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INSTITUTE OF COMPUTING STUDIES

MCC-IT Research Journal 2022

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EDITOR	:	Dennis L. Tacadena, PCpE, DIT
TECHNICAL ADVISER / EDITORS	:	Engr. Robbert M. Bamba, MEECE Marilou B. Cabuñag Ralph B. Cadalzo, MIT Dessalyn J. De Castro Ronaldyn T. Domingo, MSIT Ritchelle Z. Escoto, MIT Lorenzo C. Macam Jaypee B. Patdu, MIT Engr. Ernie Lee E. Pineda, MIT Frederic D. Santos Dennis L. Tacadena, PCpE, DIT Lovely Ruth C. Valdez Agustin Edmin S. Yuzon, MIT
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 wanted to take a moment to extend my warmest congratulations to all of you who have successfully completed the capstone projects amidst the challenging time of the COVID-19 pandemic. Your determination, resilience, and unwavering commitment to your studies and research have truly been remarkable.

The pandemic presented unprecedented obstacles and disruptions to our daily lives, including the academic sphere. However, despite these challenges, you have proven that your passion for knowledge and your ability to adapt knows no bounds. Your ability to remain focused and dedicated to your capstone project, despite the uncertainties and constraints imposed by the pandemic, showcases your exceptional IT skills and unwavering dedication to your chosen field of specialization.

Your accomplishments are a testament to your strength and perseverance. You have not only overcome the hurdles presented by the pandemic but have also managed to produce outstanding work that demonstrates your expertise and innovative thinking. Your capstone projects will undoubtedly contribute to the advancement of knowledge in your respective fields and serve as an inspiration for future generations of researchers.

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,

I would like to extend my warm congratulations to each one of you on your successful completion of the capstone projects in the middle of a pandemic. Your resilience, perseverance, and dedication to your studies and research are truly admirable. You have been amazingly adaptable and tenacious amidst the chaos and uncertainty of the pandemic, hence yielding exceptionally outstanding work that stands to testify to your ability and ingenuity.

Your achievements epitomize hard work and the undying spirit for academic excellence, and I have no doubt that all of you will make important contributions in respective field of specialization in Information Technology.

Engr. Robbert M. Bamba, MEECE

BSIT Program Head, Institute of Business and Computing Education

Mabalacat City College

BSIT FACULTY MEMBER & TECHNICAL ADVISER



Engr. Robbert M. Bamba, MEECE
BSIT Program Head



Marilou B. Cabuñag



Ralph B. Cadalzo, MIT



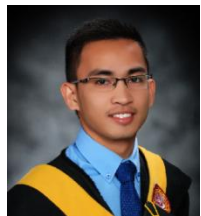
Dessalyn J. De Castro



Ronalyn T. Domingo, MSIT



Ritchelle Z. Escoto, MIT



Lorenzo C. Macam



Jaypee B. Patdu, MIT



Engr. Ernie Lee E. Pineda, MIT



Frederic D. Santos



Lovely Ruth C. Valdez



Agustin Edmin S. Yuzon



Engr. Dennis L. Tacadena, DIT

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NOTE:

A – Application

1..n – Test Video

BSIT
FULL PAPER PRESENTATION
ABSTRACTS

AGSL: A Guide to Sign Language using Android App for Deaf Person

John Carlo D. Bengco
Ericka C. Manabat
Frederic D. Santos (Technical Adviser)

ABSTRACT

Technology plays an important role in our society, especially in the field of education. It is quite regrettable that people, particularly the deaf, still face a lot of challenges in acquiring an education. Their learning methods are different as compared to hearing people. They use Sign Language (SL) rather than natural language to communicate and learn. They are required to put a lot of effort into learning different concepts using conventional pedagogies. Therefore, there is a dire need for some assistive technology to improve their learn-ability and understandability. That is why the researcher of this study aimed to develop an innovative offline application that would help the deaf people and their families communicate more effectively utilizing Basic American Sign Language. The chosen methodology is an iterative waterfall model which primarily focuses on preliminary growth and design, then gradually develops until the final software is completely created. By following the necessary methods and procedures, the researchers were successful in providing "AGSL: A Guide to Sign Language using Android App for Deaf Person" that can be downloaded through google play store. The application was tested using test cases based on the ISO/IEC 25010 standard, and the test results were marked "Passed." Overall, the testing was successful in that no issues were generated and the application continued to function properly. The study's objectives were completed, and it is now available for usage by deaf people and their families.

INTRODUCTION

Communications via gestures or commonly known as Sign Language are utilized everywhere on the world as an essential methods for communication by hard of hearing individuals. According to the Senate bill 2117 in the Philippines, 1.23% of the entire population is deaf, mute, or hearing impaired. As of 2009, the application deaf population is already at 241,624 for those who are totally deaf and 275,912 for those who are partially deaf. That means that at least 517,536 people currently have very limited access to media and information because of their hearing impairedness [1].

Children that are born deaf acquire different language than those who are born with no disability. In many cases, deaf babies are mostly born with hearing or no other disability parents who oftentimes do not know to use and express feelings using sign language. Most parents don't expose their child in their early days until later in their life and in some cases parents don't expose their children with disability at all in sign language.

As of now, challenges for finding this kind of system or a way that can interpret sign language or can serve as Interpreters between

sign languages and spoken languages are hard to seek but there is a limited number of hearing people who are competently able to communicate in sign language. These people are called Sign Language Interpreters. Sign language interpreters can be used to aid communication between deaf and hearing people but this is often difficult due to the limited availability and high cost of interpreters. These troubles in correspondence among hearing and hard of hearing individuals can prompt issues in the integration of hard of hearing individuals into society and problems with an independent and self-determined lifestyle. Hearing individuals learn and see language as a visual portrayal of communicated in language where letters encode phonemes while for deaf individuals, this correspondence doesn't exist along these, and the letters are simply seen as images with no significance. Deaf individuals consequently have major troubles with pursuing reading and writing because of the way that there is no immediate correspondence between their common language (gesture based communication) and composed language. [2]

Background of the study

Deaf people across the globe use sign languages, which are natural manual languages that are functionally and structurally similar to spoken languages. Signs, on the other hand, are made by hand and interpreted visually, while words are made verbally and perceived aurally. This means that phonology, which refers to the sub-lexical language structure, varies depending on the language modality.

ASL is a comprehensive and dynamic language that primarily relies on hand movements to communicate. Three primary sources of knowledge characterize each human sign: 1) hand shape, 2) hand movement, and 3) the relative position of two hands. Every sign's meaning is encoded by a combination of these three main characteristics[2].

The researcher presents a crucial gap in this paper by presenting an app that is called "A Guide To Sign Language Using Android App For Deaf Person". A learning-based sign language application that provides visuals, signs, hand gestures to help both children and parents to learn sign language gradually that starts from basic words.

Objective of the study

The general aim of this study is to develop an Android application that would be using as a guide to American Sign Language for Deaf Person and relatives of deaf person.

In line with this, the study aimed to achieve the following specific objectives:

- To gather data and relevant information using internet libraries, articles, journals, and related application
- To identify the hardware and software specification and requirements
- To design mobile application using designing tools such as storyboard and flowchart.
- To create and develop mobile application that would aid deaf children and relatives in learning sign language.
- To evaluate the mobile application using the ISO 25010 Software Product Quality Standards in terms of Function Suitability, Usability, and Portability.

Scope and limitation

The scope of the study refers to the development of an AGSL application for deaf

and relatives. The model visualization of the application's features would encourage the users to increase their trust and explore the application more to learn. Additionally, made application would be validate by an expert to authenticate that the learning materials used inside the application is true and reliable.

The researchers gathered the necessary data, journals, and related applications to stimulate the content and design of the AGSL application. Then, as an outline, a flow chart was produced which included the flow of data from sign language alphabets and numbers gestures to sign language videos and making a test assessment.

The researchers then evaluated the system's available hardware resources, determining whether they were compatible with the application's system software requirements for installation and configuration. The researchers then used the internet to gather information about open-source software technologies that would be suitable for application development. Photoshop, Construct 2, and Android Studio. The app would be tested on a variety of Android phones after it has been incorporated to see if there are any issues. A story board was also included in the design tools as a reference for developing the application's overall detailed features and used flow chart as well as a designing tool for the researchers to easily create the app's content.

Furthermore, the system's features were developed in response to the user's desire to learn fundamental sign language. Basic sign language (ABC icon), Videos (book icon), and Test your knowledge are the three (3) options accessible at the bottom of the main menu screen of this android sign language software for the deaf (computer icon). The researchers used some of the core ASL topics including alphabets and numbers from one to ten utilizing hand gestures in their online American Sign Language (ASL) course. It also includes films for topics such as Family, Greetings, Pronoun, Places, Feelings, Money, Shapes, Colors, Request, and Food that are commonly used by deaf people and their families. Lastly, Test your knowledge have combined questions gotten from American Sign Language alphabets, numbers and some portion of the videos.

Finally, waterfall development approach would be utilized to conduct the study in order to define the requirements and phases for developing the application. The AGSL, on the other hand, is limited to Android smartphones running KitKat or later, up to and including Android 11. Because the software is offline, it is difficult to patch or update when a bug occurs. In addition, the researcher used ISO 25010 Software Product Quality Standards to evaluate the user's perspectives on the application in areas of Functional Suitability, Usability, and Portability. The functional suitability survey consists of questions to determine the accuracy and correctness of the application. The survey for the Usability includes questions to determine the app's usability in terms of accessibility and learnability, and the survey for the Portability includes questions to demonstrate that the researchers were able to achieve mobile app portability in terms of installability for low-storage phones.

SYSTEM DEVELOPMENT METHODOLOGY

This section describes the study's techniques and methods in detail. The researchers have specified the System Development Methodology that was used for this study as well as the development of the, "A Guide To Sign Language Using Android App For Deaf Person" using construct 2. This section discussed the procedures that must be completed to achieve the specified objectives.

The methodology employed in this study was an iterative waterfall model. The software development life cycle was utilized in the design and development of the AGSL application to identify the overall process and how it would flow through the many phases leading up to the project's completion (see figure below).

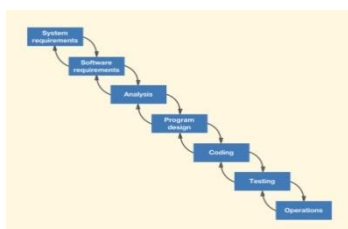


Figure 2. Waterfall SDLC
(Source:

<https://www.sciencedirect.com/topics/computer-science/waterfall-process>)

System Requirement

The data obtained via internet library research, internet research journals, and collaborations provided the researchers with sufficient ideas, information, and a thorough understanding to help in the development of the AGSL application. The researchers used the internet to arrange virtual meetings for collaboration and to obtain useful information. The researchers distributed each tasks to each other to accomplish. In terms of hardware resources, researchers assessed the required hardware resources. The researchers then identified and used the required hardware (see Table 1) in the development of the application.

Table 1. Hardware specification during application development

Component	Description
Processor	Intel i3 or Higher
Memory	4 GB
Free Space	100 GB or Higher

The system hardware requirement specification would be verified to see if it was adequate for the installation and configuration of system software needs during this phase.

Software Requirements

During this phase, the researchers gathered information about open-source software technologies that could be used to develop the system. During the creation of AGSL application, the researchers found the system software requirement (see Table 2).

Table 2. Software specification during application development

Software	Description
Android 6.0 Marshmallow	Android Operating System
Android 7.0 Nougat	
Android 8.0 Oreo	
Android 9 Pie	
Construct 2	Software Services
Android Studio	
Adobe Photoshop	

As soon as the system development begins, the team developer would use a different application to confirm that the system design is suitable.

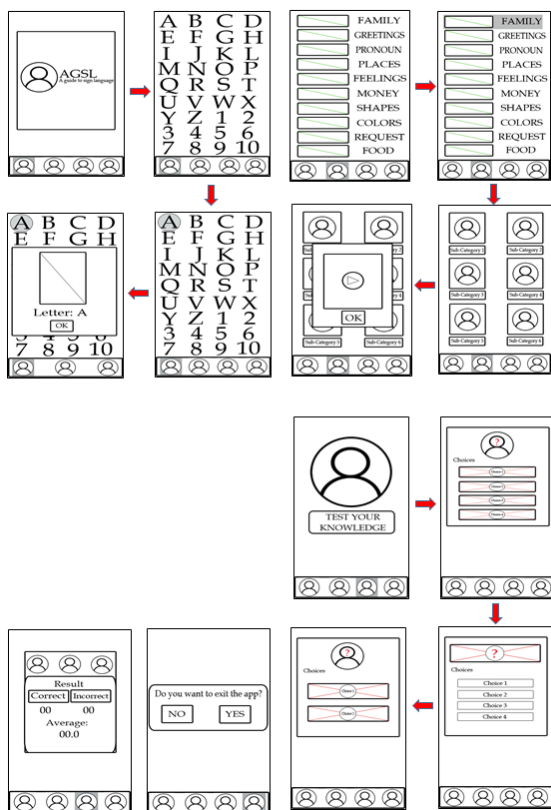
Analysis

The researcher would design plans to turn the team's goals into operational processes during this phase. The researchers discussed each goal and documented each development phase output, work, and ensured that all task targets would be met at the highest possible level of the AGSL application.

Program Design

This phase leads to the creation of the design that meets the system's criteria. The AGSL application design was created using the system specifications established in the previous phase. The Researchers analyzed the design and layout by using Story Board. This helps the researchers to overview the appearance and structure of the mobile application as a guide and framework for creating eye-catching and visually appealing icons to turn it into a working app that would capture the user's interest (see Appendix X).

APPENDIX X
AGSL Mobile Application Storyboard



Coding

In this phase, the researchers used Construct2 software to develop the application using the drag-and-drop method. The Android Studio would be used to import the source code from Construct 2 and export it as an APK. The data given to the app's content is based on the DepEd curriculum for sign language, which the researchers utilized as a reference. The team developer rapidly loaded the app on Android phones and debugged it to look for any potential flaws or faults.

