, vol. 29, pp. 1269-1279, 1997.
- [6] "Waterfall Model - an overview | ScienceDirect Topics," [Online]. Available: <https://www.sciencedirect.com/topics/computer-science/waterfall-model>. [Accessed 02 June 2023].
- [7] "blender.org," [Online]. Available: <https://www.blender.org/about/>. [Accessed 02 June 2023].
- [8] "Data Analysis Tools: Definition and How to Choose One," [Online]. Available: <https://au.indeed.com/career-advice/career-development/data-analysis-tools>. [Accessed 02 June 2023].
- [9] "iso25000.com," [Online]. Available: <https://iso25000.com/index.php/en/iso-25000-standards/iso-25010>. [Accessed 02 June 2023].
- [10] K. Siddharth, "Statistical Treatment of Data," 10 April 2009. [Online]. Available: <https://explorable.com/statistical-treatment-of-data>. [Accessed 02 June 2023].

Talakutnangan: Sistematikong Mipagsabi Queting MCC

Jarlem Red J. de Peralta

Ardrin S. Gregorio

Angelo L. Magtoto

John Jerome S. Pertez

Kenneth Trecy C. Tobias

Dennis L. Tacadena, PCpE, DIT (Technical Adviser)

ABSTRACT

The communication process has become sophisticated with the available platforms for individuals and organizations, solving superfluous calls with instant message responses. According to this study, the advancement of message exchange equates to more options in communication platforms' channels. With the use of various communication channels, the students and professors (employees) of Mabalacat City College (MCC) experience challenges such as inconsistency and unclear communication when exchanging dialogues. The professors and students, as well as Student Affairs and Support Services (SASS) at Mabalacat City College, needed a formal consultation platform. The study aims to create a dedicated consultation platform for Mabalacat City College, settling most of the critical challenges to proper communication between students and professors. In terms of methodology, the researchers used the modified waterfall model in the software development life cycle (SDLC), step by step in a sequential stage, inspiring the conceptual framework of the study by starting with scoping, planning, development, testing of the functionality, and finally, deployment. Within the results, the researchers developed Talakutnangan, a web system allowing a proper and formal consultation between students and consultants. Talakutnangan serves as a unified communication platform for Mabalacat City College, providing consultation services and information dissemination in the Talakutnangan forum. In conclusion, the Talakutnangan web system garnered high functionality, suitability, usability, and portability results. As recommendations for future researchers, the Talakutnangan web system requires a large and fast web server to access lacking features such as saving files and recording video consultations.

INTRODUCTION

In the early 1960s, workplace live chat was introduced in the Computation Center of MIT [1]. By the 1990s, short message services (SMS) emerged, without photographs, video, text, web links, or any of the other elements. Today, it pales in comparison to the sophisticated communications tools and platforms available [2]. The instant message platform effectively incorporated everyone, including people and everything, into communication. It removed superfluous calls and provided instant responses to concerns in business. The link made through a platform of an organization is productive, fulfilling the job of the messaging app in allowing individuals to speak with one another [3]. A case study conducted at the University of Kebangsaan Malaysia highlights the significance of smartphone messaging apps. Many easily available messaging apps serve a range of roles, whether in a professional or peer-to-peer context [4].

Furthermore, space and respect are the finest techniques in conversation. Those should be enough to solve most communication problems. A few communication challenges are overburdened channels, inconsistencies, and hazy communication [5]. The relaxed communication style normalized informality and distractions [3]. Despite the fact that the Philippines was renowned as the social capital of the world [6], Labor Secretary Silvestre H. Bello III mentioned a bill that encourages employees to have the "right to disconnect" [7]. However, in some academic institutions, time issues are one of the top barriers that prevent students from asking [8]. Aside from professors, students are hesitant to ask for help from healthcare professionals [9]. In Mabalacat City College (MCC), Student Affairs and Support Services (SASS) was formed to monitor the services units which improve the lives of students [10]. However, it needs a dedicated consultation platform. Any

group which uses chat platforms prefers the convenience of having a centralized route of communication [2] [3] [4] [11]. Currently, MCC employees, particularly professors, use free platform apps as a medium for consultation.

However, these apps still lack features that respect the "right to disconnect" stated in [7]. For example, Messenger has a "last active status," which users can explicitly turn off [12]. The study's purpose is to provide a means of communication for MCC students to use for consultation with student services and professors. This helps the employees document communication with students in an appropriate manner. When finished, the signatures of participants would be used to sign the online consultation form. The system also provides forum discussions wherein every kind of user interacts with each other. In this feature, users with enough permissions can manage their posts and comments, while students can only comment on posts.

Background of the study

The location of the study is MCC. It was founded by former mayor Marino Morales in Barangay Atlu-Bola. It is now a college with ALCUcoa Level II accreditation programs on Rizal Street in Mabalacat City, Pampanga. It is growing now and aims to be the top choice in its community by 2025. For this reason, the number of students is rising, and employees, especially the professors, talk to numerous students with regard to concerns about assignments, grades, projects, activities, and others.

Currently, teachers now have a variety of applications to choose from as a means of communication. The most common apps would be disrespected [7]. Some names on social media are hard to identify because of informal differences from teachers' real names. These were the reasons that led to the development of this study.

Recently, MCC has created Student Affairs and Support Services (SASS) [10]. This office handles unit offices that provide services to improve students' well-being. Some of these are Health Services, Guidance Services, and Library Services. However, these services also use external platforms such as Messenger or MS Teams. Therefore, even non-teaching

personnel who provide student services can use the system.

Most colleges and universities nowadays use communication apps, but some schools need a dedicated website or app. This issue is quite common, especially in public schools. Most of the time, some schools use free communication apps such as Facebook, Edmodo, etc. [13]. Some private schools and universities have a particular website or application that must be used to communicate with students. The eLearning Management System (ELMS) of the System Technology Institute (STI) is one of the best examples of it. In the school, students and teachers are prohibited from using other communication apps for consultation; instead, students are required to use the app or website provided by the school to communicate with each other. Teachers are required to be available at the time the schools set for consultation with the students [14].

Other chat platforms, such as Facebook Messenger, have offered the ability to turn off active status. If the active status has been turned off, the status will be hidden from other people when the user is last active, even if the user is surfing the platform [12]. However, the user can still receive messages. Therefore, a disturbance occurs during an employee's free time. Edmodo lacks indicators of whether the message has been acknowledged or if the teacher is active.

Meanwhile, MS Teams is almost good due to its chat features [15]. However, it needs the feature of creating consultation forms to start and end the consultation formally. In addition, one of these chat platforms has gone out of service [16]. This study aims to solve the issues mentioned above.

Objective of the study

The general objective of the study is to develop the system entitled "Talakitnangan: Sistemang Mipagsabi Queting MCC." In line with this, the study has achieved the following objectives:

- To identify hardware and software requirements to build the website on Windows 10 or 11
- To design the system application using:
 - Use Case Diagram (UCD)
 - Visual Table of Contents (VTOC)
 - Data Flow Diagram (DFD)

- Entity Relationship Diagram (ERD)
- To create a front-end and back-end system interface using the following technologies
- To develop client-server systems
- System checks using the researchers-made test case criteria in terms of functionality suitability, usability, and portability

Scope and limitation of the study

The study aimed to develop a dedicated consultation system. With the system developed, any hardware can be used if it supports Microsoft Windows 10 or 11. To design the Use Case Diagram (UCD), Visual Table of Contents (VTOC), Data Flow Diagram (DFD), and Entity Relationship Diagram (ERD), Microsoft Visio was utilized since it is able to support to create of the types of diagrams necessary for the study [17].

Viewing the system starts at the home page. For guests, the home page contains links to the login page. It also contains information about the system and tips and steps for students and professors to orient users on how to use it.

Users in the system can be registered in batches by administrators (or admins). Admins would need to upload a comma-separated values (CSV) spreadsheet file containing user registration information. Admins also need to indicate the kinds of users to be registered and the associated roles. The CSV file generally has a column for the complete name, e-mail address, and department. If the reachable employees' data is uploaded, reachable employees have a default schedule of 8 a.m. to 5 p.m. every weekday. Default passwords are sent to registered users via e-mail, and users are advised to change the passwords immediately.

Log in page is for every kind of user. Entering e-mail and password is required for users. Participants (students and employees) may attach files such as images or documents (e.g., excuse letters) or send emojis. Previously attached files are seen as a list on the chat box. Admin's home page contains links to create or update employee accounts.

Deans and heads of student services in a department, considered department account managers, can manage employees' accounts.

Deans and institute secretaries also have a link to a page to manage users within the deans' institutes (e.g., shifting a student from or to another institute).

Admins have a page to manage their accounts and a page where user management can be done regardless of the department. Users with administrative permissions, referred to as admins can add/update deans for each institute or heads of student services. Administrators can also manage the departments since MCC is still growing. Admins can also reset the user's password to the default password.

Admins also manage the roles of each user. These roles indicate the permissions and attributes associated with the user. In creating a role, admins must input the role name and other functionalities, such as the scope of post-management, tag management, and user management. Admins are prohibited from editing the "admin" role to prevent locking out. In updating a role, administrators should change any necessary information. Admins could archive single or multiple roles. Finally, an archived role will be able to be restored by admins, depending on the changes in the organizational structure.

Additionally, admins can manage departments. Creating a department requires the department's acronym and full name. Institute departments can admit students, while Student Affairs and Support Services (SASS) departments are prohibited. In updating, administrators can change any necessary information about a department. In archiving, institute departments must have no users. Admins can archive single or multiple existing departments. Finally, admins can restore archived departments in case there are new institutes or departments.

However, administrators are prohibited from chatting with students as they are primarily concerned with managing the users, roles, and departments. For security purposes, admins can view the audit trails containing records of user actions concerned with the system's security, like creating accounts.

There is also a page to update the profile, which may differ slightly depending on the kind of user. However, it generally contains editable fields for email, name, profile picture, and e-

signature that users may update. A user's role is also displayed on this page but is also read-only. Reachable employees can also modify the available free time used for scheduling consultations. Aside from the respective update form, users have a password reset form that needs three passwords: (1) one old password to verify, (2) one new password, and (3) one password to confirm the new password. Changing the default password to a new one is crucial, as this allows any user to fully access the website, especially the consultation page. Generally, a post would contain text content. Posts could also have attached files. However, these limitations limit the validation of posts containing vulgar or offensive words. If, in the worst-case scenario, a post contains such profanities; the consultation system would serve as the method of reporting the post. On the other hand, comments may only contain text content.

The researchers created unit tests to ensure that the functions work correctly. Finally, test cases are performed to ensure the system passes the functionality, suitability, usability, and portability criteria.

The researchers used a modified waterfall methodology. This is a variant of the waterfall methodology. The original waterfall methodology is a linear process where developers follow the sequence strictly and are prohibited from going back to previous steps [18]. On the other hand, the modified waterfall model allows going back to previous steps to verify or validate the results of a particular step. Other models were used, but some have constrained flexibility [19], need heavy administration [20], or are expensive [21].

Researchers created the pages according to their importance. The researchers primarily used JavaScript, Cascading Style Sheets (CSS), and Hypertext Markup Language (HTML) to implement the previously mentioned pages. All the program code changes were tracked using Git and uploaded to a GitHub repository. At the end of the implementation, the website was deployed on the Digital Ocean platform and utilized its offered Postgres database [22].

The researchers' plan for a native mobile application was denied due to resource constraints (e.g., time, storage, and types of devices used). On the other hand, the system

can use responsive web design to ensure accessibility in mobile web browsers. In addition, researchers built an HTTP server using Node.js and a separate PostgreSQL database server.

Looking at Messenger's deployed system, reactions, and other features [23] was outside the researchers' options. Saving replies is a feature in MS Teams. However, this was excluded from the system. The system needs special handling of graduates' or dropped students' accounts, as the dean or admin archives these accounts.

SYSTEM DEVELOPMENT METHODOLOGY

Certain methods were used to gather the information that influenced the development of the system. The study has discussed the methodology that guides the creation of the system. An overview of various software process models was done to evaluate the effectiveness of the chosen model. Then, each phase (as outlined by the chosen methodology) was discussed.