Testing

The researchers created test cases for alpha and beta testing to verify and validate the developed "A guide to sign language" application functional suitability across a set of actions or conditions to verify the expected result for more stable application performance and better user use. To test the application's functional suitability, the researchers would conduct alpha testing to IT Experts and IT educators as alpha testers to test the app. However, in beta testing, the researchers would conduct interview and survey to non-IT experts which are deaf and deaf relatives. While the foreign sign language professional would test the app in order to validate the accuracy of the contents of the letters, numbers, lesson videos, and test your knowledge assessment.

The researchers use statistical treatment, or descriptive statistics. Where the researchers gathered data from IT experts, IT educator, non-it expert by using google form survey in alpha/testing for the researchers to have an idea if the app can actually be working in deaf person and deaf relative or to the person that wants to learn sign language.

The researchers use purposive Testing, also known as judgmental, selective, or subjective test, is a form of non-probability test in which researchers rely on their own judgment when choosing members of the population to participate our survey. The team use IT experts, IT educator, non-IT expert and deaf person.

The alpha testing was used the researchers talked to some IT experts and IT educators to test our app by sending them the download link of the app and after they tried the app, they answered the survey that is in a form of google form.

The researchers gathered information by using beta testing and used it to non-IT experts or deaf also by giving them the application and the google form survey. The researchers used the same hardware that the IT expert and IT educator use in alpha testing.

The researchers also would use the Likert scale. The outcome from the Likert scale conducted from the respondents were then processed by computing the weighted mean of every survey item. The formula that the researchers used is Weighted mean = $\sum wx / \sum w$ where, $\sum$ = summation where you should add them up. w = the weights and lastly x = the value. The researchers used this to determine if the application used and explore by the respondents have met the objectives of the study.

Table 3: Likert Scale

Scale	Mean Range	Description	Interpretation
1	1.00 to 1.79	Strongly Disagree	Very Poor
2	1.80 to 2.59	Disagree	Poor
3	2.60 to 3.39	Neutral	Fair
4	3.40 to 4.19	Agree	Good
5	4.20 to 5.00	Strongly Agree	Very Good

Table 4: Android Smartphone Specification used to test the application

Android Smartphone Specification

Processor	Mediatek MT6762R
Memory & Storage	4GB + 64GB
Display	6.3" , (HD + 1600 + 720)
Software	EMUI10.0

Operations

In this phase, the "A guide to sign language" application was fully developed and underwent into alpha and beta testing, the researchers moved on the deployment of the application in which it would be uploaded to apkpure.com. The AGSL application would be downloaded using apkpure.com only. The AGSL app should have include the feature where the teacher can add his/her sign language gestures and add also another set of question for test knowledge.

RESULTS AND OUTCOMES

This section showed the results and outcomes based on the objectives of the study and it is important that the research output is presented in an organized and presentable manner. These discussions and conclusions are based on the objectives of the study, completed analysis, and testing of the

developed application. The study covers primarily the design development and testing of the application prototype entitled "A Guide To Sign Language Using Android App For Deaf".

First, the researcher successfully gathered data from internet library research, internet research journals, related applications and collaborations which gives the researchers enough ideas, information and a deep understanding that would help in the development of the mobile application. The gathered data from the internet library research, internet research journals and related applications such as hand gestures and videos were used in the application's content to easily help the deaf and their relatives to learn basic sign language.

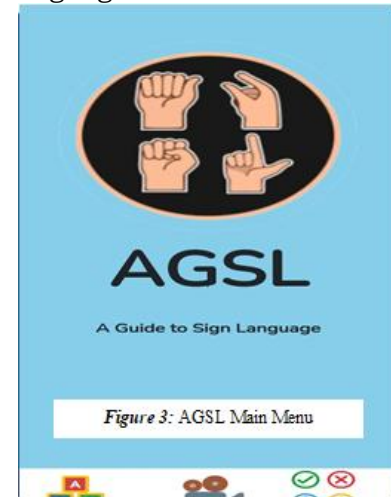


Figure 3: AGSL Main Menu

Second, software technologies and system requirement were identified by the researchers. The assessed available hardware compatible for the installation and configuration has met the system software requirements that enables the researchers to develop the AGSL application. In terms of software resources, researchers used Photoshop for the designing of app story board, for cropping and removing background of the images and icons used in the application. Construct 2 was used in the development of the app to reduce the coding in a form of drag and drop procedures. Android studio was also used by the researchers to import resources from construct 2 and export it in an APK format.

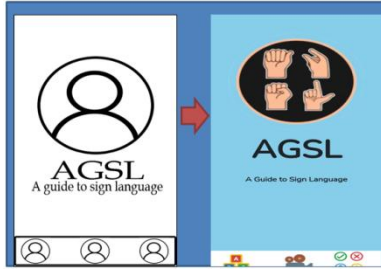


Figure 4: AGSL Working Application

Third, to design the mobile application, the researchers used a story board to overview the appearance and the layout of the mobile application work as a guide and framework to create eye-catching and visually appealing icons to transform it into a working application that would pique the user's interest.



Figure 5: AGSL Features

Fourth, the researcher used the software development tools (see Figure 6) to translate the designed diagrams into working system. The researcher successfully developed and created "A Guide To Sign Language Using Android App For Deaf", an app that would be able to aid deaf and their relatives in learning basic sign language in an advance and innovative way. Through the mobile application, the deaf and their relatives learned how to use the features of the application such as hand gestures in terms of letters and numbers, as well as learn from watching the sign language videos. Thereafter, the user went through a thorough assessment to determine the effectiveness of the application.



Figure 6: AGSL Contents

Fifth, after the survey was conducted through a form of google form to evaluate the user's insights and suggestions about the application using ISO 25010 Software Product Quality Standards in terms of Functional Suitability, Usability, and Portability. The gathered data from the Alpha and Beta Testing are as follows;

Alpha Test

In order to determine the acceptability of the application, alpha test was conducted after the acceptance testing of the adviser. The Alpha testing is the final testing before the software is released to its potential users. It is typically performed by developers and IT Experts. The alpha test respondents were Mrs. Rose Bengco, Professor in PUP, Completed her Master of Information Technology. Aira Venice Talatala Professor in Colegio de San Juan de Letran Calamba, Completed her Master of Information Technology and John Gregory Alandy Voice Network Analysis, Completed her Bachelors of Information Technology.

Table 5. Shows the survey result under the category of functional suitability, which shows that the app is suitable for deaf person. The result shows that the system has met its requirement for being accurate for deaf person and deaf relatives in terms of ways of teaching in local schools and there is existing.

Overall, the functionality feature of the system result was given a positive result and received an average weighted mean of 4.66, with a verbal interpretation of "Very Good". This proves that the researchers achieved the mobile application functional suitability in terms of accurateness and suitable for deaf users and their family.

Table 5: Evaluation Result for the Functional Suitability Criteria for Alpha Testers

Question	5 (VG)	4 (G)	3 (F)	2 (P)	1 (VP)	Mean	Interpretation
The AGSL application is suitable for deaf individuals and their relatives who are subjected to basic sign language demonstration	2	1	0	0	0	4.66	Very Good
The AGSL application is accurate for deaf person and deaf relatives in terms of ways of teaching in local schools and there is existing category for basic sign language	2	1	0	0	0	4.66	Very Good
Average Weighted mean= 4.66							

Table 6 shows the survey result under the category of Usability, which shows that the application is accessible to use by the deaf and relatives. The result shows that the app has met its requirement when it comes to usability. Overall, the Usability feature of the mobile application was given a positive result and received an average weight mean of 4.65, this proves that the researchers achieved the mobile application Usability in terms of accessibility of features and learnability of contents.

Table : Evaluation Result for the Usability Criteria

Question	5 (VG)	4 (G)	3 (F)	2 (P)	1 (VP)	Mean	Interpretation
The AGSL application is very useful to learn more on the basic sign language.	3	0	0	0	0	5	Very Good
The AGSL application can be used by means of installed sign gestures images/videos/ test your knowledge assessment.	1	2	0	0	0	4.3	Very Good
Average Weighted mean= 4.65							

Table 7 shows the survey result under the category of Portability, which shows that the application can easily be adapted by the deaf and relatives in terms of its installability in low storage phone because of its memory. The result shows that the app has met the application requirements when it comes to portability.

Overall, the Portability feature of the mobile application result was given a positive result and received an average weight mean of 4.66, with a verbal interpretation of “Very Good”. This proves that the researchers achieved the mobile application portability in terms of installability for low storage phones.

Table 7: Evaluation Result for the Portability Criteria for Alpha Testers

Question	5 (VG)	4 (G)	3 (F)	2 (P)	1 (VP)	Mean	Interpretation
The AGSL application is an innovated technology that consists of recorded videos and tests that would help practice their knowledge on basic sign language	2	1	0	0	0	4.66	Very Good
The AGSL app can be downloaded through low storage phone devices.	2	1	0	0	0	4.66	Very Good
Average Weighted mean= 4.66							

Table 8: Alpha Testers Weighted Mean

Alpha Testers	Mean
functional suitability	4.66
Usability	4.65
Portability	4.66
Total Weighted Mean	4.65
Overall results conducted from the Alpha Testers	

Beta Test

After alpha test and for the completion of the application evaluation, the proponents have undergone beta testing using the same evaluation tools to ensure the quality effectiveness of the said app. The beta testers were Kate Lee Sicat (Deaf) Regina A. Sicat (Deaf relatives) and Sarah Valdez (Foreign Sign Language Passer)

Table 9 Shows the survey result under the category of functional suitability, which shows that the app is accurate when demonstrating the sign language. The result shows that the system has met its requirement for being accurate for deaf person and deaf relatives in terms of its features.

Overall, the functional suitability feature of the system result was given a positive result and received an average weighted mean of 4.66, with a verbal interpretation of “Very Good”. This proves that the researchers achieved the mobile application functional suitability in terms of Accuracy.

Table 8: Evaluation Result for the functional suitability Criteria for Beta Testers

Question	5 (VG)	4 (G)	3 (F)	2 (P)	1 (VP)	Mean	Interpretation
Using the sign language for the given category is accurate and demonstrate properly. The AGSL application can be used by means of sign language gesture/images/videos/test your knowledge assessment/language demonstration	2	1	0	0	0	0	4.66
Average Weighted mean= 4.66							

Table 10. Shows the survey result under the category of Usability, which shows that the app is suitable for deaf person because of its visual attractive icons and its content. The result shows that the system has met its requirement for learnability for deaf person and relatives.

Overall, the Usability feature of the system result was given a positive result and received an average weighted mean of 5, with a verbal interpretation of “Very Good”. This proves that the researchers achieved the mobile application Usability in terms of Learnability of deaf and relatives.

Table 10 Evaluation Result for the Usability Criteria for Beta Testers

Question	5 (VG)	4 (G)	3 (F)	2 (P)	1 (VP)	Mean	Interpretation
The AGSL application is user friendly with visual attractive icons and important messages using the sign language alphabets of the app. It is easy to learn and access the application	3	0	0	0	0	0	5
Average Weighted mean= 5							

Table 11 Shows the survey result under the category of Portability, which shows that the app is can be easily adapted because of its simple yet attractive interface. The result shows that the system has met its requirement for its adaptability of deaf person and relatives.

Overall, the Portability feature of the system result was given a positive result and received an average weighted mean of 5, with a verbal interpretation of “Very Good”. This proves that the researchers achieved the mobile application Portability in terms of adaptability of deaf users and their family.

Table 11 Evaluation Result for the Portability Criteria for Beta Testers

Question	5 (VG)	4 (G)	3 (F)	2 (P)	1 (VP)	Mean	Interpretation
The AGSL Application can be adapt by the deaf and relatives easily because of its features.	3	0	0	0	0	0	5
Average Weighted mean= 5							

Beta Testers

		4.6	Table 12: Beta Testers Total Weight Mean
functional suitability		6	
Usability		5	
Portability		5	
Total	Weighted	Mean	
4.88			

Alpha and Beta testing overall results

Based on the table 8 & 12, the Alpha Testing to IT experts and Beta Testing to non-IT experts in terms of Functional Suitability were both able to produce an average weighted mean of 4.66 – Very Good. Which enabled the researchers to conclude that both of the testers have enjoyed and learned from the application as well as good experience in terms of the accuracy of the app when it comes to contents and accessibility of its features.

Based on the table 8 & 12, the Alpha Testing to IT experts got an average weighted mean of 4.65 – Very Good in terms of Usability. While the Beta Testing to non-IT experts got an average weighted mean of 5 – Very Good in terms of Usability. Which enabled the researchers to conclude that the Beta Testers had a better experience than Alpha Testers in terms of the learnability of its contents and visual attractiveness of its features.

Based on the table 8 & 12, the Alpha Testing to IT experts got an average weighted mean of 4.66 – Very Good in terms of Portability. While the Beta Testing to non-IT experts got an average weighted mean of 5 – Very Good in terms of Portability. Which enabled the researchers to conclude that the Beta Testers also had a better experience than to Alpha Testers in terms of the adaptability. Wherein, the Beta Testers were able to easily adjust within the changes in the system.

DISCUSSION

The researcher was able to integrate the data, draw inferences, and offer study proposals after a rigorous and critical examination of the capstone project results.

Summary Of Findings

The AGSL application was built using the waterfall model SDLC process. The functional suitability of the applications prototype was shown in compliance with the requirement criteria. As a result, the researcher successfully planned and produced "A Guide To Sign Language Using Android App For Deaf" system prototype.

System and software requirements were identified to proceed to the next step. Scope and limitations were as well identified as the system underwent analysis. Moreover, story board were constructed for the application's

program design. As the application underwent coding phase, Construct 2 and Android Studio were used to translate the Story Board to a functional Application. Afterwards, testing phase was done in order to verify if the given specifications were working as expected. Hence, the application was deployed during the deployment phase.

For the design visualization, adobe Photoshop was used to enhance the images used in the application as well as in the making of the app story board. The images that was created were added to fully customize the application's features. Also, Construct 2 and Android Studio was a big help for the researchers that made it possible to produce the AGSL app.

In regard to the system's functional suitability, usability and portability testing, test cases using ISO 25010 were divided into two categories which are the Alpha Testers as the IT Experts and IT Educators and Beta Testers as Non IT Experts. The alpha testing and beta testing conducted showed a favorable outcome in terms of functional suitability, usability and portability.

Lastly, a user manual was created to guide the users on how to use the application to its full potential. It would enable the user grasp and comprehend the application's available features and contents. The "A Guide To Sign Language Using Android App For Deaf" also known as AGSL could now be accessed through google play store.

Conclusions

The researchers were able to identify the objectives needed to AGSL app. The gathered related literature, studies and existing applications were used to deepen the knowledge of the researchers to help construct the AGSL app.

The researchers were able to identify the hardware and software specification and requirements using the android mobile app, was able to design and develop the AGSL to aid deaf person as well as their relatives to learn the American Sign Language.

Conclusions

The capstone project focused on the development, design, and outcomes of Application for AGSL. The researcher came at the following conclusions based on the findings and discussions of the application's goals:

First and foremost, AGSL was successfully planned and built in accordance with the specifications and goals. The software tools were crucial in turning the Story board into a viable and operational application.

Second, the application's intended features and contents were properly rendered. As a result, the programmers were able to create a visually appealing user interface with accurate material.

Third, the desired objective of the app to aid deaf and their relatives were met in terms of the accuracy and correctness of the contents inside the application.

Fourth, the functional suitability, usability, and portability test cases performed by the alpha and beta testers yielded the intended results. These findings demonstrated that the AGSL application met the requirements, indicating that it could now be utilized and accessible by potential users.

Finally, the AGSL application received a unique domain address and was successfully deployed. With all of the facts, the researcher came to the conclusion that the study's overall goal and system acceptance had been met.

Recommendations

The researchers recommend the following features, which would further improve the capabilities and functions of the app:

Create another mobile app to a more American Sign Language gestures and phrases, using interactive videos of actual deaf persons and with voice attach to it. Include a database of AGSL app that should have a login of user then progress report of their test knowledge taken.

The AGSL app should have include the feature where the teacher can add his/her sign language gestures and add also another set of question for test knowledge.

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AMANU: An Android-Based Kapampangan Dictionary Application

Jabes Sarmiento
Jean Andrea Nobleza
Estie Moore Yalung
Ma. Noemi Santos
Jhuerome Bacani
Ralph B. Cadalzo, MIT (Technical Adviser)

ABSTRACT

Along with the emerging development of mobile technology, several mobile applications have been developed as reference tools. Dictionaries on mobile devices are more efficient than traditional ones because they allow users to receive information easily and save time. Due to language attrition and the indomitable confusion with the construction and usability of Kapampangan words of non-Kapampangan and Kapampangan speakers, the researchers took advantage of the situation and created a Kapampangan Dictionary app for Kapampangan and non-Kapampangan speakers to broaden their knowledge of the Kapampangan language with Father Venancio Samson's Kapampangan Dictionary, a comprehensive collection of Kapampangan words with English definitions. The HAU Center for Kapampangan Studies published the book in 2010. The Agile Method Approach enabled the development of this study to meet the study's objectives. The Kapampangan Dictionary app was pre-launched in the Google Play Store to address and identify technical issues, and it was tested by the researchers, capstone adviser, and some of the focal persons involved in this study. To validate the functionalities, test cases were used to validate the application's specific functionalities based on the research objectives. Furthermore, the researchers have proved that the application can assist someone who uses the app intentionally by using statistics included in the study from the Google Play Store. With that, all of the recommendations and objectives have been met and this resulted in a working Kapampangan Dictionary application.

CCS CONCEPTS

- Computer systems organization → Embedded systems; Mobile Application Development → Android Application

INTRODUCTION

In the Philippines, 187 languages are spoken. Kapampangan, one of Pampanga's eight major languages, is the statutory language of provincial identity. Along with Tagalog, Cebuano, Ilocano, Ilonggo, Bicolano, Waray, and Pangasinense, it is the seventh-most spoken native language in the Philippines, with over 2 million native speakers. (M.A. Bravante and W.N. Holden, 2019) Considering that the Kapampangan nation is personified by a woman, Indûng Kapampangan. Indûng Kapampangan, on the other hand, means "mother of all Kapampangans." The honorific name of the Kapampangan language, Amánung Sísuan, is influenced by Indûng Kapampangan, which is a woman, meaning "language suckled from the mother's breast." (K. Garcia, 2019) Moreover, Kapampangan is the dominant

language in the provinces of Pampanga and southern Tarlac, with the majority of the population belonging to the Kapampangan ethnic group. It is also spoken in northeastern Bataan, in the bordering municipalities of Bulacan, Nueva Ecija, and Zambales.

Kapampangan is mistakenly identified as a dialect and not a language. However, Kapampangan is the official language of Pampanga, at least in Angeles City, according to Ordinance No. 424, Series of 2017 (PO-940-08-17). (J.V Flores, A. Rivera, E. Pamintuan, 2017) Mr. Tangingco, director of the Center for Kapampangan Studies, stated "A language is when two people who talk to each other don't understand each other, then you know they are speaking two different languages. But, if they talk to each other and understand each other except for two or three words, you know they are talking about dialects. In other words, a language is an entire set of words in and of itself, and a dialect is the variation of that language. It is all about the mutual intelligibility to identify each."

Kapampangan language is considered a highly threatened language that has been showing signs of endangerment. Despite its status as a rich language due to its large vocabulary, several Kapampangan speakers are losing touch with their native tongue. The process of losing one's native or first language is language attrition. (S. Montrul and J. Yoon, 2019) It is usually caused by both isolations from speakers of the first language and the acquisition and use of a second language, which interferes with the correct production and comprehension of the first. Several citizens who still speak the language exhibit signs of language attrition, with words borrowed from Tagalog gradually replacing indigenous vocabularies and integrating English and even informal phrases. Kapampangan grammar is complex, making it difficult to learn for those who want to know more about the language.

Technology has become an essential part of the contemporary world, and people are becoming increasingly reliant on it. Then, even for the younger generations, access to applications for educational purposes became mandatory. In that case, some people no longer want to read printed books or turn the pages of a book. When given the option of using a mobile dictionary app or reading a printed dictionary, some would prefer to use the mobile dictionary application. (D.S. Abdullayeva, 2021) With technological advancements and the assistance of a newly developed application, citizens, and immigrants now have a new platform to help further their Kapampangan vocabulary by simply using their gadgets. (K.Y. Aryanto, M. Bandem, W. Mudana, N.L Partami, N. Suandi 2020) The intent of developing an Android-based Kapampangan dictionary application is to make it more accessible to a wider audience. The study aims to replace the traditional word searching methods with a more accessible and user-friendly feature. The application includes the following features: Kapampangan words with English definitions, synonyms, antonyms, audio pronunciations, suggestive word searching, limited web browsing, and Kapampangan categories like common phrases, frequently asked questions, numerical terms, etc.

Background of the study

Pampanga is a province located in the central region of the Philippines' biggest archipelago, Luzon. Spaniards gave the name La Pampanga when they discovered it in 1571, making it the first province in Luzon to become Spanish. During the three centuries, Spanish colonizers learned and adopted the locals' customs, particularly their languages, because it was the most effective way for them to carry out their mission, which was to spread Christianity, and Pampanga undoubtedly absorbed some of the Spaniards' culture and language in return.

During the colonization, Fray Diego Bergaño, a Spanish friar, wrote one of the first Kapampangan-Spanish dictionaries, which helped Kapampangans and Spaniards understand each other. Over time, experts translated Bergaño's dictionary from Kapampangan-Spanish to Kapampangan-English. However, Father Venancio Samson, a Kapampangan priest, created a much more comprehensive version of Father Fray Bergaño's Vocabulary of the Kapampangan Language in Spanish and Dictionary of the Spanish language in Kapampangan: The English translation of the Kapampangan-Spanish dictionary, updated with a collection of Kapampangan words with definitions also includes limited synonyms and antonyms in English. The HAU Center for Kapampangan Studies published this book in 2011.

The Kapampangan language has several names, including Amánung Kapampangan, Pampango, and Capampañgan but the natives refer to it as Amánung Sisuan. According to Michael Raymon Pangilinan, a well-known Kapampangan linguist, on his website SIUÁLA, which stands for Kapampangan Culture and Language. It is widely spoken in central Luzon with over 2 million speakers. Although the language has a wide population of speakers, linguists have stated that little did the citizens know, the Kapampangan language is showing early signs of endangerment. Locals have more than a few deficiencies that they refuse to concede for their Amánung Sisuan. If the citizens do not address this problem, certain words may die and eventually the language itself. It is where the idea of a user-friendly and accessible Kapampangan language learning material has come to light.

The Kapampangan dictionary has a purpose more than just a word-reference book. It has been very helpful to many since both languages are spoken in the province. When technology has taken its course, the townspeople have converted the book into a portable document format. This action has been beneficial because of its wider accessibility to the public. However, the traditional one-by-one searching method is still being used – which is time-consuming and tedious. Aside from this, only some people know how to pronounce Kapampangan words. Leaving this issue unaddressed could lead to mispronounced words and inaccurate meanings which could result in the dialectical difference.

People who are neglecting their mother tongue, are unknowingly abandoning a huge part of their history and identity. To some, this could be just a plain and unimportant issue, but language is where the soul of a country lies. This study is made to prevent the apprehensions that linguist experts have on the Amánung Sísuan. Kapampangans - especially the young generation - could remember their prosperous past and appreciate how Pampanga has splendidly progressed despite the numerous misadventures it encountered along the way.

Objectives of the study

The general objective of the study was to design and develop Amánu: An Android-based Kapampangan Dictionary Application.

In line with this, this study aims to achieve the following specific objectives:

- Gather documents from museums and public libraries in Pampanga about the Kapampangan language and dictionary.
- Design the flow of the system using Conceptual Framework and Story Board.
- Identify the required specification for Hardware and Software in development and in testing of the application.
- Design and develop an Android-based Kapampangan dictionary application and its interface; and
- Integrate the gathered documents from the museums and public libraries, test the system using test cases in terms of functionality, reliability, usability, and portability of the Amánu: An Android-

based Kapampangan Dictionary Application.

Scope and limitation of the study

The developers gathered the necessary information for the study and conducted a review of previous related research. Following the collection of the necessary information, a series of diagrams was created to provide a visual representation of how the application works.

The study was focused mainly to expand the vocabulary of Kapampangan and non-Kapampangan residents in Pampanga. The goal was to provide an Android-based Kapampangan Dictionary Application of Father Venancio Samson's Kapampangan Dictionary which contains Kapampangan words with English definition, synonyms, Kapampangan common phrases, frequently asked questions, numerical terms, etc., suggestive word search, a limited web search for words that are not available in the dictionary database, and interface personalization of user's screen theme into light and dark modes.

After installation, the application can function without an internet connection, retrieving words and definitions and playing audio. There is also a suggestive word search feature in the application. If the word entered in the search bar is not found in the dictionary, the application will prompt the user to search for it online using the phone's web browser. Users will also be able to view their previously searched words and decide whether to delete or keep them all. Users can also bookmark a specific term and return to it the next time they need it, as well as change the theme of their screen to light or dark mode.

The application was optimized for Android devices running Android versions ranging from Jelly Bean (4.1) to Q. (10). Additionally, if a computer device has an Android emulator, this program can be used on it. The understanding capacity gap of the user before and after the usage of the application will also be on the boundaries of this study. The application is not intended to be a tool for the Kapampangan writing system. The Center for Kapampangan Studies included in the published book of Father Venancio Samson entitled The English translation of the Kapampangan-Spanish Dictionary that “there are many determined

proponents of the c/q orthography as there are of k orthography, the dictionary cannot settle for their differences. No single organization or institution can claim the authority to set the conventions of spelling on behalf of the entire population, and in fact, no single generation can impose its preferred orthography on generations still to come.” The application will entirely focus on the main purpose of the dictionary - a word reference and provide the needed information about a specific word.

SYSTEM DEVELOPMENT METHODOLOGY

In this section, the design and the methods were explained to meet the objectives, as well as its design and project development.

The Agile Methodology divides tasks into smaller iterations or sections, avoiding long-term planning. The number of iterations, lengths, and constraints for each iteration are all fixed. Dividing a large project into smaller components reduces overall project completion time requirements while also lowering project risk. One of the first steps in the process is to understand the project's requirements. These procedures necessitate assessment, evaluation, and execution to optimize performance within constraints.

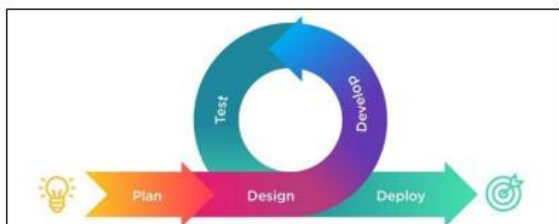


Figure 4: Agile Model

Source: (<https://readdive.com/how-to-use-agile-approach-to-scope-software-projects/>)

Figure 4 shows the Agile Model that was used in the development of the application. Working on the project as soon as possible is possible with Agile, even if not all of the project requirements have been collected or functionality included in the final version has not been decided. Furthermore, by breaking down the process of determining project requirements, increasing flexibility to make it easier to adapt to change, and later building and testing the project, this method can help in project development. Quality is improved by

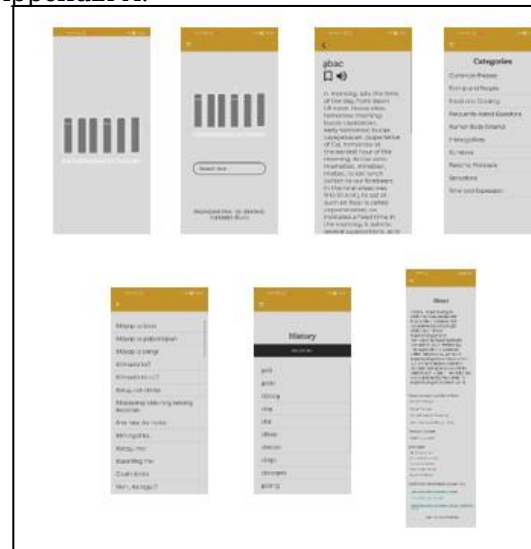
identifying and correcting bugs quickly, identifying expectation mismatches early in the development process, and conducting testing and reviews during each iteration.