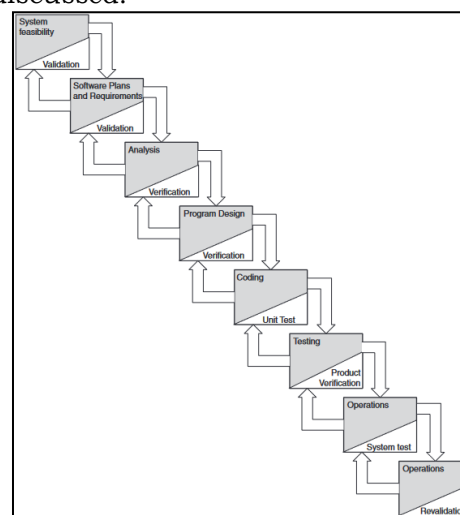


Figure 1: Illustration of modified waterfall model according to Eric Conrad
(Source:

<https://www.sciencedirect.com/science/article/pii/B9781597495660000084>)

General Method Used

The study used the modified waterfall model to develop the system. This methodology uses a software development life cycle (SDLC) sequentially. The researchers first assessed if the study was feasible, then gathered

requirements and planned the creation of the system.

Websites that mainly explain other systems' features are help centers, blogs, and tutorials. Observation is another tool that researchers used to elicit the requirements. A digital scan of a censored consultation form (as observed in Fig. 2) previously in the pre-pandemic period was one of the inspirations of the system under development.

Figure 2: Pen and paper variant of consultation before the pandemic

These requirements were analyzed to determine the program design. The program has been implemented and tested. The tests used the test cases based on the use case diagram determining its functional suitability, usability, and portability. After testing, it was deployed. If one of the steps experienced some technical problems due to decisions made from the previous step, researchers were able to return to the previous step [18]. A modified waterfall was chosen as a methodology because its requirements are stable. Therefore, its development was documented thoroughly.

Compared to other models like the V model, iterative model, and others, the modified waterfall model is more appropriate than other models as it is inexpensive and simpler compared to the spiral model [21]. The study also had no drastic changes in the requirements where the iterative model is a good fit [20]. Meanwhile, the V model may be easy to use but has limited flexibility [19], unlike the feedback system offered by the

modified waterfall model [24]. Some models require a tremendous amount of work that may make the study unattainable. Besides, the modified waterfall model is more suitable than the classic waterfall model because flexibility is necessary between implementation and testing [25].

Procedures

System Feasibility

First, the researchers hypothesized that the system was attainable. A brainstorming session was held to refine ideas further. Some of the idea generations have already occurred (as shown in Fig. 3). The researchers have decided, through voting, the study to propose, and this research was one of the chosen ideas.

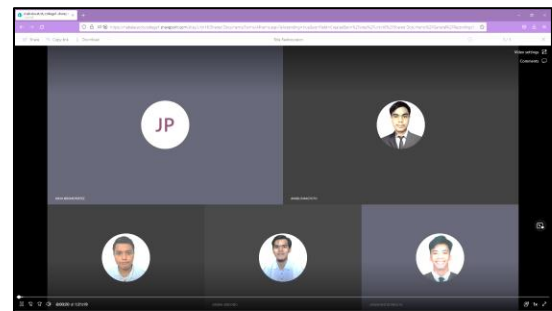


Figure 2: Screenshot of video of title re-discussion

Researchers searched for the minimum hardware requirements of the operating system and browser to be utilized to develop a website. Then, researchers employed observation and online research to gather the requirements. Some of these requirements were derived from experiences and were witnessed firsthand by researchers or participants.

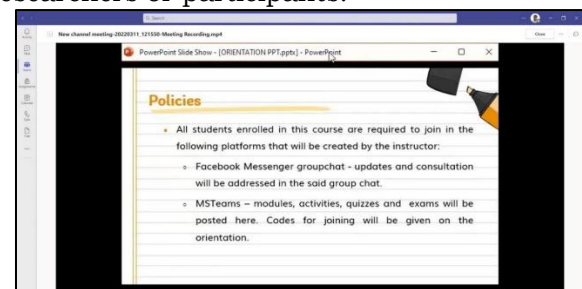


Figure 3: Policy on platforms to be used for online class in ITELE6

Various literature and studies (from official help centers, tutorials, and others) were gathered and used to inform the decisions that were made on the development of the system.

The researchers made sure that the online sources they used for this research paper were at least five years old by looking at the date of publication or last change.

Software Plans and Requirements

The plans in the conceptual framework were followed by the researchers. The software that is required to implement the system. Most of it is based on the technologies that were used, as stated earlier. The majority of these programs are free and open-source [26] [27] [28].

The minimum hardware specifications that were required for the developer based on Windows 10 or 11 operating systems [29] [30] and the Firefox Browser [31]. This ensured that developers installed the necessary software to develop the system.

Analysis

In this phase, the requirements were specified and analyzed to see how the system should act. The researchers also reviewed which features to include or exclude. Thus, the scope and limitations were determined. In addition, the roles of researchers in the development of the system were assigned. A Gantt chart was created to estimate the time needed to complete the task.

System information diagrams were created based on the requirement analysis. These diagrams were validated against the requirements. The UCD identified the possible use cases. Students will be able to inquire about employees and view previous consultations. Employees will do the same except for consulting other employees. Also, employees would reply to students' consultations. Once the consultation has started, both students and employees will interact with each other through chat. In addition, the admin is responsible for user registrations, but the admin, service heads, and deans will manage registered users. Lastly, admins have access to all user management features except consultation features.

The VTOC was created and enhanced to show the initial layout of pages. The application should start at home. Then, the user will log in using his/her credentials. Employees or students will be added by the admin. All users can update some fields in the profile settings. In addition, employees could update the available times. Admins, service heads, and

deans could manage users. Admin could also manage the roles and departments.

Program Design

The ERD portrayed how different concepts are linked in a database. As depicted in the ERD, the user has the most significant number of relationships in this diagram since the entity is involved in different functionalities. There were tables like roles and groups containing records associated with the users. DFD gave an overview of where the data was input by the users and where the information presented by the system was stored. The DFD was simplified up to level 0.

Aside from the diagrams, mock UI screens were created to guide the front-end developers in implementing the design. Note that the mock screens are unrestricted in their ability to dictate the design.

Coding

With all the system information diagrams created and with the panelists' approval, the system was created using the technologies mentioned earlier, conforming to the conceptual framework and modified waterfall model. Then, back-end and front-end interfaces were implemented using open-source technologies, Vue for the front-end development, and Express JS/Node.js for the back-end development of the system.

Testing

The system's test respondents were chosen randomly using purposive sampling, one of the many sampling methods that can be used [32]. Researchers have chosen thirty-three (33) respondents from students and teachers within Mabalacat City College (MCC). The system was thoroughly tested using researchers'-made test cases based on ISO 25010 to determine the system's value to stakeholders by measuring and evaluating desired characteristics [33]. These test cases were based on UCD, which evaluated the system on the following criteria: The first is functional suitability, which examines the following: functional completeness, or whether user-level access is properly distributed and working properly; functional correctness, which ensures the system is functional and features are properly and accurately working; and functional appropriateness, which ensures a specific user

level can access and navigate what the user is supposed to access.

The second is Compatibility, which ensures the system can interact with different client web browser applications without causing problems with the different operating systems (OS) running on internet-capable gadgets like desktop PCs, laptops, and smartphones.

The third is Usability which ensures the following: appropriateness and recognizability of the system designs and function; checks user error protection for system response with an error message; learnability and operability, which means that the system is user-friendly and can be easily operated without any problems; the system's graphical user interface background and foreground colors are blended and suitable, or user interface aesthetic; and the accessibility of the system, which ensures the functions are working as expected.

Finally, Portability ensures that the system's adaptability is properly demonstrated, that it can independently adapt an active session on either the server or client side, and that it can be easily installed and configured on a web-hosting site.

$$P_s = \frac{A_s}{\sum A_i} \times 100$$

Notation 1: Formula to get percentage of yes or no

After gathering the data from respondents, the frequency of yes and no responses was calculated. Then, each percentage was derived for each subcriteria of functional suitability, compatibility, usability, and portability (see notation 1). P_s indicated the percentage of yes or no responses on a given subcriteria. A_s indicated the raw number of answers, which may be yes or no. $\sum A_i$ indicated the total number of yes or no responses for a given subcriteria.

$$\bar{x}_c = \frac{\sum P_s x}{n}$$

Notation 2: Formula for the mean score of a certain criterion

Afterwards, the average of these subcriteria was calculated to determine the performance of the system on different criteria (see notation 2). $\bar{x}_c$ indicated the mean score of a criteria. As indicated by, each criterion has a different number of subcriteria. In addition, these subcriteria also have different numbers of

percentages of answers that are "yes.". The said percentages were added to get the total percentage, as indicated by the arrow, indicates the weight depending on the answer if yes (1) or no (0).

Table 1: Nominal values for the interpretation

Range	Interpretation
95% - 100%	Excellent
90% - 94.99%	Very good
85% - 89.99%	Good
Below 85%	Extremely Poor

After the calculations, each mean score was interpreted using the table above. The scores were classified into four distinct classes: excellent, very good, good, and poor/needs improvement. The composition of respondents was also analyzed to allow comparisons between reproductions [34].

Operations

Finally, the complete system was uploaded to the chosen hosting provider, which is DigitalOcean. The system was checked again to see if it was compatible and worked properly with the hosting provider. The system was deployed and completed. End-users would access it using the Firefox browser. Meanwhile, this paper was scanned for plagiarism to ensure its authenticity.

RESULTS AND OUTCOMES

Software and Hardware Requirements

During the development, the researchers utilized numerous software packages that are open source and compatible with the current setup. The system also uses other software and services to develop the website. For end users using a desktop, an operating system such as Windows 10 [29] or 11 [30], as well as a modern browser to access the site such as Mozilla Firefox, are required [31].

Testing Results Prototype

The system was evaluated using researchers'-based test cases inspired by ISO 25010 [33]. Different students and faculty members evaluated the functionality, suitability, usability, and portability of the system. To see all test cases in one table. In addition, the composition of respondents was also provided,

which is useful for future analyses with replicated studies [34].

Composition of Respondents

Table 2: Composition of Respondents by Gender

Gender	Percentage of Respondents
Male	27.27%
Female	69.70%
LGBTQIA+	3.03%

The table above shows the composition of the respondents by gender. Nine (9) of the respondents are male, 23 are female, and one is a member of LGBTQIA+. In total, 33 respondents answered the survey.

Table 3: Composition of Respondents by Institute

Institute	Percentage of Respondents
IBCE	75.75%
IHTM	21.21%
IASTE	3.03%

Twenty-five respondents came from the Institute of Business and Computing Education (IBCE). Institute of Hospitality and Tourism Management (IHTM) came second. The Institute of Arts and Sciences and Teacher Education (IASTE) makes up the rest.

Table 4: Composition of Respondents by Year Level/Occupation

Year Level/Occupation	Percentage of Respondents
Student (1st Year)	27.27%
Student (2nd Year)	15.15%
Student (3rd Year)	12.12%
Student (4th Year)	42.42%
Teacher	3.03%

Nine of the respondents were first-year students. Five of students were second-year students. Also, there were four third-year students. Meanwhile, 14 students were graduating students. Lastly, there is one teacher who also evaluated the system. The researchers acted as a dean or professors to

demonstrate the system to students. However, the researchers acted as the dean or admin for the teacher.

Functional Suitability

Table 5: Average score for functional suitability

Test Case	Yes (%)	No (%)	Interpretation
Functional Completeness	93.36%	6.64%	Very good
Functional Correctness	98.18%	1.82%	Excellent
Functional Appropriateness	96.97%	3.03%	Excellent

An average score of "Yes" as 96.17% the answer Excellent

Upon calculation of averages, the system scored 96.17% in terms of functional suitability. Based on the nominal scale, the system's functional suitability is "Excellent". The table above indicates that the system performs most of the functions, all of which return a correct and appropriate output. None of the subcriteria scored perfectly, yet they scored highly.

Compatibility

Table 6: Average score for compatibility

Test Case	Yes (%)	No (%)	Interpretation
Interoperability	96.97%	3.03%	Excellent
Coexistence	100%	0%	Excellent

The average score of "Yes" 98.48% as the answer Excellent

Upon calculation of averages, the system scored 98.48% in terms of compatibility, which is "Excellent" when interpreted in terms of the nominal scale. The table indicates that the web system interacted with various web browser applications with the different operating systems (OS) running on internet-capable gadgets like desktop PCs, laptops, and smartphones with almost no errors. Note that coexistence is the highest among the subcriteria.