Plan

Researchers utilized their related studies by gathering information from trustworthy web domains, schools, and public libraries to develop a conceptualized idea that was turned into a project. The panelists approved the development of an Android-based Kapampangan Dictionary titled "Amánu: An Android-based Kapampangan Dictionary" after discussing and analyzing a few ideas.

Design

Based on the information gathered, the researchers define the requirements, tools, applications, and hardware required for the development of the application. This stage also includes deciding which components, functions, and features to include in the application. The researchers also created mock-ups of the dictionary's user interface. These prerequisites include the hardware and software required for the development of the Android-based Kapampangan Dictionary. See Appendix A.



Develop

The researchers used trial and error to navigate and use the IDE, Android Studio, which aims to create and deploy a working Android-based Kapampangan Dictionary. Because the Android application is still in its early stages of development, its functionality is basic and

limited. Some of these basic features are included in the panelists' recommendation form. This prototype was tested, and the modifications, revisions, and improvements were determined using certain hardware and software requirements.

Table 1: Hardware Specifications in the Development of the Application

Hardware	Description
1 TB HDD	Hard Disk Drive Capacity
8GB RAM	Memory Capacity
Intel Core i5	Unit Processor
1920 x 1080 pixels	Screen Resolution
Microphone and Condenser	Voice Recording

Table 2: Software Specifications in the Development of the Application

Software	Description
Android Studio	Used in Android Application Development.
DB Browser for SQLite	Used in creating, inserting, and editing database files.
Audacity	Used for recording, editing, and mixing audio.
Adobe Illustrator	Used for designing the logo.

Tables 1 and 2 show all of the hardware and software specifications used in the development. Based on the plan and design phases, the researchers have developed the application in this phase. For hardware requirements, a laptop with a one-terabyte hard disk drive, eight gigabytes of RAM, an Intel Core i5 processor, and a resolution of 1920x1080 pixels was used in programming and database creation, and a microphone and condenser were used to record the audio required for pronunciation of Kapampangan words. In terms of software requirements, Android Studio was used to develop the dictionary, SQLite Db browser was used to create the database, Audacity was used to record, edit, and mix audio, and Adobe Illustrator was used to design the application's logo. All of these devices and software applications worked together to develop the "Amánu: An Android-based Kapampangan Dictionary".

Test

Following the completion of the development, initial testing was initiated, and the first round of testing was carried out. The researchers then

assessed the project's performance and look for flaws. To determine the working Dictionary's strengths and limitations, the application was presented to the researchers' capstone adviser as well as to the director and staff of the Center for Kapampangan Studies.

Table 3: Smartphone Specification Used for the Testing and Integration

Hardware	Software
Huawei Nova 7i	Android Operating System (Android X)
128GB	Mobile Memory Allocation

Table 3 shows the smartphone specification used in testing and integration to identify and correct unforced errors, bugs, and the overall design of the application. The capstone adviser for the researchers made suggestions and recommendations about the look of the dictionary, such as creating the main logo, the color of the interface, and the calculated aspect ratio for each mobile device. Following that, the application was refined to improve its user interface and functionality.

Deploy

After going through all of the stages and iterations, the researchers were able to develop a working application entitled "Amánu: An Android-based Kapampangan Dictionary". The finished application is published on the Google Play Store. The application is in its final stages of development.

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.

Table 4. Hardware Requirements (for development)

Devices	Functions
Laptop/ PC	Coding, Database, Audio Editing
Microphone and Condenser	Audio Recording
Android phone	Testing

Table 5. Software Requirements (for development)

Application	Functions
Android Studio	IDE/Mobile Application Developer
SQLite Database Browser	Database
Audacity	Audio Editing

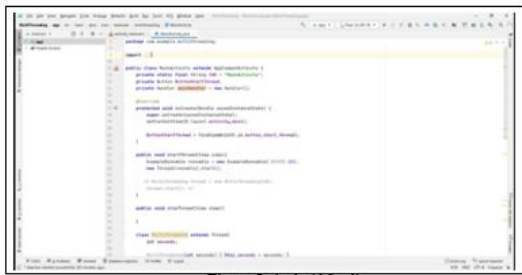


Figure 5: Android Studio

Figure 5 shows the user interface of Android Studio, the integrated development environment (IDE) used to create the *Aminu: An Android-based Kapampangan Dictionary*.

Figure 6 shows the application used to create the Android-based Kapampangan Dictionary's database.

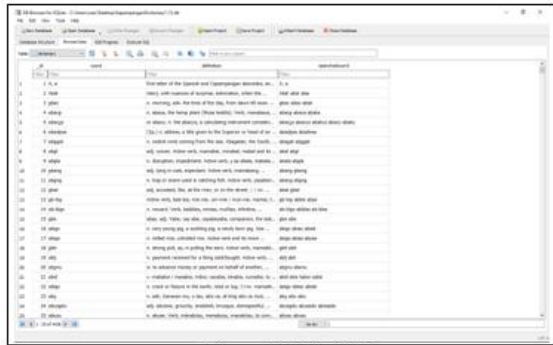


Figure 6: SQLite DB Browser

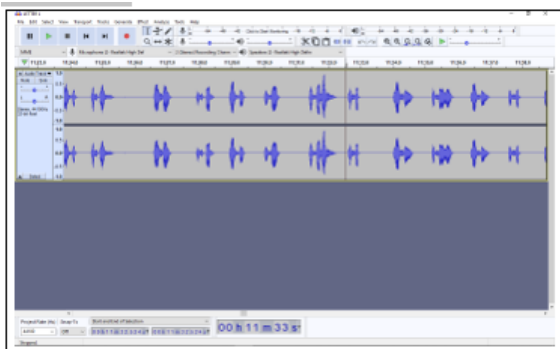


Figure 7: Audacity

Figure 7 shows the application used in editing the audio pronunciation the Kapampangan words.

Figure 8 shows the front cover of Father Venancio Samson's book, *The English Translation of the Kapampangan - Spanish Dictionary*, which was used as a resource for this study.

The development phase was divided into four different tasks: the development of the application diagram, the development and construction of the database, the development

of the graphical user interface, and the development and recording of the audio for the pronunciation of words in the application.

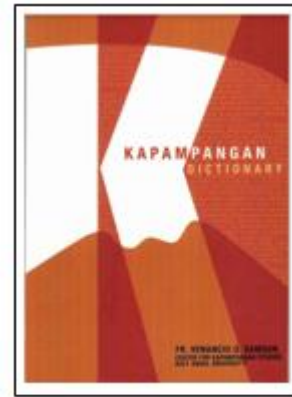


Figure 8: Kapampangan Dictionary

To obtain the necessary documents for developing an Android-based application for the Kapampangan Dictionary, the researchers contacted the Center of Kapampangan Studies, located within Holy Angel University in Angeles City and serves as Pampanga's archival museum. The museum granted permission to use Father Samson's Kapampangan Dictionary in this study.

The next step was inputting the dictionary data into SQLite DB Browser—the application used to create the application dictionary's database. Alongside the sorting and storing of data into the database is the development of the graphical user interface of the mobile application using Android Studio, an application to create an Android-based application.

To integrate the application's functionality with necessary files like database and audio files were inserted directly into the program—allowing the application to be used even without internet access unless with the use of online searching using a web browser.

Based on the objectives, test cases were used to validate the functionality and portability of the application. See Appendix C and Appendix D. After validating the functionalities using the test cases, the researchers were able to determine the windows, buttons, and information to be displayed in the application. The application includes Father Venancio Samson's book, *The English Translation of the Kapampangan - Spanish Dictionary*, as well as

Kapampangan audio files and other necessary documents such as Kapampangan common phrases, frequently asked questions, numerical terms, and so on, as well as application features such as suggestive word search, limited web search, and interface personalization of the user's screen theme into light and dark modes. See Appendix A and Appendix B.

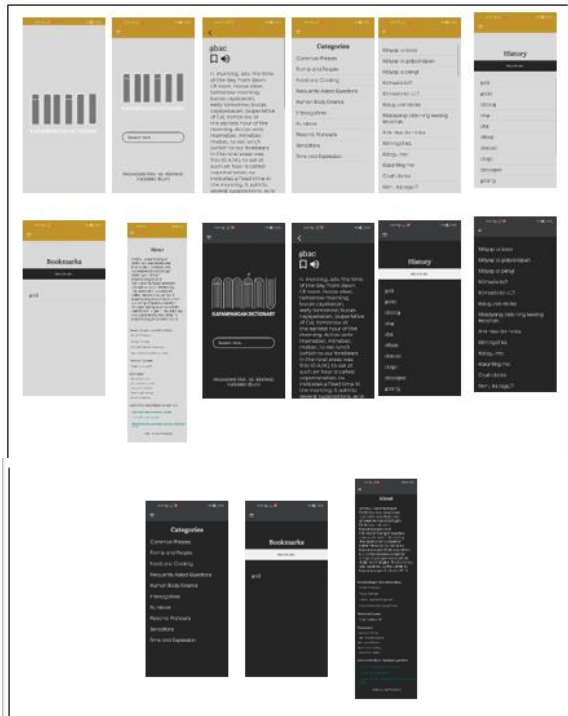


Figure 9: Kapampangan Dictionary User Interface: Light and Night Mode

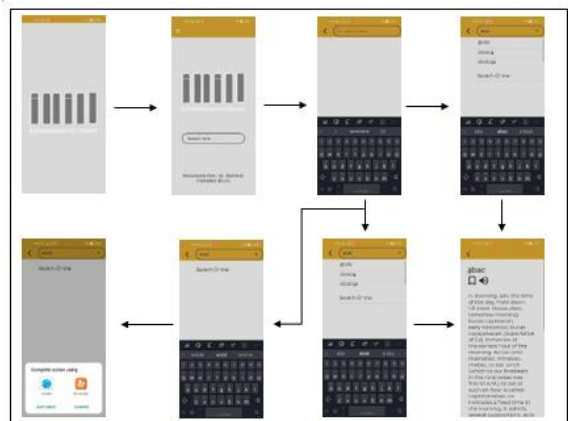


Figure 10: Word Search: Light Mode

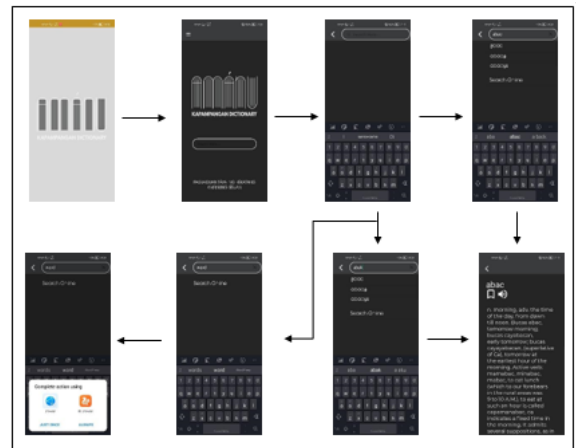


Figure 11: Word Search: Night Mode

Figures 10 and 11 above show how the word search in the dictionary works. When launching the mobile application, the smartphone will display the logo before reverting to the main screen. The application's main screen consists of a side navigation bar and a search bar. Users should be able to type and search for the desired Kapampangan word once the search bar is selected. If the user is unsure of the spelling, the application suggests words related to the typed word, and if the word is not found in the dictionary database, the user can search online using the cellphone's web browser.

The user can then select the suggested word from the list, which will take them to the next window, which contains the Kapampangan word, definition, audio button, and bookmark button.



Figure 12: Navigation Bar: Light Mode

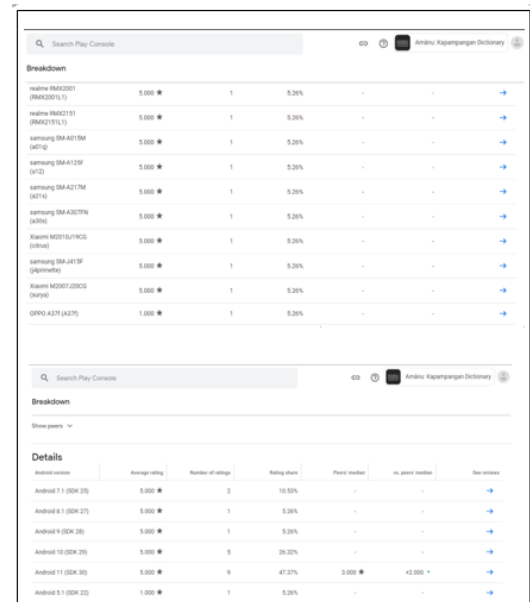
Figures 12 and 13 show the contents of the side navigation bar. The user can access the history, bookmarked words, Amánu for Beginners, categories, and the about us window via the side navigation bar. The mode switch can also be found in the side navigation bar.

The researchers were able to determine that the applications worked properly after validating the functionalities with test cases. There were no issues with the application's installation or uninstallation, and it functions as expected. It was demonstrated that the dictionary will perform word searching, suggestive word search, and display the correct typed word along with its definition and audio. All buttons, including the bookmark, audio, and delete all buttons, are fully operational and functional. The History, Bookmark, Amánu for Beginners, Category, and About Us Windows in the side navigation bar are all functional. The application can also switch from light to night mode without error or complication. See Appendix C.

Under usability, installation and uninstallation were easy to operate. The application is user-friendly, and testing is not hard to utilize. Furthermore, all of the application's functionalities are operational, and it serves their intended purpose and usage. The application can function without an internet connection, but the user has the option to search for words online if the word is not in the dictionary database. The graphical user interface is responsive and remains in its proper position even when installed on different Android devices that are running in 4.1 to 10 Android OS. The application does not display any errors when using other applications. The audio played also corresponds to the user's word search. When the user types a word into the search field, a list of words that are similar to the typed word appears on the screen; however, if the typed word is not available, the web browser search option is available. When the user switches the application's interface to night mode, the application will remain in that mode even after it is closed. To return to light mode, the user should use the side navigation bar and use the switch button. Lastly, the links provided in the About Us window will direct the

user to the correct domain. See Appendix D, Appendix E, and Appendix F.

Before the application is finalized and presented to the panelist, it is pre-launched in Google Play Store to address and identify technical issues. The researchers were the first to test the application to see if the recommendations were met, after the focal persons, the thesis group adviser, and others who initially installed the application. The following are the Google Play Store statistics:



The screenshot shows the Google Play Console interface for the app 'Amánu: Kapampangan Dictionary'. It displays two sections: 'Breakdown' and 'Details'.