Usability

Table 7: Average score of usability

Test Case	Yes (%)	No (%)	Interpretation
Appropriateness Recognisability	96.97%	3.03%	Excellent
Learnability	100%	0%	Excellent
Operability	92.93%	7.07%	Very Good
User Error Protection	92.42%	7.58%	Very Good
User Interface Aesthetic	97.98%	2.02%	Excellent
Accessibility	100%	0%	Excellent
The average score of “Yes” as the answer			96.72% Excellent

Upon calculation of averages, the system scored 96.72% in terms of usability. The system scored “Excellent” in accessibility and learnability despite scoring highly in other subcriteria. The table indicates that the system is intuitive, readable, convenient to use, and protects respondents from system errors by showing sufficient user-friendly error messages.

Table 8: Average score of portability

Test Case	Yes (%)	No (%)	Interpretation
Adaptability	98.48%	1.52%	Excellent
Installability	98.48%	1.52%	Excellent
The average score of “Yes” as the answer			98.48% Excellent

Upon calculation of averages, the system scored 98.48% in portability. Therefore, it is concluded that the system is “Excellent” with this criterion. The table indicated that the system was adaptive in any web hosting Node.js environment, free from vendor lock-ins, and matched the server and client sides in any state. The system scored highly on both.

Implementation Results

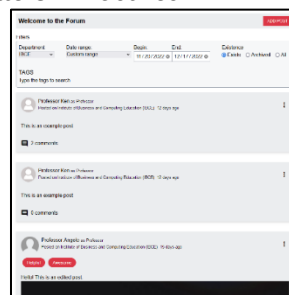


Figure 4: Forum page

The forum page listed all the posts based on their existence. Permitted users could post announcements in designated departments on this page. The administrator has unique permission to post generally, which every user could see regardless of the department.



Figure 5: Consultation page

The consultation page allowed users to see present and previous consultations that were conducted. It also showed the number of all tickets requested, the time remaining for the requested consultation, the status of the consultation, and the printable form, which could be used as a reference, evidence, requirement, etc. On the consultation page, the consultee(s) can request a video conference with the consultant. Attaching files like pictures and files could also be done on this page.

DISCUSSION

The system was created while conforming to the conceptual framework and modified waterfall model [25] [24]. Several open-source technologies and tools were used such as VS Codium [26], Node.js [35], Express JS [36], PostgreSQL [27], Vue [28], and Firefox [31]. The system adhered in JSON:API standard [37] [38] for communication between front-end and back-end. Github [39] [40] and DigitalOcean [41] were used to collaborate between developers and deploy the system. Microsoft

Visio [17] was used to create the diagrams such as ERD and VTOC.

After the main development, the researchers created a Microsoft Form to administer the survey. The respondents of the study were mostly female, came from IBCE; and were fourth-year students

The system was evaluated for functional suitability, compatibility, usability, and portability and achieved an average score of "Excellent" (96.17%, 98.48%, 96.72% and 98.48%) on a nominal scale. The system performed well in all the criteria, including performing most functions correctly and appropriately, interacting well with various web browsers and operating systems, being highly accessible and learnable, and being highly portable.

Several challenges were encountered, such as compatibility of the new package with the existing packages, limited financial and time constraints, and integration of front-end and back-end interfaces. Another bottleneck is that the development server loads slowly at the start yet runs fast after some optimization.

REFERENCES

- [1] A. Conrad, "The 7 Rules of Business Chat Etiquette Your Team is Definitely Breaking," 21 May 2021. [Online]. Available: <https://www.getapp.com/resources/business-chat-etiquette-rules-for-small-business/>. [Accessed 24 March 2022].
- [2] C. Constandache, "Why Messaging Is The Platform Of The Future | The Drum," 13 March 2020. [Online]. Available: <https://www.thedrum.com/opinion/2020/03/13/why-messaging-the-platform-the-future>. [Accessed 02 April 2022].
- [3] D. York, "Best Practices for Instant Messaging at Work," 11 March 2020. [Online]. Available: <https://hbr.org/2020/03/best-practices-for-instant-messaging-at-work>. [Accessed 2 April 2022].
- [4] S. K. Abd, R. Hassan, F. H. Siran and W. Wahi, "The Use of Messaging Applications among University Students: A Case at Universiti Kebangsaan Malaysia," *International Journal of Engineering & Technology*, vol. 7, pp. 925-931, 2018.
- [5] M. O'Neill, "Communication Failure: Why It Happens and How Team Chat Apps Can Help | Promises at Work," 19 November 2018. [Online]. Available: <https://www.samewave.com/posts/how-to-avoid-communication-fails-with-teamwork-chat-apps>. [Accessed 22 March 2022].
- [6] Statista Research Department, "• Number of social network users in the Philippines 2018-2023 | Statista," 12 August 2021. [Online]. Available: <https://www.statista.com/statistics/489180/number-of-social-network-users-in-philippines/>. [Accessed 23 March 2022].
- [7] Department of Labor and Employment, "Bello: 'Right to disconnect' after office hours choice of employees | Department of Labor and Employment," 1 February 2017. [Online]. Available: <https://www.dole.gov.ph/news/bello-right-to-disconnect-after-office-hours-choice-of-employees/>. [Accessed 26 March 2022].
- [8] W. J. Lammers, "Why Won't Students Ask Us for Help?," 24 March 2017. [Online]. Available: <https://www.facultyfocus.com/articles/effective-classroom-management/wont-ask-us-help/>. [Accessed 27 March 2022].
- [9] E. Wicklund, "Telehealth Gives College Students a Discreet Path to Counseling," 24 January 2019. [Online]. Available: <https://mhealthintelligence.com/news/telehealth-gives-college-students-a-discreet-path-to-counseling>. [Accessed 27 March 2022].
- [10] Mabalacat City College, "Mabalacat City College Student Affairs and Support Services (SASS)," 22 October 2021. [Online]. Available: <https://mcc.edu.ph/post/mabalacat-city-college-student-affairs-and-support-services-sass>. [Accessed 2 April 2022].
- [11] J. Lumawig-Buensalido, "Why messaging apps are your new best friend | Joy Lumawig-Buensalido," 10 June 2019. [Online]. Available: <https://businessmirror.com.ph/2019/06/10/why-messaging-apps-are-your-new-best-friend/>. [Accessed 21 March 2022].
- [12] L. H. Wei, "Why Can't I See 'Last Active' on Facebook Messenger? - Followchain," 28 February 2021. [Online]. Available: <https://www.followchain.org/cant-see-last-active-facebook/>. [Accessed 5 April 2022].
- [13] dtedit, "6 Social Media Platforms & How Educators Are Using Them - MMS Education," 8 November 2017. [Online]. Available: <https://www.mmseducation.com/6-social-media-platforms-educators-using/>. [Accessed 25 October 2022].
- [14] "ONE STI Learning Model," [Online]. Available: <https://www.sti.edu/onestilearningmodel.asp>. [Accessed 6 April 2022].
- [15] K. Beaudway, "First things to know about chats," 30 September 2020. [Online]. Available: <https://www.technology.pitt.edu/blog/chat>. [Accessed 5 April 2022].
- [16] D. Mollenkamp, "Popular K-12 Tool Edmodo Shuts Down | EdSurge News," 16 August 2022. [Online]. Available: <https://www.edsurge.com/news/2022-08-16-popular-k-12-tool-edmodo-shuts-down>. [Accessed 25 October 2022].
- [17] Microsoft, "Types of diagrams that are supported in Visio in Microsoft 365," 25 August 2021. [Online]. Available: <https://support.microsoft.com/en-us/office/types-of-diagrams-that-are-supported-in-visio-in-microsoft-365-877c30a8-0951-4b7a-a53b-daa3d81bea03>. [Accessed 30 March 2022].

- [18] E. Conrad, "Chapter 8 - Domain 8: Application Development Security," in *Eleventh Hour CISSP*, E. Conrad, Ed., Syngress, 2011, pp. 129-145.
- [19] Prasanna, "V Model Advantages and Disadvantages | What is V-Model? When and How To Use It? Merits and Demerits," 7 January 2022. [Online]. Available: <https://www.aplustopper.com/v-model-advantages-and-disadvantages/>. [Accessed 29 April 2022].
- [20] P. Pedamkar, "Iterative Model | Examples | Advantages and Disadvantages," 5 June 2021. [Online]. Available: <https://www.educba.com/iterative-model/>. [Accessed 4 May 2022].
- [21] "Software Engineering | Spiral Model - GeeksforGeeks," 9 February 2022. [Online]. Available: <https://www.geeksforgeeks.org/software-engineering-spiral-model/>. [Accessed 29 April 2022].
- [22] A. S. Gillis, "DigitalOcean," TechTarget, June 2022. [Online]. Available: <https://www.techtarget.com/searchcloudcomputing/definition/DigitalOcean>. [Accessed 09 November 2022].
- [23] Messenger, "Introducing Message Reactions and Mentions For Messenger | Meta," 23 March 2017. [Online]. Available: <https://about.fb.com/news/2017/03/introducing-message-reactions-and-mentions-for-messenger/>. [Accessed 23 March 2022].
- [24] Prashant, "What is Waterfall Model? | Modified Waterfall Model," 3 January 2022. [Online]. Available: <https://www.thestudygenius.com/what-is-waterfall-model/>. [Accessed 29 April 2022].
- [25] D. V. Bosman, "Using binaural audio for inducing intersensory illusions to create illusory tactile feedback in virtual reality," 2018.
- [26] A. Jones, "What is VSCode and Should You be Using It | by Alan Jones | Towards Data Science," 5 October 2021. [Online]. Available: <https://towardsdatascience.com/what-is-vscode-and-should-you-be-using-it-926e1369169a>. [Accessed 19 October 2022].
- [27] I. Panchenko, "PostgreSQL benefits and challenges: A snapshot," 27 May 2021. [Online]. Available: <https://www.infoworld.com/article/3619531/postgresql-benefits-and-challenges-a-snapshot.html>. [Accessed 19 October 2022].
- [28] S. Omojola, "Comparing Vue.js to new JavaScript frameworks - LogRocket Blog," 19 June 2021. [Online]. Available: <https://blog.logrocket.com/comparing-vue-js-to-new-javascript-frameworks/>. [Accessed 24 October 2022].
- [29] P. McNally, "Windows 10 System Requirements," 1 October 2021. [Online]. Available: <https://support.microsoft.com/en-us/windows/windows-11-system-requirements-86c11283-ea52-4782-9efd-7674389a7ba3>. [Accessed 25 October 2022].
- [30] Microsoft, "Windows 11 System Requirements," Microsoft, 12 January 2022. [Online]. Available: <https://support.microsoft.com/en-us/windows/windows-11-system-requirements-86c11283-ea52-4782-9efd-7674389a7ba3>. [Accessed 25 October 2022].
- [31] Mozilla, "Firefox 102.0.1 System Requirements," 6 July 2022. [Online]. Available: <https://www.mozilla.org/en-US/firefox/102.0.1/system-requirements/>. [Accessed 14 July 2022].
- [32] K. Nikolopoulou, "What Is Purposive Sampling? | Definition & Examples," Scribbr, 10 October 2022. [Online]. Available: <https://www.scribbr.com/methodology/purposive-sampling/#:~:text=Purposive%20sampling%20refers%20to%20a,on%20purpose%20of%20purposive%20sampling..> [Accessed 4 November 2022].
- [33] ISO, "ISO/IEC 25010:2011(en), Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuARE) — System and software quality models," March 2011. [Online]. Available: <https://www.iso.org/obp/ui/#iso:std:iso-iec:25010:ed-1:v1:en>. [Accessed 2 December 2022].
- [34] C. Hammer, "The Importance of Participant Demographics," *American journal of speech-language pathology / American Speech-Language-Hearing Association*, vol. 20, p. 261, November 2011.
- [35] C. Kopecky, "What is Node.js? A beginner's introduction to JavaScript runtime," 30 September 2020. [Online]. Available: <https://www.educative.io/blog/what-is-nodejs>. [Accessed 19 October 2022].
- [36] A. Sharma, "What Is Express JS In Node JS?," Simplilearn Solutions, 13 October 2022. [Online]. Available: <https://www.simplilearn.com/tutorials/nodejs-tutorial/what-is-express-js>. [Accessed 21 October 2022].
- [37] R. Batra, "How important is JSON API for a Headless website | Opensense Labs," 21 June 2018. [Online]. Available: <https://opensenselabs.com/blog/tech/json-api-important-headless-website>. [Accessed 25 October 2022].
- [38] L. Bradford, "GitHub: What Is It?," 24 July 2020. [Online]. Available: <https://www.liveabout.com/what-is-github-and-why-should-i-use-it-2071946>. [Accessed 4 April 2022].
- [39] Devopedia, "GitHub Actions," 21 March 2022. [Online]. Available: <https://devopedia.org/github-actions>. [Accessed 4 April 2022].
- [40] DigitalOcean Dev Center, "Node.js Hosting & Deployment | DigitalOcean," 2022. [Online]. Available: <https://www.digitalocean.com/solutions/nodejs-hosting>. [Accessed 30 November 2022].
- [41] "What is Agile Development? Scrum Events in Agile Methodology," 3 March 2021. [Online]. Available: <https://www.educba.com/what-is-agile-development/>. [Accessed 4 May 2022].

The Adventure of Techy Stud2: A 3D IT Essentials Game for Android

Ronche A. Encio
Monica G. Macabanti
John Dave P. Pineda
Glen Amiel P. Regino
Raissen D. Serrano
Erika Mae D. Udiong
Engr. Ernie Lee E. Pineda, MIT (Technical Adviser)

ABSTRACT

In the last few years, some previous studies have proven that the motivation to learn and effectiveness can be increased through games that teach, and the most recent overview of improved gaming features has made games more well-known. Smartphone games, particularly those on an Android platform, are famous as a time-killer; however, they also boost the number of multitasking individuals can perform. In this situation, combining learning and entertainment with education is a good idea. The researchers developed “The Adventure of Techy Stud2: A 3D IT Essentials Game for Android.”, a 3D adventure game based on the Android platform. This study combines an adventure and an educational game that best suits people who want to play and learn simultaneously. The researchers used a Modified Waterfall Model for software development. The study has undergone game evaluation using the criteria of MEEGA+. Based on the beta test results, the researchers achieved overall application acceptance. As for the recommendations, that should expand the game to other platforms and include a password in account creation to make the account transferrable to another device.

INTRODUCTION

Technology refers to the use of science-based knowledge to achieve the goals of life for humans. Technology has helped improve the manipulation and modification of the environment for humans because of people’s demands and needs. [1]

Android is the most robust mobile platform. Android development is now the most sought-after career option for those who wish to reach a broad, multi-faceted audience. Computer software is a popular tool that has seen a boom in mobile devices and other technology. Apps like games and apps are a part of the market. Developers and programmers are constantly creating new styles and features for apps and games that would appeal to most people. [2]

The purpose of the games has moved beyond entertainment and has become an essential tool in fields like business, education, and health. Students need to be familiar with the various concepts of information literacy, like search terms, identifying sources, and appropriate reference citations. The game centers around an exciting experience. The evaluation results show that players face an extremely competitive soon. The game is beneficial to the players or players as it

improves memory, brain speed, and focus. Games that are involving require problem-solving and strategy to be successful and need players to be able to recall and absorb a lot of information. Engaging in these games helps players and users increase short- and long-term memory and aid in processing information more quickly. Additionally, it can stimulate players’ imaginations, which allows players to focus on specific goals and determination to achieve an objective. Also, it helps improve multitasking skills that require players to search for objects while fighting others, which requires attention to detail and quick responses. [3]

The researchers developed a mobile game entitled “The Adventure of Techy Stud2: A 3D IT Essential Game for Android.” to educate and entertain gamers. This game aims to assist users, especially IT Essentials students because one of its features is the IT Essentials core topics taking the game challenges by learning the lessons.

Background of the study

In the demand of game development, the researchers needed some concepts and ideas to help develop the study.

The researchers brainstormed and exchanged ideas to make a fictional story for the game so it would be more fun and exciting.

The game was first seen in 2D under the same name as Techy Stud. The researchers chose 3D as the game's foundation in development because it has better graphics than 2D and 2.5D.

The 3D game environments are the best source for creating high-quality artwork for various game worlds. The students learned how to create realistic textures using photo sources and multiple techniques to depict natural and lively game worlds using Photoshop or Unity 3D. The students provided all the tools required to build realistic gaming environments, including detailed instructions on how to create 3D models, incorporate 2D art into 3D models, and clear guidance on the effectiveness and optimization of the 3D games engine. [4]

Gaming apps have become an increasingly well-known kind of smartphone entertainment and could pose a problem with risky or prohibited usage among a small percentage. The objective was to utilize an online questionnaire to study the connection between gaming on smartphones and self-perceived problems with smartphone use to discover factors that could be a predictor. [5]

The game is intended to entertain and challenge gamers by guiding them through a complete quest on an Android mobile device. The researchers enhanced the gameplay by incorporating sound effects, background music, skill effects, and portion activation effects, and the players would feel and experience better gameplay as a result. The IT Essentials core topics are the educational components of this game, such as familiarization with networking concepts and computer hardware assembly. The researchers came up with an idea to make version 2 of the previous mobile game entitled "The Adventure of Techy Stud1." which was proposed and completed three years ago. The researchers would have an improved gaming environment by converting the old version into 3D by adding new maps, levels, challenges, and an enhanced storyline. Version 1 focuses on computer hardware assembly. This time, the researchers would include learning mechanisms from the IT

Essentials subject to assist players and BSIT students taking the game challenges by learning the lessons. It's intended for students enrolled in the BSIT course to help players understand IT Essentials core topics while having fun. The player's primary goal in the game is to fight and defeat all minions and bosses. The player can collect in-game items while providing knowledge and information that would be helpful in technology. In this game, items and power-ups are IT Essentials core topics, which would help the player survive and complete each level.

General objective

The general objective of the study is to develop a 3D mobile game entitled "The Adventure of Techy Stud2: A 3D IT Essentials Game for Android."

Specific objectives

This study has the following specific objectives:

- To gather information on planning the mobile-based game by incorporating IT Essential topics.
- To identify the mobile hardware and software requirement specifications of the game.
 - Unity 2021.1.17f1
 - Visual Studio 2019
 - MonoDevelop
 - Photon Unity
 - Audacity
 - Adobe Photoshop CS6
 - Sai Paint Tool
 - Blender 3D 3.1
 - Java JDK, Android NDK
- To design an Android-based game using the following designing tools:
 - Storyboard
 - Character Design
- To create a mobile game with the following features:
 - Single Player
 - Character Selection
 - Map
 - Hardware Information and Trivia
 - Assembly
 - Computer Parts
 - Saving System
 - Inventory
 - Real-time Battle System
- To develop a 3D Multiplayer game with PvP battle feature.

- Multiplayer (Player vs. Player type)
- To test the developed mobile game using MEEGA+
- To deploy the mobile game on Google Play Store

Scope and limitation of the study

The study is aimed at an upgraded version of the mobile game-based with the name Techy Stud, which would allow users or gamers to have fun and learn about IT Essentials' core topics while playing. It is a 3D game entitled "The Adventure of Techy Stud2: A 3D IT Essentials Game for Android."

The researchers used a Windows Operating System powered computer to build the game. The researchers used Unity 3D and Blender 3D to create the game and model animations of the game's characters, minions, and bosses. Mono Develop and Visual Studio are used for the programming and debugging of the game. Adobe Photoshop and Sai Paint Tool are used to put sketches and artwork into the game and adjust the lighting to create a 3D environment. Audacity was used to input game music and soundtracks to make upbeat challenge music. To make the multiplayer feature, the programmers used Photon Unity, Java JDK, and Android NDK to write the game's programming language in Java and C# languages. There is also a multiplayer mode that accommodates three players. The researchers have also created settings, maps, hardware information, and trivia.

The researchers used sketches of character models from the paper: including the main characters, enemy minions, and bosses. It served as an approach to creating the Character Design and the game's environment, including using IT Essential topics as the educational part of the game. This game is only available on the Android operating system and runs through Wi-Fi. The game is recommended to be played on Android phones. It is suitable to be played in landscape orientation and intended to be played by a single-player and multiplayer.

The researchers made the game target users around 12-20 years of age; most teens around this age have smartphones, and introducing the game would help them familiarize the computer and understand IT Essential topics

that would allow the users to be computer literate.

The researchers used the MEEGA+ criteria of Player Experience and Usability as tools for testing and survey. Usability comprises Aesthetics, Learnability, Operability, and Accessibility, all essential considerations. User Error Prevention comes first in the Player Experience, followed by Challenge, Fun, Confidence, Relevance, Satisfaction, and Learning. As a result, the researcher determines whether or not additional improvements to the game are required.

The game had undergone beta testing. In the beta testing, the researchers used a purposive random sampling approach and randomly selected thirty (30) random students of Mabalacat City College to evaluate the game.

SYSTEM DEVELOPMENT METHODOLOGY

Game Development Methodology

The modified waterfall is an organized development cycle that incorporates numerous flexible, iterative steps to ensure the precision of the design and documentation, ensuring the quality and reliability, and maintenance of the software created. The MWF method is preferable for complicated and technical projects requiring customized software design. In this method, there are several phases that the software would go through. The steps include the analysis phase, the design stage, implementation phase, testing phase, as well as maintenance phase. [6]

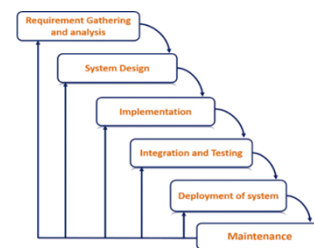


Figure 5: The Modified Waterfall Development Methodology of Techy Stud2

(Source: <https://www.thestudygenius.com/wp-content/uploads/2020/04/modified-waterfall-model-e1588262461818-1024x891.png>)

The researchers chose the modified waterfall methodology (see figure 5). This methodology was suited to the development of the study. In addition, unpredictable changes and risks are

inevitable along the process of development of the study, thus, using this methodology helped with the study's needs.

Requirements Gathering and Analysis

The researchers conducted brainstorming activities and planned the titles presented at the title defense. Among the proposed titles, the panelist approved the study. After the title defense, the researchers collaborated with the chosen adviser to further improve the initial functions of the study. In addition, the researchers also did the initial research on a few related studies and game requirements that could help determine the project's functions—the programmer prepared by watching and understanding video tutorials in the project development area. The researchers chose a technical adviser who could help with the project's technical side.

The researchers met with the capstone adviser twice per week to verify and identify the essential information gathered to be used to create the project's strategy documents. The researchers collected data through the internet and the school library for additional ideas and knowledge to develop the study further. The researchers shared those thoughts and created an adventure game related to IT Essentials' core topics' information and technology concept entitled "The Adventure of Techy Stud2: A 3D IT Essentials Game for Android." The Software and Hardware Specification for application development (see table 1) shows the software and hardware used to develop the project.

Table 1: Software and Hardware Specification

Hardware Specification	Software Specification
Smartphone	Unity 2021.1.17f1
Android version 9.0 (Pie)	Visual Studio 2019
Up to Android 12 (Snow Cone)	Audacity
	Adobe Photoshop C36
	Sai Paint Tool
	Photon Unity
Computer	MonoDevelop
LAPTOP i5 4th gen	JDK and Android NDK
8GB RAM	Blender 3D 3.1
Integrated graphics	

System Design

System designs are an essential part of any software project. It is also a process that involves the team's cooperation and the target

user's opinion because when the developer does the system design task, the researchers and the target user are the ones doing the user testing. So, the developers can present the new design requested or the users' feedback at the next meeting.

The researchers used the designing tools to illustrate the character and environment of the developed game. The designing tools are Storyboard, Character Design, and Game Layout.

Storyboard

The researchers developed a storyboard that outlines the game's activities, and a storyboard can help developers immediately understand what work needs to be completed. Anyone can see completed work once the team updates the storyboard. It provides the product owner transparency and helps the team visualize the sequence and interconnectedness of user stories. Storyboards can be physical or digital.

Character Design

The first thing to establish during the design of characters procedure is how the surface to designed. Comprehending the character's intended audience based on the work is essential. For instance, the game's theme is appropriate for the intended users. The researchers determined various parameters compatible with the persona, like background stories and the character's persona. The goal of a game is to establish background information for portraying the character.

Game Layout

The game layout gives the users easy accessibility to all the software required for the game's development, like vertex standard editing and texture baking, in addition to exporting the game's engine. The game's layout has a flexible structure, making it ideal for being used as a primary layout. The lower toolbar can quickly collapse the panels and access different tools without overflowing the user interface with unnecessary tools. The versatility of this layout can also reduce the necessity of

switching layouts to access an exact device.

Implementation

This phase is where the researcher's stage is inspected and adapted. The developer explained the minimum specification and demonstrated it to the target users. At this time, the target users analyzed the game to identify the requirements missed or issues with the initial conditions. The developer, target users, and researchers worked through these issues during the iteration, evolving the codes that can have the guidelines for accomplishing and finishing throughout.