Breakdown Table:

Device	Version	Number of ratings	Average rating	Rating share	Percent of total	Percent of total	Percent of total
Android 7.0 (SDK 24)	1.0.0	1	5.00	100%	100%	100%	100%
Android 8.0 (SDK 26)	1.0.0	1	5.00	100%	100%	100%	100%
Android 9.0 (SDK 28)	1.0.0	1	5.00	100%	100%	100%	100%
Android 10.0 (SDK 29)	1.0.0	1	5.00	100%	100%	100%	100%
Android 11.0 (SDK 30)	1.0.0	1	5.00	100%	100%	100%	100%
Android 12.0 (SDK 31)	1.0.0	1	5.00	100%	100%	100%	100%
Android 13.0 (SDK 33)	1.0.0	1	5.00	100%	100%	100%	100%
Android 14.0 (SDK 34)	1.0.0	1	5.00	100%	100%	100%	100%
Android 15.0 (SDK 35)	1.0.0	1	5.00	100%	100%	100%	100%
Android 16.0 (SDK 36)	1.0.0	1	5.00	100%	100%	100%	100%
Android 17.0 (SDK 37)	1.0.0	1	5.00	100%	100%	100%	100%

Details Table:

Android version	Average rating	Number of ratings	Rating share	Percent of total	Percent of total	Percent of total
Android 7.0 (SDK 24)	5.00	2	100%	100%	100%	100%
Android 8.0 (SDK 26)	5.00	1	50%	100%	100%	100%
Android 9.0 (SDK 28)	5.00	1	50%	100%	100%	100%
Android 10.0 (SDK 29)	5.00	1	25%	100%	100%	100%
Android 11.0 (SDK 30)	5.00	1	47.0%	100%	100%	100%
Android 12.0 (SDK 31)	5.00	1	5.0%	100%	100%	100%

Figure 13: User Cellphone Models with Android OS and Ratings

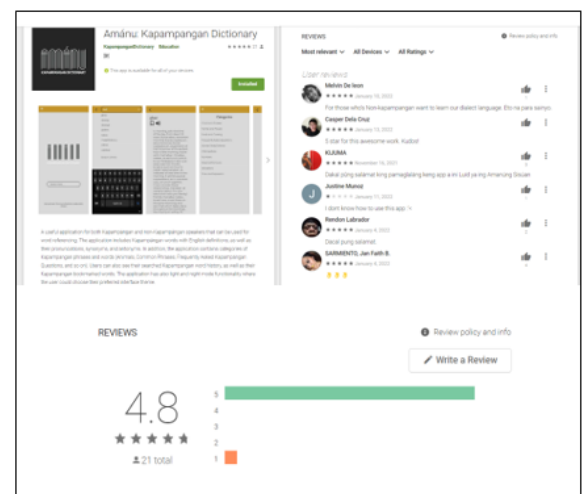


Figure 14: Application Uploaded in Google Play Store with User Ratings

DISCUSSIONS

This section discussed the findings, conclusions, and recommendations based on the analysis of the result of the study entitled *Amánu: Android-based Kapampangan Dictionary*.

Summary of findings

Based on the reviewed related literature and recommendations, all of the specific requirements that were required were easily determined.

The researchers were able to understand the flow and requirements for the mobile application to be successful and fully functional by using diagrams such as a conceptual framework and software development methodology.

The results of test case analyses are all passed in the categories of Functionality, Portability, Usability, and Reliability. The findings indicate that all of the application's functionalities, such as buttons, windows, and links, are functioning properly. Furthermore, it was demonstrated that the application is simple to use, test, understand, and run properly with or without the internet. Furthermore, regardless of the user's screen dimensions, the user-interface components are all in the proper place in the interface.

Panelist suggestions for additional features such as word categories, user preferences for light and dark modes of the screen, suggestive word search, and a web browser search were also considered. After extensive testing and panelist feedback, the researchers were able to design and develop *Amánu: An Android-based Kapampangan Dictionary*.

Conclusions

The researchers developed an application that can provide a free source of Kapampangan Dictionary for Kapampangan speakers and non-Kapampangan speakers who want to know the definition or pronunciation of a certain Kapampangan word using an Android-based Kapampangan Dictionary that includes: Kapampangan words with English definitions, synonyms, antonyms, audio pronunciations, suggestive word searching, limited web browsing, Kapampangan categories such as common phrases, frequently asked questions, numerical terms, etc.

To achieve the application's goals, the study's objectives and agile approach methodology were used. As a result of a series of experimental test cases, the application was developed and tested by experts in Kapampangan Language, and it qualifies as a fully functional Android-based Kapampangan Dictionary. Every phase is repeated following the requirements until the project is completed and all expert and panelist recommendations have been met.

Finally, based on the results of the experimental test cases gathered, the researchers have successfully developed a working Kapampangan dictionary that works on any Android device with a 4.1 to 10 Android operating system.

Recommendations

The researchers considered the following recommendations for future improvement of the developed application entitled "*Amánu: An Android-based Kapampangan Dictionary*".

- Improve the graphical user interface of the application for security and for the additional documents.
- Consider adding Kapampangan phrases/translations for future references from eligible Kapampangan documents.
- Consider using .wav as an audio file extension to reduce the application's memory assumption of the user's mobile phone.

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BELITTLE: An Android 3D Based Survival Horror Game

Mikholae B. Baniaga
George Derek Kyle M. Bravo
Daniel Mark B. Larios
Nicolai Keann P. Cortez
Ronnie G. Castro
Ritchell Z. Escoto, MIT (Technical Adviser)

ABSTRACT

Mobile games have a certain attractive quality that inspires everyone to play, regardless of the user's age. Mobile games are being developed as a result of the increase of smartphone and technological advancement, as well as the growing popularity of trendy technologies for game development such as the Unity application. The gaming sector is growing over the world, and smartphones are playing a big role in this growth. The researchers developed a horror survival android game named "Belittle" with 3-dimensional graphics. The game has two game modes the story mode and cooperative mode. In story mode, there are three chapters with different level mechanics that the player will need to solve and overcome. In chapter one, the player needs to find the right block and move it to the platform to open the gate. The player will need to avoid traps and enemies while solving the puzzle. Chapter two include solving the riddle by pushing buttons and passing the moving platforms. The objective of chapter three is to find the keys hidden in the map while avoiding the enemy. In cooperative mode, two players need to solve a riddle that has been shown on the board before the time runs out. The target audience is aged 15 years old and up as this is the recommended age for playing the game. Players who enjoy horror games that require them to utilize critical thinking skills to solve riddles will find the game entertaining.

CCS Concepts: • Computer systems organization → Embedded systems; Internet of Things • Mobile Application Development → Android Application

General Terms: Design, Performance

INTRODUCTION

For kids, many games are scary. For example, Spirit of the Glass, Zombie Tag, and the all-time favorite game of every child, the Ghost in the Graveyard. Ghost in the Graveyard, a scary game to play with three or more friends outdoors, is a variation of Hiding and Seek. One person hides while the other players stay at a rock, tree, or certain area known as the base. Players count to twenty slowly while the ghost hides. When the ghost is found, whoever finds him yells, "Ghost in the Graveyard". All the players race back to the object or area designated as a base. The ghost attempts to tag another player before they reach safety. If he manages to tag someone, that player becomes "Ghost" for the next game.

Today's time, due to the pandemic, people cannot hide the excitement to go outside,

especially teenagers who want to play together with their friends. But with the restrictions of every place, with improvements in technology, video games continue to evolve into more realistic interactive environments. Games can be accessed by downloading an application to a platform. An example genre of online application game is the survival horror game, according to Taylor. Survival horror is the child of many other genres like adventure, action, horror, and gothic. Then, it is characterized by concepts, setting, and content rather than gameplay mechanics. Additionally, the author asserts that games in genre earned inclusion due to incorporating horror elements and emphasizing survival rather than flourishing. This genre was also among the first to approach game design from an emotional standpoint. A blend of game development, gameplay mechanics, and plotline heightens the level of fear [1].

The researchers come up with the idea of developing Belittle, an Android 3D Mobile Survival Horror Game. It is about the main character named "Alfred" fighting his fears in his dream by solving puzzles and obstacles in a

frightening environment as the game is designed to scare by immersing them in an exciting tragedy through terrifying graphical character traits and resentment and elicit feelings of terrifying, suspense, and excitement in every puzzle and obstacle needed to survive for him to finish all challenges that will wake him up again in the real world and realize on how successful he overcomes his fears. This game comprises three distinct stages that will test players' critical thinking and problem-solving abilities. This new survival horror game application provides an ideal platform for spending leisure time, honing critical thinking skills, and experiencing enjoyment, terrifying, and challenging mind-puzzling game that utilizes 3D advanced technology to immerse players in the game, especially those who enjoy horror and puzzle games and are at least 15 years old and is compatible with Android smartphones.

Background of the study

Games have made a huge impact on our society since the early times. It could lead to addiction for it is immersing, or it could be a coping tool to relieve stress. Different games are being developed to serve as entertainment for every user and player, but not all developed games give attention to the storyboard and the theme or helpful to the users.

The researchers have focused on developing the project for today's situation which is the pandemic. The people tend to stay at home and spend their leisure time with their gadgets, surfing the net, watching movies, and playing games with their mobile phones. With the increase of mobile phones, it is also the rise of mobile gaming.

The researchers come up with this study the 3D Mobile Survival Horror Game named Belittle. The purpose of a survival horror game is not just to give the player the feeling of being scared but also to give the excitement and satisfaction through finishing the levels of the game by solving puzzles, avoiding traps, and running from a monster in a frightening environment.

Objectives of the study

The general objective of the study is to develop a survival horror mobile game named Belittle - an android 3D-based survival horror game. Also, it is to provide entertainment to the users

in their free time. The said game is an easy-to-play mild horror game that will be both exciting and thrilling.

In line with this, this study aims to achieve the following specific objectives:

- To design the game application in terms of:
 - Storyboard;
 - Modeling of objects and characters; and
 - Sounds and background music.
- To identify the requirements and analysis of the study through the use of gathered information and research using the internet and survey form.
- To develop Belittle: an android 3d game that has the following features:
 - 3-Dimensional;
 - Story mode; and
 - Cooperative mode.
- To develop three chapters on the story mode.
- To identify the necessary hardware and software required to develop the application.
- To test the game using the following criteria:
 - Functionality;
 - Usability;
 - Portability; and
 - Reliability.

Scope and limitations of the study

The study of Belittle: An Android 3D Survival Horror Game will provide entertainment to the users in their free time.

The researchers aim to provide a 3D survival horror game that will give entertainment and, at the same time, will allow the users to understand societal issues, and improve one's cognitive skills and will serve as a coping tool from stressful circumstances.

The project has an interactive user interface that the player can use to easily navigate the game from the title screen to gameplay. The game is in the landscape but provides a sensor which the player can use to rotate the game screen. In addition, there is a menu setting in the main menu that will give the player an option to adjust the brightness from high to low, joystick opacity to adjust the transparency of the joystick, and the sensitivity option to adjust the smoothness of the joystick. The option is to make a delay for the movement of

the character when the game is played. The project also has the option to turn on and off the background music and sound effects. The game covers level-by-level game features that allow the player to get a challenging game environment.

The project has a level selection in the main menu. This will allow the user to change the level and go back to the previous level that the user finished. The game has three playable levels, and each level will indicate an objective that the player should accomplish.

The objective of the first level in the first chapter is to find a way out by pushing the right block into the place. There are four blocks in total that the character can choose from. Once the right block is placed, the gate will open, and the character can proceed to the next level of the chapter. In the second level of chapter one, the player will need to avoid traps to survive and advance further. When the player gets caught in a trap, he will die and revive at the previous checkpoint. The player will need to find the right way to find the block that is hidden while avoiding the traps that are scattered on the map. Once the block is placed in the right place, and the character does not hit a trap, the gate will open, and the player can advance to the next level. In the third level of chapter one, the player needs to turn on switches to operate the tower to advance. There are three switches that the player needs to find and need to activate by pulling the lever to supply electricity to the tower. When the switches are not activated, the lights will remain red. The player will need to go back in the switches to pull the lever to give electricity to the tower. When all the switches are turned on, the color of the lights will turn green. The final switch which is located at the top of the tower is activated. Once the player pulled the lever, the alarm will be turned on, and an enemy will pursue and follow him. The player needs to wait as the gate slowly opens while avoiding the pursuer. The final checkpoint on chapter one will encounter an antagonist named Grimm, the final boss on the 3rd chapter. Grimm advised Alfred to find him in the Final Chapter. In the last part, the player will find a mirror that can transfer the character to the next chapter if the player goes through it.

The main objective of chapter two first level is to find clues and solve riddles to open the gate to the next level. In this level, the player will need to read and solve a numbered riddle. The player will then need to interact with five buttons corresponding to the correct combination to open the gate and proceed to the next level. The player has three chances to enter the correct combination. Otherwise, the player will die because of the ceiling falling with each incorrect combination. The objective of the second level is to find the right blocks that the player will jump on. Once the player jumped and fell, the level will reset. There will be a checkpoint in the middle of the map. The objective of the third level of chapter two is to pass through the moving platforms. The platform movements and speed are not the same. Some move from left to right, front to back, and to another platform that comes from the walls. There is a total of four platforms that the player needs to overcome and to make it to the last chapter.

The main objective of the final level is to find the keys hidden in the map. There is a total of 10 keys needed to be found while being hunted by an enemy. For the player to fight back, he needs to hit the enemy by using a flashlight. Once hit by the light, the latter will be stunned for five seconds. The flashlight has a cool down when the green bar drops. It will start recharging for 2 seconds. First, the player needs to go to the center of the map to find the book. After reading the book, the keys will scatter all over the map and will need to be found. When all the keys are acquired, the health bar of the enemy will show up to be defeated by the player using a flashlight.