The researchers also conducted a series of testing while developing, like unit testing wherein the developer programs all the requirements in Unity 3D while the researchers debug all the encountered errors. Integration testing focuses on the functionality of the game development. In contrast, application testing involves the compilation of the game development, where the generated APK file that used to test the game on a smartphone device to see if there is an error or if debugging is required when the researchers play the game.

Integration and Testing

The compilation of the game development proceeds, wherein the unity software generates by APK file to test the game through a smartphone device to check if there is an error or if debugging is needed when the researchers try the game. Unity software would create an APK file for testing the game using a smartphone to determine if it is working correctly or if debugging is required.

The researchers prepared a questionnaire based on the MEEGA+ using a checklist to determine that it met the needed objectives. Google Play was able to upload the game created by the researchers.

The researchers used Educational Game Quality Model MEEGA+ and set the psychometric scale format to a Likert scale (see table 2) questionnaire to evaluate the game. The test questionnaires used by the researchers are based on the standard criteria specified in MEEGA+.

Table 2: Likert's Scale

Response Categories	Numerical Value	Range Interpretation Interval	Verbal
SA	5	4.21-5.00	Excellent
A	4	3.41-4.20	Good
N	3	3.41-4.20	Acceptable
D	2	1.81-2.60	Marginal
SD	1	1.00-1.80	Poor

Likert Scale

The Likert scale is a rating system used in questionnaires designed to measure people's attitudes, opinions, or perceptions. The researchers applied the Likert scale to translate the result criteria obtained into those verbal interpretations after calculating the means for each sub-criteria and standard of the survey tool.

Deployment of System

The deployment of the system phase was after the integration and testing phase. The deployment phase includes testing required to ensure the project's development, and the requirements must be well-shown to the users. During project implementation, the team executed the tasks and reported the progress data through constant group meetings. The project manager used this data to keep control of the project's direction by comparing the progress reports with the project plan to scope the accomplishment of the project activities and take remedial action as needed. The software may be distributed to users in a few environments, increasing at the end of every emphasis or iteration.

After having identified an initial feature list, prioritized it, and estimated it, the team held a deployment plan to establish the overall release schedule and determine which features could likely be delivered. The comprehensive deployment plan in prioritized features feeds individual iteration plans. Acceptance testing it's also included in the deployment phase, where the panel of panelists authorizes the researchers to release the game application in the Google Play Store.

The users can download the game by accessing the Google Play Store, which is only available for Android devices. The game is compatible with Android versions 9.0 Pie up to 12.0 Snow Cone.

Maintenance

The maintenance phase comprises the processes needed to monitor, review, and organize the progress and results of the project. That would also find any areas where adjustments are required and start the necessary changes.

In this phase, the system still needs maintenance. The researchers may significantly enhance the game using user feedback and recommendations from the Google Play Store. It includes any or all of the following: updating systems, patching them, putting software upgrades in place, or testing for flaws and correcting them if they occur. The user must have Android version 9.0 Oreo or 12.0 Snow Cone as a minimum requirement to download and play the game "Techy Stud 2" for the best experience.

Etikan (2016) cited that the purposive sampling method, also known as the judgment sample, is a measured selection of a person because of the individual's characteristics. It is not a random method that does not require using the primary theories of science or a specific number of participants. Simply put, the researchers determine what information needs to be understood and then set out to locate an organization that can and is willing to share information based on circumstances of knowledge or expertise.

Homogeneous purposive sampling was used because researchers could obtain the correct sample in a short period and where proportionality sampling was not the primary goal.

RESULTS AND OUTCOMES

The study primarily presents the design, development, and testing of the game application entitled "The Adventure of Techy Stud2: 3D IT Essentials Game for Android."

Data and Gathering Requirements

The researchers conducted online data, gathered information through internet searches, and understood the game's development. During this phase, the researchers used the internet to hold virtual meetings to collaborate and gather information. The researchers also discussed the game's gameplay, environments, properties, tools to be used, and other important information. The

group's leader has assigned a series of tasks to each team member. The panelists' recommendations significantly impacted the creation of the paper and game applications.

The researchers identified and used the required hardware and software during the application testing. The researchers used an Android phone for the test project, with the following software: Android OS 9.0 (Pie) for the mobile operating system, 3GB RAM (minimum), 4GB RAM (recommended), and for recommended mobile operating system: Android OS 12.0 (Snow Cone) 4GB (maximum) for memory, and 64 GB for internal storage.

The researchers identified and used a desktop PC powered by Microsoft Operating System (as shown in the photo above) for the development of the mobile game.

Beta Test

The researchers successfully achieved beta testing by administering a game application and collecting the beta questionnaire from the respondents. The respondents had fill-out the form in less than ten (10) minutes after they played and experienced the developed game application. The researchers started conducting beta tests and gathering data surveys on September 19, 2022, ending on October 14, 2022.

The researchers approached thirty (30) respondents to test the game. The beta testers comprised thirty (30) Mabalacat City College students enrolled in the 1st Semester of the Academic Year 2022-2023. The survey was conducted at Mabalacat City College.

Table 3. The summary of Beta Test result of MEEGA+ in terms of Player Experience criteria.

Criteria	Sub-criteria	Mean	Verbal Description
Player Experience	Focused Attention	4.72	Excellent
	Entertainment/Fun	4.48	Excellent
	Challenge	4.38	Excellent
	Social Interactions	4.56	Excellent
	Confidence	4.87	Excellent
	Satisfaction	4.74	Excellent
	Perceived Learning	4.88	Excellent
	Error Prevention and Recovery	4.87	Excellent
	Total Mean	4.69	Excellent

The Table 3 shows the summary of the beta test result of the game in terms of the MEEGA+ Player Experience test. The highest in the sub-

criteria results is Perceived Learning, with a mean score of 4.88 and a verbal interpretation of “Excellent.” It means that the game assisted in the player’s improvement of their tactical strategy. The lowest sub-criteria result is the Challenge, with a mean score of 4.38 and a verbal interpretation of “Excellent.” It means that game applications are appropriately challenging, and the game provides new challenges as the game progresses rather than becoming repetitive.

The player experience criteria got a weighted mean score of 4.69 with a verbal interpretation of “Excellent.” it means that the quality factor that encompasses the user’s deep involvement in the gaming task, including emotions, pleasures, and interactions with the game, environment, and other players.

Table 4. The summary of Beta Test result of MEEGA+ in terms of Usability criteria.

Criteria	Sub-criteria	Mean	Verbal Description
Usability	Aesthetic	4.18	Excellent
	Learnability	4.71	Excellent
	Operability	4.47	Excellent
	Accessibility	4.75	Excellent
	Total Mean	4.53	Excellent

The Table 4 shows the summary of the game’s beta test results in the MEEGA+ Usability test. The highest in the sub-criteria results is Accessibility, with a mean score of 4.75 and a verbal interpretation of “Excellent.” It means the colors used in the game application are significant, and the text’s font, size, and style combination are easy to read. The lowest sub-criteria result is the Aesthetics, with a mean score of 4.18 and a verbal interpretation of “Good.” It means that the game application interface is pleasing and satisfyingly appealing to gamers. The players all agreed that the font and color scheme of the text was harmonious and consistent.

The usability criteria got a weighted mean score of 4.53 with a verbal interpretation of “Excellent.” it means the degree to which specified users can use a product to achieve set goals effectively and efficiently in a context used in computing education.

Table 5. The summary result of MEEGA+ criteria.

Criteria	Sub-criteria	Mean	Verbal Description
Usability	Aesthetic	4.18	Excellent
	Learnability	4.71	Excellent
	Operability	4.47	Excellent
	Accessibility	4.75	Excellent
	Total Mean	4.53	Excellent

The Table 5 shows the summary of the games’ MEEGA+ method results. The highest criteria result is Player Experience, with a mean score of 4.69 and a verbal interpretation of "Excellent." It means the quality factor includes the user's intense involvement in the gaming task, such as emotions, pleasures, and interactions with the game, environment, and other players. The lowest criterion is Usability, with a mean score of 4.53 and a verbal interpretation of "Excellent." It refers to the extent to which specific users can use a product to effectively and efficiently achieve a set of goals in a computing education context. The MEEGA+ method got a weighted mean score of 4.61 with a verbal interpretation of “Excellent.” It means that the MEEGA+ method that made up of a quality model that defines quality factors to be evaluated using a standardized measurement instrument and establishes a process to assess the quality of educational games used in computing education using the MEEGA+ model.

Deployment

After clearing the acceptance testing of beta users and a panel of experts. Figure 19 shows that the researchers launched and released it. It is now easily accessible at Google Play Store. Using a summary statistic from the Google Play Store, the researchers gathered the exact data for application installations, uninstalls, and ratings. It could be helpful for the researchers to keep track of the various Android versions that the app is compatible with 9.0 Pie to 12.0 Snow Cone.

DISCUSSIONS

The main focus of this study was the development of “The Adventure of Techy Stud2: A 3D IT Essentials Game for Android”. With this, it is concluded that the researchers were able to meet the overall objectives of the study. one of the objectives of the study was to

designed and developed an android-based game application that had 3D models that Images, Audio, Information's, Map, Inventory, Assembly and Multi-player. With the used of the modified waterfall methodology, The researchers successfully developed and created a mobile game that would benefit both users and researchers. The diagrams help the researchers to view the flow of the mobile game. The mobile game was successfully created, deployed and implemented by the researchers using the tools and technologies such as Unity 3D software for the mobile game development and Adobe Photoshop CC for editing of images. The researchers believed that the gaming application had been rated as "Excellent" and met the evaluation standards based on the beta test evaluation's overall. The researchers launched and released it after it passed the acceptance testing of beta users and a panel of experts, and it is currently widely accessible at Google Play store. Using a summary statistic from the Google Play Store, the researchers obtained precise data for app installations, uninstalls, and reviews.

With the findings and conclusion of the study, the researchers recommended that the mobile game should expand the game to other platforms and include a password in account creation to make the account transferrable to another device.

REFERENCES

- [1] Front. Psychol., (November 06 2018) Sec. Human-Media Interaction Retrieved from <https://doi.org/10.3389/fpsyg.2018.02086>
- [2] Android Games (Roxannie Ibot, n.d). Retrieved from https://www.academia.edu/4215821/CHAPTER1-ANDROID_GAME
- [3] Vlachopoulos, D., Makri, A. The effect of games and simulations on higher education: a systematic literature review. *Int J Educ Technol High Educ* 14, 22 (2017). Retrieved from <https://doi.org/10.1186/s41239-017-0062-1>
- [4] 3D Game Environments by Luke Ahearn (2017) by A K Peters/CRC Press Retrieved from <https://www.routledge.com/3D-Game-Environments-Create-Profession-Game-Worlds/Ahearn/p/book/9781138920026>
- [5] Lopez-Fernandez O, Männikkö N, Kääriäinen M, Griffiths MD, Kuss DJ. Mobile gaming and problematic smartphone use: (March 2018) Retrieved from

- [6] <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6035026/>
Pharsant (2019) What is Modified Waterfall Model Retrieved from <https://www.thestudygenius.com/what-is-waterfall-model/>

WeStack: A Web-based Ordering and Inventory Management System with Sales Forecasting using Moving Average and Exponential Smoothing Algorithm for Everlife General

Mark Lewence L. Endrano

Jane B. Moleño

Mark Andrei M. Mungcal

Patricia Kim G. Rosauero

Mery Ashley Suarez

Engr. Ernie Lee E. Pineda, MIT (Technical Adviser)

ABSTRACT

The researchers developed "WeStack: a web-based ordering with an inventory management system with sales forecasting using moving average and exponential smoothing algorithm for Everlife General Marketing (Everlife)." This system has the following features: online ordering and inventory management with sales forecasting; production management; supplier management; notifications for order status and inventory monitoring; automatic product discounting; automatic saving and printing of delivery receipts; generating inventory, sales, and purchase reports. These features have helped Everlife improve the efficiency of its ordering and inventory management. The researchers used the Modified Waterfall Model (MWF) in this study. The MWF model has five (5) phases which provided an organized sequence of development processes with flexible iterative stages. The researchers were able to develop the working system of the study – for example was the main functionality's ordering system, inventory management, and sales forecasting through testing. The researchers conducted test cases using ISO25010 to ensure that each criterion satisfactorily met the standards, and they functioned as designed. The alpha test resulted to few defects and after reconfiguration, reprogramming, coding, and testing, the beta test showed that those functionalities have already worked how they were supposed to. As a result, the researchers were able to upload the definitive version of the system along with its database on the hosting site. It thus allowed the users to access the system through the internet using the web system's domain name. To improve the developed WeStack, the researchers recommend having a Decision Support System (DSS) feature like Top Salesman, System Suggest, No. of Supply, and Top Seller.

INTRODUCTION

A web-based system is a system that is accessible over the HTTP protocol. The word "web-based" usually refers to software that runs in a web browser. However, it can also describe systems with only a small portion of the solution stored on the client's personal computer (PC). A web-based system's host server could be a local server or thru the cloud, accessible through the internet [1]. Web-based software is often used from anywhere with an internet connection, allowing the user to work remotely from home or any other places. Web applications have become an increasingly helpful tool for business. The most common uses are communication with employees, secure data storage, and providing data and information to management.

The mechanical aspect of inventory management is ordering systems. These are the systems that convert stock and order quantities into purchase orders or production orders. Inventory management is the control of non-capitalized resources. It is frequently referred to as a part of supply chain management that regulates the movement of goods from producers to warehouses and from these facilities to places of sale. Inventory management relies heavily on maintaining accurate records of every new or returned item that enters or exits a warehouse. Businesses can balance the number of goods coming in and going out with effective inventory management. The better a business's inventory management is, the more money it may save on operations [2]. According to Nicholas, it is estimated that Australian wholesalers and

retailers lose an average of 1.24% of total turnover annually. The issue of manual handling is not the only point of contention. When all the inventory data is kept on paper, it could take weeks – or even months – to figure out where an issue started. As a result, the chances of detecting and correcting the flaws are pretty limited [3]. Forecasting is a method that supports previous data as inputs to make well-informed predictions about the direction of future trends. Forecasting is used by businesses to determine how to allocate the resources or plan for anticipated expenses in the future. The expected sales usually determine the products and services supplied [4].

According to ANSI Information Systems, a leading Point of Sales (POS) system developer in the Philippines, a more effective order fulfillment process and higher customer satisfaction are benefits of an improved inventory management system. Occasionally, most businesses have unavoidable issues like product shortages, delivery hiccups, or sending the wrong product to clients. However, each time one of these issues arises, the risk of permanently losing a client increases. Its aim should be to increase the efficiency of the order fulfillment processes so that the consumers continue to be content, happy, and devoted [5]. Pampanga's Best Inc. (PBI) has to deal with challenges in inventory management due to its varied distribution channels, which include some of the largest supermarkets in the nation and a network of exclusive distributors, given the company's high volume of transactions.

PBI experienced problems integrating its critical operations due to various departments in the company using only Microsoft Excel, which had slowed the generation of multiple reports. PBI boosted productivity by 10% while lowering operational costs by 5% after using SAP Business One software that helped in business processes such as inventory, purchasing, sales, financial, and customer relationships [6].

Web-based ordering and inventory management with forecasting will save time and resources and has more accurate data than the more traditional manual processes. In business, it is necessary to have a centralized system. WeStack is a web-based Ordering and

Inventory Management System with Sales Forecasting using Moving Average and Exponential Smoothing Algorithms for Everlife General Marketing that helped the business to have a centralized ordering system and inventory monitoring to cater to the growing sales market.

General objective of the study

The general objective of this study aimed to develop a web-based ordering and inventory management system with forecasting using moving average and exponential smoothing algorithms for Everlife General Marketing. The following are the specific objectives of the system developed.

Specific objectives of the study

1. Gather information through an interview in the locale. Online and offline research of related works of literature and studies.

2. Identify hardware and software requirements:

- a. Hardware
 - i. Router/Internet
 - ii. Desktop Computer
 - iii. Laptop
 - iv. Mobile Phone
- b. Software
 - i. Visual Studio Code
 - ii. XAMPP – MySQL
 - iii. Microsoft Power Bi
 - iv. Bootstrap 5.2
 - v. HTML, CSS, jQuery, and PHP
 - vi. Figma
 - vii. Infinityfree.net
 - viii. FileZilla

3. To design a system using the following:

- a. Storyboard
- b. Visual Table of Content
- c. Context Diagram
- d. Data Flow Diagram
- e. Entity-Relationship Diagram
- f. Use Case Diagram

4. To create a system that has the following features:

- a. Online Ordering and Inventory Management with sales forecasting.
- b. Production management
- c. Supplier management
- d. Notifications for order status and stock level monitoring
- e. Automatic product discounting

- f. Automatic saving and printing of delivery receipts
- g. Generate inventory, sales, production, and purchase reports
- 5. To test using ISO25010 with the following criteria:
 - a. Functional Suitability
 - b. Reliability
 - c. Performance Efficiency
 - d. Usability
 - e. Security
 - f. Compatibility
 - g. Maintainability
- 6. To deploy a Web-based Ordering and Inventory Management System with Sales Forecasting using Moving Average and Exponential Smoothing Algorithm for Everlife General Marketing.

Scope and Limitation

The researchers visited Everlife General Marketing in Angeles City, Pampanga, to observe and conduct interviews about the current ordering and inventory management system. During the observation and interview, the researchers asked questions about ordering and inventory management (transcript in appendices). After the interview, the researchers discovered some of the problems with the current ordering and inventory management process, such as (1) Time-consuming order processing, (2) Typographical errors, (3) Manual catering of orders from all sales agents, (4) Incorrect pricing/discounting, (5) Manual Inventory monitoring, (6) Manual Inventory of raw materials, (7) No alerts or reminders for the stock levels and order status, (8) Inaccurate and time-consuming reports creation, (9) Supplier Management, (10) Lack of a proper forecasting method.

Based on the interview, the oldest raw data Everlife provided was starting in July 2020. It was because the raw data between 2006 – July 2020 got damaged and have been lost, according to Mr. Roberto Co, the owner of Everlife. Everlife does not have a regular inventory of raw materials, which was why the latest raw materials inventory was used. Everlife allowed the researchers to have the copy of sales invoices starting March 01, 2022 – October 28, 2022. However, Everlife refused to disclose any information on its accounting side. Also, Everlife kept its purchase records in

a folder physically. Due to confidentiality, Everlife cannot provide physical receipts of the purchases. The interview transcripts were exhibited in chapter 4. The researchers also conducted online research using different search engines, such as Google and Microsoft Bing. Offline research was also done when the researchers visited the Mabalacat City College library. All the related systems, literature and studies that were researched were exhibited in chapter 2.

The researchers identified the software and hardware requirements to develop and employ the system. The researchers used Visual Studio Code, XAMPP-MySQL, Microsoft Power Bi, Bootstrap, PHP, jQuery, and InfinityFree for software development. Router/Internet, Desktop Computer, Laptop, Mobile Phone for the hardware. Different design and analytical tools were used, such as a Storyboard, Visual Table of Content, Entity-Relationship Diagram, Data Flow Diagram, and Use Case Diagram.

The researchers developed a system entitled “WeStack: a web-based ordering with an inventory management system with sales forecasting using moving average and exponential smoothing algorithm for Everlife General Marketing.” This system has the following features: online ordering and inventory management with sales forecasting; production management; supplier management; notifications for order status and inventory monitoring; automatic product discounting; automatic saving and printing of delivery receipts; generating inventory, sales, and purchase reports. These features have helped Everlife improve the efficiency of its ordering and inventory management.

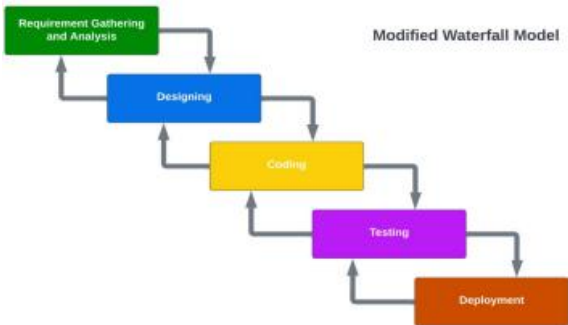
The system was evaluated using ISO25010 with the following criteria: Functional Suitability, Reliability, Performance Efficiency, Usability, Security, Compatibility, and Maintainability.

The researchers deployed WeStack, a Web-based Ordering and Inventory Management System with Sales Forecasting using Moving Average and Exponential Smoothing Algorithms at Everlife General Marketing.

SYSTEM DEVELOPMENT METHODOLOGY

The researchers used the Modified Waterfall Model (MWF) in this study. The MWF model

has five (5) phases and provided an organized sequence of development processes with some flexible, iterative stages. It has the same phases as the pure waterfall model.



The researchers started brainstorming ideas on how the system would work. The researchers conducted a virtual meeting via Microsoft Teams to discuss the overall plan to complete the study. The researchers decided to divide the responsibilities into two, one group of two members was responsible for system development, and the other group of three members was responsible for the documentation. The researchers gathered related literature, studies, and systems to widen their knowledge about forecasting, ordering, and inventory management. The researchers visited Everlife General Marketing, the locale, to acquire more information to help identify system requirements. During the visitation, one of the researchers interviewed the owner. The researcher provided questions about their current ordering and inventory management and discovered that Everlife uses Microsoft Excel, pen-and-paper, and physical folders to record keep orders and in inventory management. After the interview with the locale, the researchers decided to develop a webbased ordering and inventory management system with forecasting to make their work easier. The researchers identified the software and hardware requirements needed for software development.

Table 1: Hardware and Software Requirement

Hardware	Software
Laptop	XAMPP v3.3.0
Hp ProBook	PHP 8.1.6
Intel(R) Core (TM) i7-4712MQ CPU @ 2.30GHz 2.30 GHz	phpmyadmin 5.2.0
8GB RAM	Apache 2.4.53
64-bit operating system, x64-based processor	Visual Studio Code
Windows 10 Pro	GitHub Desktop
Desktop	Microsoft Power Bi
Desktop Computer	
Intel(R) Core (TM) i5-3470 CPU @ 3.20GHz 3.20GHz	
16GB RAM	
64-bit operating system, x64-based processor	
Windows 10 Pro	

For the initial visual concept of the system, the researchers created a storyboard and visual table of contents (VTOC) (see appendices [A] and [B] for the storyboard and VTOC). In making the logical design of WeStack, the researchers used CD, ERD, DFD, and Use Case to show the relationships and flow of data (see appendices [C], [E and F], [G] for the ERD, DFD, and Use Case). ERD was used to show the relationship of entities. The researchers used DFD level 0 or Context Diagram to show the system's overview in a single process. DFD level 1 indicated the system's primary functions and showed all the external entities. DFD level 2 showed the sub-processes and stored data of the system. For the physical design of WeStack, the researchers used Figma to create graphical user interface designs for different pages.

The image displays a collection of 18 wireframes arranged in a 6x3 grid, illustrating the user interface for a web application. Each wireframe represents a different user role and their corresponding actions:

- SALES AGENT:**
 - NEW ORDER:** Includes a sidebar with 'SALES AGENT' and 'MANAGER AGENT' roles, and a main area with 'NEW ORDER', 'VIEW INVENTORY', and 'ADD CUSTOMER' buttons.
 - VIEW INVENTORY:** Similar to the 'NEW ORDER' wireframe, but with a different sidebar layout.
 - ADD CUSTOMER:** Features a sidebar with 'SALES AGENT' and 'MANAGER AGENT' roles, and a main area with a 'NEW ORDER' button and a 'VIEW INVENTORY' button.
- MANAGER AGENT:**
 - NEW ORDER:** Includes a sidebar with 'MANAGER AGENT' and 'SALES AGENT' roles, and a main area with 'NEW ORDER', 'VIEW INVENTORY', and 'ADD CUSTOMER' buttons.
 - VIEW INVENTORY:** Similar to the 'NEW ORDER' wireframe, but with a different sidebar layout.
 - ADD CUSTOMER:** Features a sidebar with 'MANAGER AGENT' and 'SALES AGENT' roles, and a main area with a 'NEW ORDER' button and a 'VIEW INVENTORY' button.
- ADMINISTRATOR:**
 - NEW ORDER:** Includes a sidebar with 'ADMINISTRATOR' and 'SALES AGENT' roles, and a main area with 'NEW ORDER', 'VIEW INVENTORY', and 'ADD CUSTOMER' buttons.
 - VIEW INVENTORY:** Similar to the 'NEW ORDER' wireframe, but with a different sidebar layout.
 - ADD CUSTOMER:** Features a sidebar with 'ADMINISTRATOR' and 'SALES AGENT' roles, and a main area with a 'NEW ORDER' button and a 'VIEW INVENTORY' button.
- SALES AGENT (continued):**
 - NEW ORDER:** Includes a sidebar with 'SALES AGENT' and 'MANAGER AGENT' roles, and a main area with 'NEW ORDER', 'VIEW INVENTORY', and 'ADD CUSTOMER' buttons.
 - VIEW INVENTORY:** Similar to the 'NEW ORDER' wireframe, but with a different sidebar layout.
 - ADD CUSTOMER:** Features a sidebar with 'SALES AGENT' and 'MANAGER AGENT' roles, and a main area with a 'NEW ORDER' button and a 'VIEW INVENTORY' button.
- MANAGER AGENT (continued):**
 - NEW ORDER:** Includes a sidebar with 'MANAGER AGENT' and 'SALES AGENT' roles, and a main area with 'NEW ORDER', 'VIEW INVENTORY', and 'ADD CUSTOMER' buttons.
 - VIEW INVENTORY:** Similar to the 'NEW ORDER' wireframe, but with a different sidebar layout.
 - ADD CUSTOMER:** Features a sidebar with 'MANAGER AGENT' and 'SALES AGENT' roles, and a main area with a 'NEW ORDER' button and a 'VIEW INVENTORY' button.
- ADMINISTRATOR (continued):**
 - NEW ORDER:** Includes a sidebar with 'ADMINISTRATOR' and 'SALES AGENT' roles, and a main area with 'NEW ORDER', 'VIEW INVENTORY', and 'ADD CUSTOMER' buttons.
 - VIEW INVENTORY:** Similar to the 'NEW ORDER' wireframe, but with a different sidebar layout.
 - ADD CUSTOMER:** Features a sidebar with 'ADMINISTRATOR' and 'SALES AGENT' roles, and a main area with a 'NEW ORDER' button and a 'VIEW INVENTORY' button.