The project provides a game mode selection that includes a story and cooperative mode. The graphics can be adjusted from low, medium, to high to provide smooth gameplay. The option to adjust the opacity and the joystick is also available in the options menu. The opacity adjustment option will help the player to see the background while playing when lowered. The character can be controlled using an analog joystick controller for movement, a button for jumping, and a button for touching in-game items. The sensitivity option can help to adjust the delayed movement of the joystick and character. The

sensitivity is ranging from 1-5. The lower the number, the delayed movement it is.

The researchers used the BandLab application for editing the music and sound effects that will be used in the game. They used Photoshop for creating in-game assets like jump button, joystick, and menu and options buttons for pause, play and quit. Also, they utilized the Blender application for creating in-game objects and items like blocks and doors.

First on the criteria is the functionality of the game. Game mode selection should be working for the player to select different game modes from single to multiplayer. The single-player mode provides three chapters selection with different objectives to pass the game. The option to adjust the graphics from low, medium to high should be available as the users have different device specifications. The option to adjust the opacity of the joystick and button is important because the player can see through the game well depending on the opacity level set by the player. Option to turn on and off the background music and sound effects are also available. The main functions to play the character should be working. The functions include running, jumping, and interacting with objects.

The second criterion is about the usability of the game. The researchers need to know if the system is easy to implement. After implementation, the researchers will test the system. The testing was used to know if the system is easy to check and maintain. The game is easy to understand by providing a tutorial on how to play. Making the user interface to match the theme of the game is important to suit the background music and sound effects. The game can easily be installed and uninstalled without any error when the required device specification is met.

The third criterion is portability. The game can be played on a variety of android devices that have at least 3 gigabytes of ram and 700 MB of free storage to run the game and play single and cooperative game mode. Screen adaptability of the game will be available to run on different smartphone screen sizes. Multi-touch is supported. For example, the player controls the character using the joystick while using the jump button at the same time.

The last on the criteria is reliability. The installation required an active internet connection, and the mobile device should be running at least on Android OS 8. The user can uninstall the game without any error when going to application management. Find the application and tap the uninstall button. The game can still run when other applications are in use or open. The game can still run while charging, connecting to the internet, and receiving phone calls.

The system is not supported to be played on IOS (iPhone Operating System). It is limited to be played on an android operating system only. The character cannot go through holes in the wall and does not allow the player/character to fall outside the map. The game's visuals are likely to be good since the game has 3D characters and surroundings that will need a higher version of Android, at least Android version 8 (Oreo Version), 3GB of RAM, and an octa-core central processing unit. Players must be at least 15 years old to play as the game's visuals and plot may not be acceptable for young people, and it contains aspects that are not fit for them. Since the game includes dark graphics and a terrifying setting, this research does not cover audiences under 14 years old due to design restrictions. In cooperative game mode, only two-player should be playing inside a lobby. The players should have an active internet connection to join. Connecting to Wi-Fi is highly recommended to reduce lag and latency.

The respondents played the game for the researchers to know what graphic settings their device can handle. The result shows that the higher the devices that have high random access memory tend to have a faster central processing unit and graphics processing unit. Devices with only 3 gigabytes of memory can only run the game in low to medium graphic settings without the gameplay getting lag than those with 8 gigabytes of memory that can handle high graphic settings. The researchers obtained the hardware requirement with the help of an online survey. For example, see Appendix C for the game survey.

The user's device needs to meet the minimum device specification to install, run the game smoother, and without error. First, the API (Application Programming Interface) should be

at least level 26 or Android version 8.0 named Oreo. Second is the capabilities. The device screen should be a touch screen and has network or internet compatibility. Third, the RAM (Random Access Memory) should be at least 3 gigabytes. Fourth, the CPU (Central Processing Unit) should be at least Octa-core. The GPU (Graphics Processing Unit) should be Qualcomm Adreno 505/ PowerVR GE8320 or better. Fifth, the device should have at least 700 MB of free storage to install the game. The recommended display size is 6.5 inches or above to take advantage of a full and clear screen.

SYSTEM DEVELOPMENT METHODOLOGY

This section identified the methodologies used by the researchers to develop the propose study. In this section, the theoretical methods and diagrams were also added to explain the function and complement the process flow.

Scrum is an agile development methodology used in the development of Software based on iterative and incremental processes. It is an adaptable, fast, flexible and effective agile framework that is designed to deliver value to the customer throughout the development of the project. The primary objective of Scrum is to satisfy the customer's need through an environment of transparency in communication, collective responsibility and continuous progress. The development starts from a general idea of what needs to be built, elaborating a list of characteristics ordered by priority (product backlog) that the owner of the product wants to obtain. These are the following list of activities that the researchers prioritize in developing the game. (1) Game Design. The researchers consider the background of the game setting, the pieces model or the players, also the interface of the whole game staring from the splash screen and the scope of the whole game. (2) Coding. The researchers are still on the process of coding the game, but beforehand the researchers decided what will be algorithm of the game, the program and the syntax. (3) Animation. The researchers also decided how the splash screen was, pieces model and effects should be animated that will give

An immersive feeling to the user. (4) Testing. In this activity, the researchers will make sure that the developed game will be tested.

The researchers used scrum methodology as the method focused on experiences that encouraged the team to learn to be self-organized while working on a problem, and the researchers can reflect while developing the game to continuously improve.

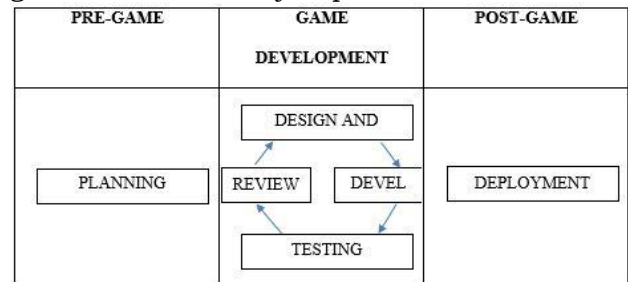


Figure 2: Scrum Methodology

Pre-game stage

In the Planning Phase, the project plans are documented, the project deliverables and requirements are defined, and the project schedule is created. It involves creating a set of plans to help guide the team through the implementation and closure phases of the project. The researchers decided to come up with the title Belittle an Android 3D-based Survival Horror Game with three chapters or game levels to be played (see Appendix A). The game is going to be developed for android devices with a recommendation to be played on Android Oreo 8.0 and 3 gigabytes of ram above to handle the 3D graphics of the game. The researchers have thought of some possible tools to be used in making the game such as Unity for game development and programming, using the Blender application for creating 3D objects and Photoshop for creating the user interface, buttons, and joystick for movement and using BandLab application for editing in-game sounds. The researchers will use a computer for developing the game and an android device for testing. The researchers will use an interactive user interface to let the players have a friendly game environment throughout the game.

Table 1. Planning the Designs and Tools to Use

Software	Hardware
- Unity 3D - Blender - Photoshop - Bandlab	- Used computer for developing and designing the game - Mobile phone (Android 8 and above)

APPENDIX A

Storyboard of the Game



Figure 18: Story Board of Chapter One

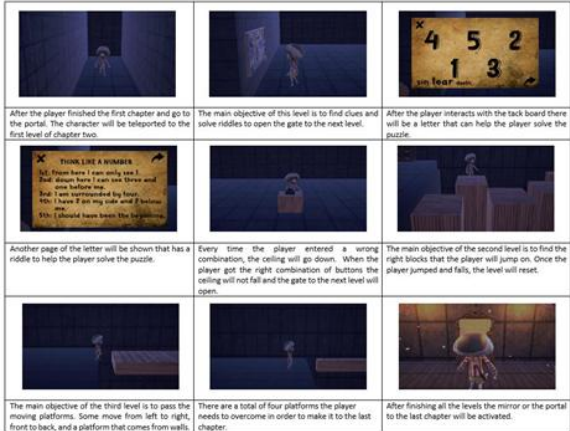


Figure 19: Story Board of Chapter Two

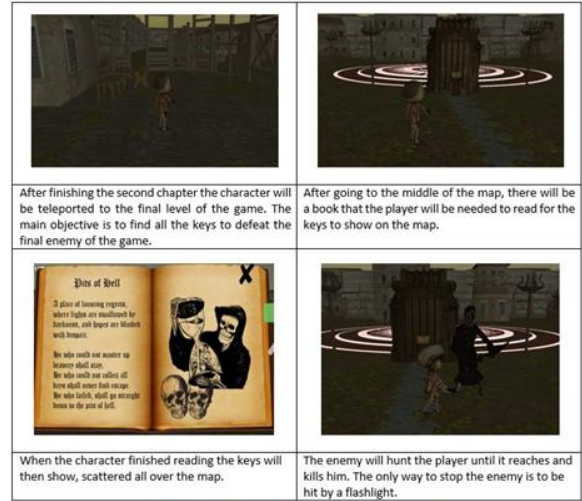


Figure 20: Story Board of Chapter Three

Mid-game stage

In the Game Development phase, the researchers have different part in making the game. A member is assigned to be the game programmer that is responsible for the mechanics of the game from the main menu which has play, options, and quit button. The play button is where the chapters can be found and played from first to third chapter which is the final level. The programmer also programmed the movement of the character like running, jumping and the interactions between the objects and the environment of the game. The options button is where the player can turn on and off the music and sound effects of the game as well as the option to adjust the graphics of the game from low to high settings. The other members are assigned to be the game level designer. Level Designer is the creator of the levels within a game, mapping out the layout so that it functions within the rules of the game and executes gameplay. The researchers developed a 3-Dimensional game that runs on android using Unity software.

In the Review Stage, the researchers conduct beta testing to find bugs that can be found in the game. For example, there is a bug where the character of the game will fall outside the map when walking beside the rocks and edges of the in-game objects. To solve the problem, the programmer put an invisible block so that the character of the game cannot walk through it and to not fall outside the map or the game

level area. The functionalities of the game are also tested from the audio settings to turn on and off the music and sound effects. The option to adjust the graphics from low, medium, to high is also tested. The researchers also tested the movement of the character from running to jumping, and to make sure that the interactions of the character to the objects are working properly. The example of the object and player interaction is the moving of blocks that the character needs to push to the right place to open the gate to the next level. The researchers tested the music and sound effects as well as the functionalities of chapters 1 to 3 by the use of test cases. Qualified individuals who have an android smartphone tested the game and answered the game survey provided by the researchers. The researchers conduct test cases to identify if each functionality of the game runs properly.

Post-game stage

In the Post-Game Stage, the researchers monitored the system when it is deployed to the public to get feedback for further improvements and updates to maintain and improve the quality of gameplay based on the comments and reviews collected when the project is released for timely updates.

The researchers got the minimum and recommended device specifications through the help of random and qualified users to test the game. To install, run the game smoothly and without error, the user's device must meet the minimum device criteria. First, the API (Application Programming Interface) of the device must be at least level 26, or Android version 8.0 Oreo. The second factor to consider is the device's capabilities; the screen should be touch-sensitive and network or internet-compatible. Third, at least 3 gigabytes of RAM (Random Access Memory) should be available. A fourth requirement is that the CPU (Central Processing Unit) be at least Octa-core. Qualcomm Adreno 505/PowerVR GE8320 or better should be used as the GPU (Graphics Processing Unit). Fifth, to install the game, the device must have at least 700 MB of free storage. To make use of a full screen, a display size of 6.5 inches or more is recommended.

RESULTS AND OUTCOMES

Planning Phase - In this phase, the researchers plot different strategies in creating and developing a study. The questions are as follow: Do the researchers list some possible answerable questions like what would be the study? What methodological methods are to be used? Who is the target user of the study?

The researchers came up with the idea of developing Belittle, an Android 3D Mobile Survival Horror Game, which is about the main character named "Alfred" fighting his fears in his dream by solving puzzles and obstacles in a frightening environment. The target users of the study are players aged 15 years old and above as it is the recommended age to play this game. The study will give enjoyment to players who love playing horror games that require players to use critical thinking skills to solve puzzles.

Design Phase - To satisfy the user by the application developed, the researcher came up with a design that would easily cope up with the user. The researchers used a Photoshop application for designing the user interface. It is also used for creating the game controls from the settings menu to character movement that includes joystick and buttons. The interface is user-friendly as the design is appropriate to the theme of the game as well as the text and instructions are readable. For example, see Appendix A for the storyboard.

Development Phase - Developing the system is one of the hardest parts done by the researchers. In the Conceptual Framework, this is the fifth stage which is Prototyping. At this stage, it includes the coding and testing in which the researchers are developing the system. For example, see Appendix C for the game survey.

Testing Phase - After developing the system, testing is required to prove that the developed system is running. The researcher tested the system and gave sampling to the target respondents by allowing them to play the game to determine the strength and weaknesses of the study. The respondents tested the user interface that includes screen orientation, animation, movements of character, text, and title screen. Settings, save settings, and chapter 1 to 3 functionality were also tested while checking the performance to know what

graphic settings their device specification can handle. The researchers test the game to get the results of each evaluation.

APPENDIX C

Game Survey

Table 9: Device Specification

Timestamp	Name	Device model used for playing	Android Version	CPU (Central Processing Unit)	GPU (Graphics Processing Unit)	RAM
12/2/2021 21:28:31	Ladrielle Arreaza	Redmi 9	Android 11	Qualcomm 1.6 GHz	Adreno 505	4gb
12/23/2021 12:46:24	Guillermo Castro	Redmi 9	Android 11	Qualcomm 1.6 GHz	Adreno 505	4gb
12/24/2021 15:59:49	Allen de Guzman	Blackview 7	Android 8	4x 1.4 GHz: ARM Cortex-A53	Qualcomm Adreno 505	4gb
12/26/2021 12:27:11	Mary Grace Guzman	Vivo 1906	Android 11	Qualcomm (4x) 1.9 GHz: Cortex-A75	Adreno 505	4gb
12/26/2021 12:55:06	Therrell Larios	Redmi 9	Android 11	2x 2.0 GHz: ARM Cortex-A75	Adreno 505	4gb
1/4/2022 12:01:59	Andres Lala	Redmi 7	Android 11	Qualcomm (2x) 2.0 GHz: Cortex-A75 & 6x2.0 GHz: Cortex-A53	Adreno 505	4gb
1/4/2022 16:42:50	Bonnie Castro	Redmi 9	Android 10	Qualcomm (4x) 2.0 GHz: Cortex-A75 & 4x1.8 GHz: Cortex-A53	Adreno 505	4gb
1/4/2022 16:46:30	Adrian Guzman	Redmi 9	Android 8	Qualcomm 1.8 GHz: Cortex-A53	Adreno 505	4gb
1/4/2022 21:07:17	Juan Guzman	Redmi 9	Android 10	Qualcomm (4x) 2.0 GHz: Cortex-A75 & 4x1.8 GHz: Cortex-A53	Adreno 505	4gb
1/5/2022 14:58:26	Jose M. Guzman	Redmi 9	Android 10	Qualcomm (2x) 2.0 GHz: Cortex-A75 & 4x1.8 GHz: Cortex-A53	Adreno 505	4gb

Testing Results - The background music and sound effects are working properly. The sound effects are in sync with the character's actions. The Settings functionality is working properly. The chapter selections run smoothly. The player can go back to their previous chapter as long as they finish the chapter using the chapter selection option in the main menu. The sensitivity setting is tested and it is working as expected by the researchers. The opacity setting works, and it can adjust the transparency of the buttons. The graphic selections setting functions as expected and can adjust the graphics from low, medium to high. Game mode selection is working properly and is located in the main menu. All the buttons work properly.