WeStack: A web-based Ordering and Inventory Management system with Sales forecasting using moving average and exponential smoothing algorithm for Everlife General Marketing

ADMIN

- Production Report
- Sales Forecast
- List of Supplier
- List of Formula
- List of Products
- List of Customers
- List of Invoices
- List of Orders
- Account Login
- User Account Details
- Order Details
- Invoice Details
- Customer Info
- Purchase Details
- Product Details
- Formulation
- Supplier Info
- Query Sale Forecast
- Admin Account Details

WAREHOUSE

- List of Orders
- List of Suppliers
- List of Purchases
- List of Products
- List of Formulas

SALES AGENT

- Production Details
- Product Details
- Purchase Details
- Account Login
- Customer Info
- Order Details
- Account Login

SUPER ADMIN

- Admin account information
- Activity Logs

[illegible][illegible]

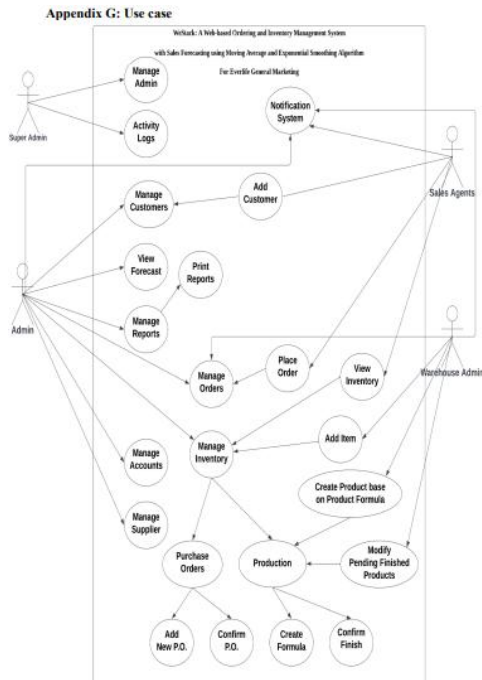
```

graph LR
    subgraph Column1 [ ]
        direction TB
        A1[Admin Account Details]
        A2[Customer Info]
        A3[Product List]
        A4[Sales Info]
        A5[Supplier Info]
        A6[Production Details]
        A7[Sales Forecast]
    end

    subgraph Column2 [ ]
        direction TB
        C1[Manage Admin]
        C2[Manage Customer]
        C3[Manage Product]
        C4[Manage Supplier]
        C5[Manage Inventory]
        C6[Forecasting]
    end

    subgraph Column3 [ ]
        direction TB
        D1[Admin Information]
        D2[Customer List]
        D3[Invoice List]
        D4[Production Report]
        D5[Inventory Details]
        D6[Sales Info]
    end

    A1 --> C1
    A1 --> D1
    A1 --> D2
    A2 --> C2
    A2 --> D2
    A3 --> C3
    A3 --> D3
    A3 --> D4
    A4 --> C4
    A4 --> D5
    A5 --> C5
    A5 --> D6
    A6 --> C6
    A6 --> D6
    A7 --> D6
  
```



The researchers decided to use PHP and JavaScript as the programming language. Visual Studio Code as a text editor is a simplified code editor that supports development activities like task execution, debugging, and version management. The researchers used XAMPP for database management and Microsoft Power Bi to generate reports and create dashboards. The researchers used Figma and Bootstrap for the CSS and GUI design of the WeStack. The system has the following features: Online Ordering and Inventory Management with sales forecasting; Production management; Supplier management; Notifications for order status and stock level monitoring; Automatic product discounting; Automatic saving and printing of delivery receipts; Generating inventory, sales, production, and purchase reports. The researchers created a to-do list of units to develop to monitor the progress of the development of the system.

To ensure that the system development was continuous, the researchers divided the system functionalities into smaller units based on the user level: super admin, admin, warehouse admin, and sales agents. First, the development of super admin. In order to have an admin account, the super admin was

created. After the super admin was created, the development of admin functionalities started. The researchers then divided the admin functionalities into further smaller units. The warehouse admin and sales agent functionalities were developed to complete the system. The researchers set a series of meetings to understand and complete each unit's development.

The researchers conducted Alpha and Beta testing. For Alpha testing, five (5) IT experts tested the system. The researchers conducted the Beta testing with eight (8) locale users, and they evaluated the system. They were: (1) the owner of Everlife, (1) the Operations Manager, (1) the General Secretary, (2) warehouse admins, and (3) Sales Agents. The system was evaluated using ISO 25010 for its Functionality, Suitability, Reliability, Performance Efficiency, Usability, Security, Compatibility, and Maintainability. The portability criteria in ISO25010 were not included in this systems test case because it was not related to the system. Portability referred to the system's installability which was the system's ability to be installed on different devices which meant that that criterion was neither related nor necessary to this system.

The researchers used Infinityfree.net, a hosting website. InfinityFree is an independent free hosting initiative that provides reliable free hosting services. It offers a free SSL Certificate that protects data entered into the web system. It also provides a MySQL database which is also free. Using InfinityFree, users could access the system via the internet. FileZilla (FTP Software Tool) allows users to set up FTP servers or connect to other FTP servers to exchange files. The researchers used FileZilla to upload the system's files into InfinityFree although it offered FTP. Using FileZilla made the transfer/upload faster. It also allowed editing or viewing the uploaded files using a local text editor and re-uploading. For the domain, the researchers used a subdomain that the hosting website offered for free users. The researchers used epizy.com as the sub-domain. To access the web system, <https://westack.epizy.com/WeStackV3/> is the URL of the system.

RESULTS AND OUTCOES

The researchers were able to use the information acquired from Everlife to accomplish the system requirements and specific objectives of the study. The researchers created a web-based ordering and inventory management system with forecasting using moving average and exponential smoothing algorithms aligned with the objectives of the study. The researchers assigned to the development of the system completed the core functionalities of WeStack. The researchers were able to create a system that has the following features: Online ordering and inventory management with sales forecasting; Production management; Supplier management; Notifications for order status and stock level monitoring; Automatic product discounting; Automatic saving and printing of delivery receipts; Generate inventory, sales, production, and purchase reports.

System Design



Figure 3: WeStack Login Page

In figure 3 above, the login page of WeStack was showed. The user accessing the web system must input their email address and password. The system would then verify the account. If there was an existing user, it would check the role and whether they were authorized to access the super admin, admin, warehouse admin, and sales agent's page.

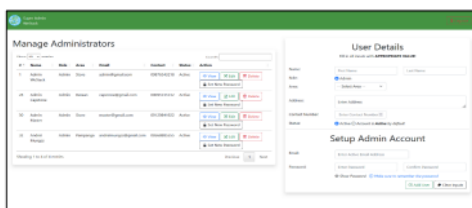


Figure 4: Super Admin Landing Page

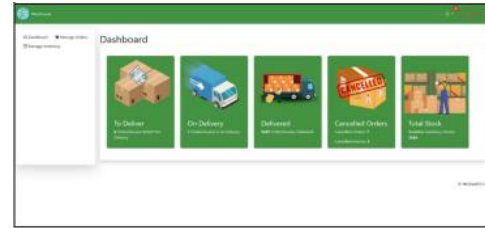


Figure 5: Warehouse Landing Page (Dashboard)

Figure 5 shown above was the landing page of warehouse admin. After verification, if the account used to log-in has a Warehouse role, the user will be redirected to this page known as Dashboard.



Figure 6: Sales Agent Landing Page (Dashboard)

Figure 6 shown above is the landing page for sales agent. After verification, if the account used to Log-in has a Sales Agent role, the user will be redirected to this page known as Dashboard.

Alpha Testing

The researchers conducted Alpha testing and the first software testing for the entire system to determine if it worked according to design. The researchers invited five (5) IT experts, namely: (1) Mr. Wilbert C. Cañas, an IT specialist at Fog Horn Inc., 8990 Luzon Housing Development Corporation- North Luzon Operations; (2) Ms. Alvira Lyn Ferrer, an App Developer Associate; (3) Mr. Marvaerick Baluyut, former Data Analyst in Global Outsourcing System; (4) Mr. Jomar Sangil, Instructor at Clark College of Science and Technology, Major in Computer Programming; and (5) Mr. John Kenner Delos Reyes, a Software Automation Engineer Team Leader at Owens Asia in Clark Global City and former Software QA Engineer II at Cloudstaff. All of the

alpha testers answered the test case evaluations created based on ISO25010

Table 2: Alpha Test Results Summary

CRITERIA	MEAN (%)
Functional Suitability	99.71
Reliability	100.00
Performance Efficiency	100.00
Usability	89.68
Security	100.00
Compatibility	100.00
Maintainability	100.00
TOTAL AVERAGE	98.48

The Functional Suitability criteria accumulated a mean of 99.71% of “Yes” responses from the testers. The results showed that the system provided the necessary functions to complete specified tasks and user objectives.

The Reliability criteria accumulated a mean of 100% of “Yes” responses. The results showed that the system performed specified tasks under specified circumstances for a specified amount of time. The sub-characteristics are Maturity, Availability, Faults Tolerance, and Recoverability.

The Performance Efficiency criteria accumulated a mean of 100% of “Yes” responses. The criteria represented the performance in relation to the quantity of resources used under the stated conditions. It has the following sub-characteristics: Time Behavior, Resource Utilization, and Capacity.

The system’s Usability criteria accumulated a mean of 71.41% of “Yes” responses, the lowest average of all the criteria. The percentage can be interpreted that the system’s usability can still be improved.

The system’s Security criteria accumulated a mean of 100% of “Yes” responses.

That indicated that the system could protect information and data. The system has the necessary data access controls according to their types and levels of authorization.

The Compatibility criteria accumulated a mean of 83.33% of “Yes” responses. The results showed that the compatibility can still be improved.

The system’s Maintainability criteria accumulated a mean of 100% of “Yes” responses. The results indicated that the system can be modified to improve, correct, or adapt to changes in environment and requirements. The total mean for Alpha testing was 98.48%, which suggested that the system was almost completed. After the Alpha testing, the researchers fixed and applied all the bugs and suggestions from the Alpha testers.

WeStack was then ready for its second software testing, the Beta Testing.

Beta Testing

The researchers conducted Beta testing which was intended for the system’s end users. The respondents of the Beta testing were individuals from Everlife General Marketing located in Angeles City, Pampanga. A total of eight (8) respondents participated in the Beta testing: (1) the owner of Everlife, (1) the Operations Manager, (1) Secretary/OIC, (1) Warehouse Admin, (1) the Warehouse record keeper, (3) Sales Agents. The feedback from the respondents helped the researchers in improving the system.

Table 3: Beta Test Result

CRITERIA	MEAN(%)
Functional Suitability	100.00
Reliability	100.00
Performance Efficiency	100.00
Usability	96.76
Security	100.00
Compatibility	100.00
Maintainability	100.00
TOTAL AVERAGE	99.54

Table 3 showed the summary of the Beta testing. All of the criteria in the Beta testing accumulated a mean of 100% of “Yes” responses from the users except for the Usability criteria although it showed improvement compared to the Alpha test results.