The player movements like running and jumping are tested and are working properly. The interaction of the character with the objects like pulling the lever to light up a light bulb is functioning properly. Screen orientation that is sensor-based is working properly. The title, font, color, and screen title are all visible and matched to the theme of the game. No cut backgrounds are seen as the game is oriented to the screen size of the user phone.

Save settings are all working. The settings set by player when they turn off and ON the device are saved. The game data will also save when exiting the game application. Checkpoints from chapters 1 to 3 are all working. The game level and progress of the player when the game closed are saved.

The mobile game has passed all the functionality settings from chapters 1 to 3. Character movement and controls are all working properly. Blocks are movable and working as well as traps, light bulbs, gates, and portal. Riddle is visible. The buttons, gates, and portal are working properly. The flashlight bar is working. The keys are obtainable. The enemy stops chasing when hit by light is also working. The mobile game also has passed all the usability testing cases set by the researchers. The system implementation and testing of the system both passed. Checking and maintaining the system also passed. The game mechanics and user interface are understandable and match the theme of the game. The user can install and uninstall the game when the minimum device specification is met.

The mobile game has also passed all the portability testing cases set by the researchers. The game is accessible, compatible, and can be installed on different brands of android devices that met the minimum specification to run the game. At least 3 gigabytes of ram and 700 MB of storage are needed. The cooperative game mode, screen size orientation, and multi-touch are working. The game can only be available to be played on the Android operating system.

Also, it has passed all the reliability testing cases set by the researchers. An active internet connection should be available, and the mobile device should be running at least on Android OS 8 when installing. Uninstallation can be done when going to settings, app management, finding the application, and tapping the uninstall button. Non-Interruption when using other apps, charging, connecting to the internet, and receiving calls are all working. Words spelling and grammar are all correct.

Device Specifications	
API level	Oreo 8.0 version (API level 26)
Device capabilities	Has a touch screen, has network compatibility
RAM	3 GB RAM
CPU Compatibility	Octa-core processor
GPU Compatibility	Qualcomm Adreno 505/ PowerVR GE8320
Disk	700 MB available space
Display Size	6.5 inches or above to take advantage of a clear screen

Table 3. Minimum Device Specification

Device Specifications	
API level	Oreo 8.0 version (API level 26)
Device capabilities	Has a touch screen, has network compatibility
RAM	4 GB RAM or Higher
CPU Compatibility	Octa-core processor or better
GPU Compatibility	Qualcomm Adreno 505/ PowerVR GE8320 or better
Disk	700 MB available space
Display Size	6.5 inches or above to take advantage of a clear screen

Table 4. Recommended Device Specification

Review Phase - The researchers have tested and gathered all information to be used in the development of the study. 3D Games nowadays are the most trending genre in terms of game development which gives the user a close to a real object. The researchers conduct a survey to test the game if there are bugs that can be found in the game. For example, there is a bug where the character of the game will fall outside the map when walking beside the rocks and edges of the in-game objects. The option to adjust the graphics from low, medium, to high is also tested. The researchers also tested the movement of the character from running to jumping, and to make sure that the interactions of the character with the objects are working properly.

Deployment Phase - Researchers continued to monitor the system when deployed to the public to get feedback for further improvements and updates to maintain and improve the quality of gameplay based on the comments and reviews collected. With the help of random and qualified users to test the game, the researchers were able to determine the minimum and recommended device specifications.

DISCUSSIONS

This section consists of the summary of findings, conclusions and recommendations based on the results of the study of Belittle: An Android 3D Based Survival Horror Game.

Summary of Findings

To achieve the prototype of Belittle: An Android 3D Based Survival Horror Game, the researchers used the steps of an agile scrum methodology in developing a prototyping method. The design and functionalities were formulated according to each specific objective and parameter. Beta testing is used to test the performance and integrity of the game as well as to see the bugs and glitches that need fixing and debugging. Test cases were done to determine the limit and functionality. The suggestion of the panelist to make the game cooperative and screen orientation was achieved as well as fixing the bugs and glitches.

The questions in the planning phase are answered and done. The researchers came up with the idea of developing an Android 3D Mobile Survival Horror Game named Belittle. Target users, players aged 15 and up are the study's target users, as this is the recommended age to play this game. Players who appreciate playing horror games that demand them to utilize critical thinking skills to solve riddles may enjoy the study.

In the design phase, the user interface design was done using a Photoshop application. The researchers have finished creating and designing the controllers for the joystick and buttons as well as the settings menu. The interface was made user-friendly by making the design match, the theme, and text readable.

The researchers have done developing the game. Such application includes coding for the interactions and character movement. It was also done in creating the designs from character to game level. The testing phases were all done by creating criteria for testing. The researcher tested the system and gave sampling to the target respondents by allowing them to play the game to determine the strength and weaknesses of the study. The functionalities are all working. Chapter 1 to 3 functionality, save settings, user interface, and options functionality were all determined.

Both the system implementation and testing were successful. The system is also checked and maintained. The game's mechanics and user interface are easily understood and fit the game's concept. When the minimum device specification is met, the user can install and uninstall the game. The game is playable, compatible, and can be installed on a variety of Android devices that meet the game's minimum requirements.

Installation and uninstallation are both working. When using other apps, there is no interruption, and charging, connecting to the internet, and receiving calls all operate. The spelling and grammar of the words are all correct. No game data interruption when using other applications, charging, connecting to the internet, and receiving calls was seen. The spelling and grammar of the words are all correct.

The in-game bugs are all fixed. The option to adjust the graphics from low, medium, to high is also done. The researchers have also done creating the movement of the character from running to jumping, and to make sure that the interactions of the character to the objects are working properly.

Researchers continued to monitor the system after it was released to the public in order to gather feedback for future changes and updates in order to maintain and improve the quality of gameplay depending on the feedback. The researchers were able to identify the minimum and recommended equipment specifications with the help of random and qualified users who tested the game.

Conclusions

The researchers used test case scenarios to test the functionalities of the game. Based on the results of the test cases, the game is working properly, however, some functions failed to achieve the desired output. The game has beta testing involving random participants to know the performance, gameplay, and further improvements that can be done to the game. The researchers collected the feedbacks of the participants thru the survey using Google forms. Using the feedbacks, the researchers were able to determine the limitations and performance of the game with different devices. The researchers were able to develop cooperative gameplay when playing the game.

Two players will be able to interact with each other when connected to the internet using wireless fidelity (Wi-Fi) of their devices.

The researchers were able to implement the screen orientation to censored-based concerning the tilting of the device to follow the desired orientation of the game while it is being played.

The researchers were able to provide a saving system for the user to have checkpoints in every part of the stage even if the player quit the game. The researchers were able to debug and fix the glitches in the game through the help of the game survey and were able to provide options to select game mode and provide chapter selection for story mode.

The researchers were able to provide a joystick for character movement and buttons for jumping. They were also able to provide the options to adjust the sensitivity of the joystick, adjust the opacity of the joystick and buttons, adjust the graphics from low to high, and options turn on and off the background music and sound effects.

The researchers were able to develop a flashlight that will be used in the third chapter of the game. The game is accessible and compatible with a variety of android devices and can run for its stated minimum RAM and Storage size (3 GB RAM, 700 MB storage). The game is implemented and tested and will not available to be installed on other operating systems such as Apple IOS.

Recommendations

The respondents were asked what they can suggest to help the researchers improve the game. The majority of the feedback was to put instructions on how to play the game like the movements, buttons, and interactions. The researchers were able to provide tutorials for movements and interactions with objects.

- The game was intended to be created and be played on an Android operating system only. Future researchers may consider to develop the mobile application to different operating systems like IOS.
- The researchers recommend the Unity application when creating 3-dimensional games. The application provides lots of tools that will help to develop the game.

- The story mode is available to be played by a single player only. Future researchers may add the options to play the story mode in two-player.
- Future researchers may use solid blocks and objects when creating 3-dimensional items. To avoid glitches, some of the glitches that the researchers have encountered were when the character goes through the wall and falls out of the map, and blocks overlap with other objects.

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C.A.R.T.S: Customization and Reservation Tailoring System for EJ Ezon Sportswear

Lester Lance P. Barrera
Dexter C. Cabal
Fritz Jensen B. Calilung
Lance Ayan D. Manalese
Mark Paul D. Pasamonte
Dennis L. Tacadena, PCpE, DIT (Technical Adviser)

ABSTRACT

This capstone study covered the transition of manual tailoring methods into a web-based content management system. With that being said, the C.A.R.T.S web system aimed to provide an online platform for EJ Ezon Sportswear, the locale chosen for this study which provides tailoring products and services. In addition, the web system features ordering and customization which are only accessible for walk-ins before the study commenced. To develop and design the C.A.R.T.S web system, waterfall software development life cycle (SDLC) was used by the researchers. Subsequently, the capstone group succeeded in identifying the system requirements needed to run the necessary open-source software. The backend was successfully integrated along with the responsive frontend design. Moreover, 2D visualization has been achieved, converting the locale's premade product designs and jersey templates and allocated them to the shop and customize page. To test the system for quality assurance, user-access-based functionality test cases were implemented and were successful. C.A.R.T.S web system was developed and designed as a fully functional web-based capstone project, and could be freely accessed online using the address: <https://ej-ezon-carts.com>. However, during the final defense of the capstone project, it was recommended by the board of panel to display the available sizes of the premade products the moment the customer lands on the shop page, to display dates when orders are tracked on the notifications page, and to integrate GCash API should the web system undergoes a further update in the future. Regardless, it was declared that all recommendations prior to the final defense have been met, and the researcher concluded that the overall objective of the study and system acceptance were achieved.

General Terms

- Management System

Keywords

- Content Management System, Customization, Reservation, 2D, Tailor,

INTRODUCTION

As information technology advances, every domain on the internet gets changed and reformed depending on client expectations. One such example is e-commerce, which has become one of the most popular prospects in the current day. Furthermore, e-commerce (or electronic commerce) refers to conducting business online by acquiring and selling things or by using the internet, and it frequently entails the movement of money and data for the purpose of carrying out these transactions. According to further studies, 70% of Filipinos

engage in e-commerce, and the number of registered online enterprises has increased from 1,753 in January to March 15, 2021 [1] to 75,876 as of Sept. 2. As a result, technology has made doing business easier for suppliers, sellers, and customers.

Additionally, the tailoring sector is yet another important example of e-commerce that provides outstanding items to customers at reasonable costs [4]. However, customers were engaged in anything which minimizes human involvement even in the selection and customization of the clothes they avail. For this reason, body measurement submission, fabric and dress type selection, and customer booking were now integrated into the still-expanding tailoring industry of e-commerce. To meet the requirements, the use of web design and development techniques were utilized by the students of Mabalacat City College. Therefore,

this study aimed to develop and design a web-based C.A.R.T.S web system.

Tailor shop management system is a system that handles customer negotiations and transactions, cost and estimating, and report production. Furthermore, the tailor shop administration system provides online support to clients (e.g., measurement submission, dress completion notification, virtual model of garments) [21]. Keeping of records is also provided to ensure that all relevant information is at hand considering data confidentiality, integrity, and availability. Moreover, the development of a tailor shop management system would aid small and medium sized tailoring businesses promote and sell their products and services, it also allows them to distinguish themselves from their online competitors. Hence, the tailor shop management system offers 2D model features, interactive user interface, data security, and competitive advantage in the digital market.

This research aimed to give a rapid and effective method of locating a tailor in the respective location. Clients were granted access to their on-demand tailors through their web browsers at any given time of the day as long as they have access to the internet. As a result, customers would not have to travel to tailoring facilities to check the completion of their clothes, and prices would be included with advance notice. Furthermore, the customer's personal data would be secured compared to the written records kept on paper. With these considerations in mind, the goal of this study is to create and construct a tailor shop management system.

Objectives of the study

The primary aim of this research was to develop and design a web-based C.A.R.T.S web system for EJ Ezon Sportswear. In conjunction with this, the study's aims were as follows:

- To develop the web-based tailor shop management system;
- To identify software technologies and system requirements;
- To design the 2D model visualization;
- To test the system using test cases in terms of functionality and operability for the web-based tailor shop management system;

- To create a web-based tailor shop management system that adapts to the screen resolution and orientation of a mobile browser.

Scope and limitation of the study

The scope of the study referred to the development of a web-based C.A.R.T.S web system for EJ Ezon Sportswear. The 2D model visualization is the web system's complexity under the customization feature, a factor which increases customer trust on a product. Additionally, security implementation plays a significant role and that is to authenticate the credentials of the user, if their credentials were valid, the system authorizes if the user has the role and permission to access the page, otherwise the user would be redirected to its previous URL. Relational Database is selected for the database architecture due to its tabular structure for managing and manipulating data. Moreover, responsive design is to ensure that smartphone users are able to access the website on their browsers.