Alpha and Beta Test

The comparison between the alpha and beta tests concluded the testing results. The researchers created a table of alpha and beta test results to identify the differences and equality of the results.

Table 4: Alpha and Beta Test Results

Criteria	Alpha	Beta
Functional Suitability	99.71	100.00
Reliability	100.00	100.00
Performance Efficiency	100.00	100.00
Usability	89.68	96.76
Security	100.00	100.00
Compatibility	100.00	100.00
Maintainability	100.00	100.00
Total Average	98.48	99.54

Table 4 showed the comparison between alpha and beta results to determine the differences and equality of the results. The researchers observed that the total summary of mean in alpha was 98.48% while the total summary of mean in beta was 99.54% which showed that beta got better test results. Based on these comparisons, the researchers found that the system met the improvements applied by the IT experts after the alpha test.

Recommendations

The following are the recommendations to improve the developed WeStack web system:

- Add a Decision Support System (DSS) feature like:
 - Top Salesman
 - System Suggest
 - No. of Supply
 - Top Seller
- Upload the system files to a paid hosting site for more security features and a remote access-enabled database.
- Have an Azure account to make the embedded reports from Microsoft Power BI accessible to users using a Microsoft Account.

REFERENCES

- [1] Senthil.k-Wp, "The benefits of web-based systems for business," Aezion, 12-Aug-2021. [Online]. Available: <https://www.aezion.com/blogs/the-benefits-of-webbased-systemsforbusiness/#:~:text=A%20web%2Dbased%20system%20is,loaded%20on%20the%20client%20P> C. [Accessed: 30-Mar-2022].
- [2] S. Amsler, J. O'Donnell, and B. Cole, "What is inventory management? Definition & Overview," SearchERP, 11-Feb-2021. [Online]. Available: <https://www.techtarget.com/searcherp/definition/inventory-management>. [Accessed: 30-Mar-2022].
- [3] Nicholas@align.me, "Solving the 3 Big Problems of Manual Stock Control - HARMONIQ -," Harmoniq, 10-Jan-2020. [Online]. Available: <https://harmoniq.com.au/inventory-management-software-solving-manual-stock-controlproblems/>. [Accessed: 30-Mar-2022].
- [4] M. Drane and H. Faramarzi, "Forecasting," Introduction to Operations Management. [Online]. Available: <https://pressbooks.senecacollege.ca/operationsmanagement/chapter/forecasting/>. [Accessed: 10-Apr-2022].
- [5] C. S. Gaspar, "Understanding the importance of inventory management system," ANSI Information Systems, 15-Aug-2022. [Online]. Available: <https://ansi.ph/understandingthe-importance-of-having-an-efficient-inventory-management-system/>. [Accessed: 24-Oct-2022].
- [6] S. A. P. News, "Pampanga's Best Inc improves operational efficiency," SAP Southeast Asia News Center, 15-Jan-2021. [Online]. Available: <https://news.sap.com/sea/2014/03/pampangas-best-inc-improvesoperational-efficiency/>. [Accessed: 25-Oct-2022].
- [7] "Algorithm definition & meaning," Merriam-Webster. [Online]. Available: <https://www.merriam-webster.com/dictionary/algorithm#note-1>. [Accessed: 14-Apr-2022].
- [8] "Forecasting," Corporate Finance Institute, 19-Feb-2022. [Online]. Available: <https://corporatefinanceinstitute.com/resources/knowledge/finance/forecasting/>. [Accessed: 14-Apr-2022].
- [9] Techopedia, "What is the internet? - definition from Techopedia," Techopedia.com, 17-Aug-2020. [Online]. Available: <https://www.techopedia.com/definition/2419/internet>. [Accessed: 14-Apr-2022].
- [10] NetSuite.com, "What is inventory? types, examples and analysis," Oracle NetSuite. [Online]. Available: <https://www.netsuite.com/portal/resource/articles/inventorymanagement/inventory.shtml>. [Accessed: 14-Apr-2022].
- [11] Techopedia, "What is a web-based application? - definition from Techopedia," Techopedia.com, 21-Jun-2017. [Online]. Available: <https://www.techopedia.com/definition/26002/web-based-application>. [Accessed: 14-Apr-2022].
- [12] K. Chris, "What is php? the PHP programming language meaning explained," freeCodeCamp.org, 30-Aug-2021. [Online]. Available: <https://www.freecodecamp.org/news/what-is-php->

- the-php-programming-languagemeaning-explained/. [Accessed: 26-Oct-2022].
- [13] "What is javascript? - learn web development: MDN," Learn web development |MDN. [Online]. Available: https://developer.mozilla.org/enUS/docs/Learn/JavaScript/First_steps/What_is_JavaScript. [Accessed: 26-Oct-2022].
- [14] Z. Ahmed, Which one is better - JavaScript or jQuery, 06-Jun-2014. [Online]. Available: academia.edu. [Accessed: 07-Dec-2022].
- [15] J. Scardina and L. Horwitz, "What is Microsoft power bi?: Definition from TechTarget," Content Management, 07-Dec-2022. [Online]. Available: <https://www.techtarget.com/searchcontentmanagement/definition/Microsoft-Power-BI>. [Accessed: 11-Dec-2022].
- [16] I. Burki, "Power bi forecasting: How to forecast in power bi," Stoneridge Software, 23-Dec-2020. [Online]. Available: <https://stoneridgesoftware.com/take-advantage-offorecasting-in-power-bi-with-the-analyticspane/#:~:text=However%2C%20there%20is%20a%20detailed%20explanation%20of%20the,and%20the%20other%20for%20non-seasonal%20data%20%28ETS%20AAN%29>. [Accessed: 11-Dec-2022].
- [17] "The benefits of web-based software for your business," Lieberman Technologies, 15-Nov-2021. [Online]. Available: <https://ltnow.com/blog/web-based-software-for-business/>. [Accessed: 30-Mar-2022].
- [18] P. Khamooshi, "The benefits of using web-based applications," Geeks Insights, 20-Dec-2019. [Online]. Available: <https://www.geeks.ltd.uk/insights/the-benefits-of-usingweb-based-applications>. [Accessed: 30-Mar-2022].
- [19] P. by A. J. A. Khanmohamed, "What are the challenges of manual sales order processing?," aimINSIGHT Solutions, Inc., 22-Aug-2020. [Online]. Available: <https://www.aiminsight.com/blog/what-are-the-challenges-of-manual-sales-orderprocessing/>. [Accessed: 30-Mar-2022].
- [20] "Save your costs of Manual Order Management," Online Ordering System, 27-Feb2022. [Online]. Available: <https://orderingstack.com/blog/save-your-costs-of-manualorder-management/>. [Accessed: 30-Mar-2022].
- [21] "What is inventory management and how does it work?," IBM. [Online]. Available: <https://www.ibm.com/topics/inventory-management>. [Accessed: 30-Mar-2022].
- [22] NetSuite.com, "What is inventory? types, examples and analysis," Oracle NetSuite. [Online]. Available: <https://www.netsuite.com/portal/resource/articles/inventorymanagement/inventory.shtml>. [Accessed: 30-Mar-2022].
- [23] "Inventory management 101: Helpful techniques + methods (2022)," The BigCommerce Blog, 28-Mar-2022. [Online]. Available: <https://www.bigcommerce.com/blog/inventory-management/>. [Accessed: 30-Mar-2022].
- [24] "Common inventory management problems, Challenges & Solutions: Tally Solutions," Tally, 29-Sep-2021. [Online]. Available: <https://tallysolutions.com/businessguides/common-inventory-management-problems-challenges-solutions/>. [Accessed: 30-Mar-2022].
- [25] HarshalKatre 5 factors that cause inventory inefficiency and how to avoid them," ProfitBooks.net, 01-Nov-2021. [Online]. Available: <https://www.profitbooks.net/inventory-inefficiency/>. [Accessed: 30-Mar-2022].
- [26] N. Kokemuller, "Challenges of a centralized inventory," Small Business - Chron.com, 26-Oct-2016. [Online]. Available: <https://smallbusiness.chron.com/challengescentralized-inventory-50557.html>. [Accessed: 30-Mar-2022].
- [27] M. B. A. S. Team, "Raw material meaning, importance, types & example," MBA Skool, 31-Dec-2020. [Online]. Available: <https://www.mbaskool.com/businessconcepts/operations-logistics-supply-chain-terms/15631-raw-material.html>. [Accessed: 22-Apr-2022].
- [28] P. by J. Patowarya, "Supplier management-benefits, process, & best practices," Zycus Procurement Blog, 05-Apr-2022. [Online]. Available: <https://www.zycus.com/blog/supplier-management/understanding-supplier-managementits-benefits-process-and-best-practices.html>. [Accessed: 22-Apr-2022].
- [29] R. J. Hyndman and G. Athanasopoulos, "Forecasting: Principles and practice," Google Books, 2018. [Online]. Available: https://books.google.com.ph/books?hl=en&lr=&id=_bBhDwAAQBAJ&oi=fnd&pg=PA7&dq=forecasting&ots=Tii2BkWQHI&sig=xKRR7bku9UFxbtSedPbqv3gKKXA&redir_esc=y#v=onepage&q=forecasting&f=false. [Accessed: 14-Apr-2022].
- [30] J. Fernando, "Moving average (MA) definition," Investopedia, 08-Feb-2022. [Online]. Available: <https://www.investopedia.com/terms/m/movingaverage.asp>. [Accessed: 14-Apr-2022].
- [31] F. S. of Business, Introduction to arima models. [Online]. Available: <https://people.duke.edu/~rnau/411arim.htm>. [Accessed: 14-Apr-2022].
- [32] J. Brownlee, "A gentle introduction to exponential smoothing for time series forecasting in Python," Machine Learning Mastery, 12-Apr-2020. [Online]. Available: <https://machinelearningmastery.com/exponential-smoothing-for-time-series-forecastinginpython/#:~:text=Exponential%20smoothing%20is%20a%20time,Jenkins%20ARIMA%20family%20of%20methods>. [Accessed: 14-Apr-2022].
- [33] Stephanie, "Exponential smoothing: Definition of simple, double and triple," Statistics How To, 16-Sep-2020. [Online]. Available: <https://www.statisticshowto.com/exponential-smoothing/>. [Accessed: 14-Apr-2022].
- [34] "What value should I use for the smoothing constant?," Minitab Express. [Online]. Available: <https://support.minitab.com/en-us/minitab-express/1/help-and-howto/modeling-statistics/time-series/supporting-topics/time-series-models/what-values-should-i-use-for-the-smoothing-constant/>. [Accessed: 14-Apr-2022].

- [35] "Exponential smoothing," Forecasting Methods: What is Exponential Smoothing and its Benefits? [Online]. Available: <https://www.vercast.eu/post/exponentialsmoothing#:~:text=Exponential%20smoothing%20produces%20accurate%20forecasts,resulting%20in%20accurate%20inventory%20levels>. [Accessed: 14-Apr-2022].
- [36] Hayes, "Autoregressive Integrated moving average (ARIMA)," Investopedia, 08-Feb2022. [Online]. Available: <https://www.investopedia.com/terms/a/autoregressiveintegrated-moving-average-arima.asp>. [Accessed: 16-May-2022].
- [37] "Autoregressive integrated moving average," Autoregressive Integrated Moving Average - an overview | ScienceDirect Topics. [Online]. Available: <https://www.sciencedirect.com/topics/mathematics/autoregressive-integrated-movingaverage>. [Accessed: 16-May-2022].
- [38] "The 4 types of forecasting models with examples," Indeed Career Guide. [Online]. Available: <https://www.indeed.com/career-advice/career-development/forecastingmodels>. [Accessed: 16-May-2022].
- [39] J. T. Rimbey, "The top 5 methods for quantitative sales forecasting," Map My Customers – Blog, 11-Nov-2021. [Online]. Available: <https://mapmycustomers.me/blog/the-top-3-methods-for-quantitative-sales-forecasting/>. [Accessed: 17-May-2022].
- [40] B. J. Paulo, B. R. Sairen Christian, C. S. Paulo, M. F. Ruben, and S. T. Ceejay, "Inventory Management System with Sales and Demand Forecasting Using Moving Average and Exponential Smoothing Algorithm for Purepower Ventures Corporation," thesis, 2018.
- [41] B. R. Louis Daniel, B. R. Louis Jannero, D. J. C. Danielle, D. R. Angelo, and P. S. Jericho, "Medicrates: A LAN-based Pharmacy Management System with Forecasting for Mabalacat City Government Central Pharmacy," thesis, 2019.