To develop a web-based tailor shop management system, the researcher gathered the required data and necessary variables from the locale in order to simulate the business logic of a tailor shop. Afterwards, diagrams were created as an outline that included the flow of data, actors of the system, and the relationship between entities. The customer user has permission to perform certain actions/operations on their carts, orders, reservations, notifications, and profile. However, customers are not given authorized access to the dashboard of the admin user which includes the following: user management, product management, fabric management, category management, order management, reservation management, and sales management. Subsequently, the admin user could also notify customers in regard to the status of the ordered product variant, or the reserved customized jersey. Moreover, the main users of the system would be the tailor of the research locale and the customers, all of which are within the geographical reach of Mabalacat City, Pampanga.

Afterwards, software technologies and system requirements were identified. The team project leader assessed the team regarding the available system hardware resources, it was

then checked if it would be compatible for the installation and configuration of system software requirements required by the web system. The researcher then gathered information on open-source software technologies available in the internet that would meet the system development. Technologies such as adobe photoshop, laravel PHP framework, livewire, twilio sdk, and tailwind CSS framework are among the software of choice. Once integrated, the system would be used on different browsers to determine if the client-server interaction is acceptable.

In addition, the system's features were based on the user requirements which include profile update, add-to-cart and ordering of premade products, customization and reservation of jersey, and notification through the system and SMS when order is shipped or reservation is done. Add-to-cart feature is primarily used in browsing the tailor shop's pre-made products before checkout, while the customized garments were saved as pending reservations. Moreover, GCash was the payment method of choice to settle orders and reservations. In terms of capabilities, the system's security is able to sanitize cross-site scripting (XSS) attacks and handle cross-site request forgery (CSRF).

In line with this, waterfall web development methodology would be used in conducting the study to determine the requirements and phases of the web-based tailor shop management system. However, the study is limited to the functionalities of the research locale, which is EJ Ezon Sportswear, therefore, the web system was specialized exclusively for small-to-medium scale tailoring enterprises. Moreover, the system is web-based which means android development is beyond the boundaries of the researcher.

Additionally, 2D visualization has a contributing factor in developing customer trust due to the following reasons: customers are hesitant to the images of products in the online market especially clothes and apparel, and customers would like to ensure that they would receive the exact product just how it was portrayed in the images. Hence, the 2D visualization was incorporated in order to allow potential customers see how the jersey would

look based on the applied customizations like measurements, text, logo, color, and style. Nevertheless, the 2D visualization would be exclusive for desktop computers, any visual rendering techniques that exceeds the capabilities of web development and design (e.g., Augmented Reality) would not be a part of the system. The following design constraints were to ensure that the researcher would be able to finish the capstone project on time.

Moreover, the researcher conducted a test based on the user-level test cases to ensure that the web system performs the desired and expected functionalities. The system testing would be carried out by a team quality assurance member to authenticate and validate the input from the client-side, and the output from server-side. This includes the categorized admin and customer functionality test cases that would undergo a systematic process to prevent errors, bugs, and defects from happening in the future that might affect the overall operability, reliability, and performance of the system. Afterwards, the researcher implemented responsiveness, for the customers to have an access to the C.A.R.T.S web system with the convenience provided by mobile phones. In addition, a web system that could adapt to the screen resolution and orientation of the mobile browser means that the customer would still be able to access particular features available on the desktop on condition that an internet access is available. Furthermore, the study is conducted by the researcher of Mabalacat City College in the Academic Year 2021-2022.

SYSTEM DEVELOPMENT METHODOLOGY

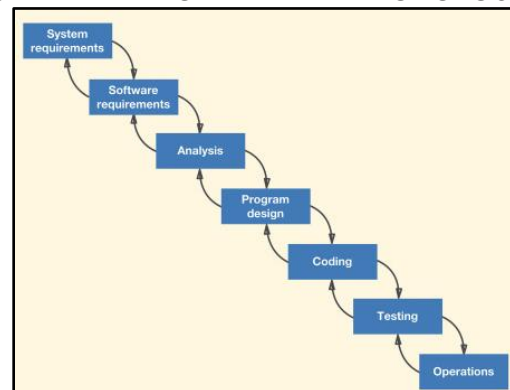


Figure 1. Modified Waterfall Model

(Source:

<https://www.sciencedirect.com/topics/computer-science/waterfall-model>)

In the System Requirements Phase, the researcher gathered data from internet library research, internet research journals and collaborations would provide the researchers enough ideas, information and a deep understanding that would help in the development of the web-based tailor shop management system. The researchers used the internet to hold collaboration sessions through virtual meetings and gathered informative ideas. During the scheduled virtual meeting, researcher team members were given a series of tasks by the project leader for them to perform. The team project leader assessed the team in regard to the hardware resources. The researcher identified and used the required hardware in the development process of the web system.

In the Software Requirements Phase, the researchers gathered information from open-source software technologies available in the internet that would meet the system development. The researcher identified the system software requirement in the development process of a web-based tailor shop management system. The team developer used different web browsers as soon as the system development started to ensure that the system design would be suitable for user-computer interaction.

In the Analysis phase, the researcher created plans to transform team objectives into operational processes. The researchers discussed each task and documented each development phase output, work, and made sure all task targets would be achieved at the expected output of a web-based tailor shop management system. The team used Gantt chart (See Appendix M) to oversee system development progress. With this, the project leader was allocated to the research team individual tasks in the optimal way to prioritize crucial tasks.

In the Program Design Phase, it involves the development of the design according to the system requirements. The system specifications defined in the previous phase were used to create the web-based tailor shop management system design. The team considered the

appearance and the layout of the web-based system. The researcher used the Visual Table of Contents (VTOC) to create an admin and user interactive dashboard that would control web-based content. Using Context Diagram, the researcher would be able to view the flow of information and its transformation through a system process with another entity. The team analyst used Use-case diagram to describe the level functions and scope of each user in the web-based system. With this, the researcher can view user interaction between a web-based system and its users. Furthermore, using Entity Relationship Diagram (ERD), the team developer can visualize, design, and create the database, its tables and fields as information system requirements. With this type of flowchart, the team developer illustrated and created the required proper system entities.

In the Coding Phase, it involves the translation of the designed diagrams into a working system. The researcher development team member configured and used XAMPP software as a web server. The PHP scripting language was used in the development of the web-based system. The researcher used laravel PHP framework for the development of the backend, and tailwind framework for the frontend design. Through unit and module testing, the team developer instantly debugged the system. The team developer developed and created interconnected modules such as registration system add-to-cart and ordering system order confirmation, and view order. With this, the researcher developed and created a working web-based tailor shop management system.

In the Testing phase, the researcher created two user-level test cases to verify and validate the developed web-based tailor shop management system functionality across a set of actions or conditions to verify the expected result for the more stable performance of the web-application and better use of the user. To test the admin user functionality, the researcher categorized checklists into login, user management, product management, fabric management, order management, sales management and notification. For user-level accounts, checklist categories such as registration, login, shop, carts, customize and reservations were tested. Overall system testing was performed by team quality assurance

members to verify and validate user input and system output and to ensure no system error would be encountered and web design defects were corrected.

In the Operations phase, the web-based system was fully developed and underwent thorough testing. The researchers moved on the deployment of the system in which the system would be uploaded into the web-hosting site. In the case of the researcher, digitalocean cloud services was the web-hosting site of choice while the domain address was registered in hostinger domain registrar services. Finally, upon the acceptance of the board of panelist, capstone adviser and technical adviser in completion of the web-based tailor shop management system, the researcher developed a web-based system that would be freely accessible at the website domain address of <https://ej-ezon-carts.com>.

RESULTS AND OUTCOMES

This section shows the results and outcomes based on the objectives of the study and it is important that the research output is presented in an organized and procedural manner. These discussions and conclusions were based on the objectives of the study, completed analysis, and testing of the developed application prototype. The study covers primarily the design, development and testing of the application prototype entitled “C.A.R.T.S: Customization and Reservation Tailoring System for EJ Ezon Sportswear” (See Figure 7).

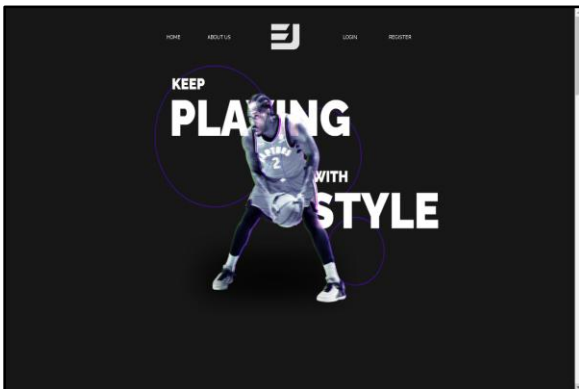


Figure 1: C.A.R.T.S Landing Page

To start off, the researcher began the design and development of the web system during the course of Capstone 1 and Capstone 2, a gantt chart was utilized to track the progress of the web system (See Appendix M). Subsequently, the researchers implemented the waterfall methodology SDLC [31] as a blueprint to build the C.A.R.T.S web system.

Afterwards, the researchers identified and used the required system requirements and software requirements during the first and second phase of the SDLC. Subsequently, the strengths, weaknesses, scope, and limitations of the web system were discussed during the analysis phase, compatible functionalities were implemented and unattainable complexities, such as the 3D customizable jersey, were constrained. In regard to the program design phase, visual depictions such as visual table of contents (VTOC), context diagram, use-case, and entity relationship diagram (ERD) were implemented.

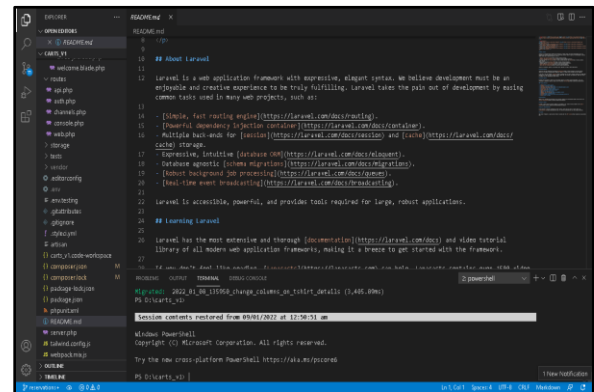


Figure 2: Visual Studio Code IDE

Software such as visual studio code (See Figure 2), an integrated development environment, was used by the frontend and backend developers during the coding phase to write PHP, html, and CSS. Afterwards, the researcher commenced the testing phase using test cases before deploying the web system in the live environment. Then in the operations phase, C.A.R.T.S web system was deployed on digitalocean and the domain name was registered on hostinger.

In line with the first development of a web-based tailor shop management system, the

The image shows the top portion of the Laravel website. At the top is a navigation bar with the Laravel logo (a red hand icon) and the word "Laravel" in red. To the right of the logo are links for "Documentation", "Forge", "Ecosystem", "News", and "Partners". Further right is a search bar with the placeholder text "Search Docs (Press /)". Below the navigation bar is a hero section with a light blue background. On the left, there is a Twitter icon and the text "Laravel can make your applications Sign up today...". In the center, the heading "The PHP Framework for Web Artisans" is displayed in a large, bold, black font. Below the heading, a paragraph of text reads: "Laravel is a web application framework with expressive, elegant syntax. We've already laid the foundation — freeing you to create without sweating the small things." To the right of the text is a large, 3D graphic of the Laravel logo, which consists of three white cubes connected by red curved lines. At the bottom of the hero section, there are two buttons: a red button with the text "Documentation" and a white button with a red circular icon containing a play symbol and the text "Watch Laracasts".

XAMPP Control Panel v3.3.0 [Compiled: Apr 6th 2021]

XAMPP Control Panel v3.3.0

Module	Service	Module	PID(s)	Port(s)	Actions
	Apache	1952	80, 443	Stop Admin Config Logs	
	MySQL	8796	3306	Stop Admin Config Logs	
	FileZilla			Start Admin Config Logs	
	Mercury			Start Admin Config Logs	
	Tomcat			Start Admin Config Logs	

1:35:00 PM [main] All prerequisites found
 1:35:00 PM [main] Initializing Modules
 1:35:00 PM [main] Starting Check-Timer
 1:35:00 PM [main] Control Panel Ready
 1:35:10 PM [Apache] Attempting to start Apache app...
 1:35:10 PM [Apache] Status change detected: running
 1:35:10 PM [mysql] Attempting to start MySQL app...
 1:35:10 PM [mysql] Status change detected: running

The screenshot shows the AWS IAM console 'Users' page. The 'Users' list is empty, and the 'Groups' list is also empty. The 'Groups' list is empty, and the 'Groups' list is also empty.

[illegible]

To achieve the 2D visualization, the designer utilized adobe photoshop to render the 2D images of the premade products (See Figure 6) from EJ Ezon Sportswear (See Figure 7). The former is being shown in the web system's shop page to be ordered by customers after undergoing the add to cart process, the conversion of the locale's premade products to 2D were crucial for the reason that the shop page should only display products that were exclusive to EJ Ezon Sportswear. On the other hand, the latter's primary purpose is to serve as a customizable jersey template exclusive only for EJ Ezon Sportswear, which is rendered in the customize page of the customer (See Figure 8), this is to simulate the locale's customization and reservation services to the C.A.R.T.S web system.



37



Figure 8: EJ Ezon Sportswear Premade Product

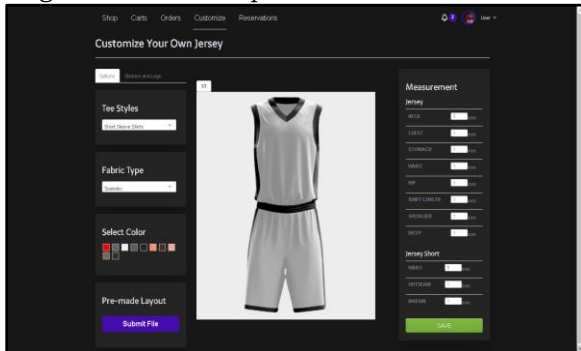


Figure 9: Customize Page

In line with the system testing through test cases, the integration and testing of C.A.R.T.S web system functionalities were fulfilled through the use of test cases. These test cases were anchored with the use case diagram, and divided into two categories based on the user roles, which were the admin functionality test cases and customer functionality test cases. The research team ensured that the test cases passed the desired results before proceeding to deploy the C.A.R.T.S web system.

Moreover, the mobile responsiveness was achieved through the use of tailwind, a utility-first CSS framework (See Figure 9). The frontend developer made sure that web system's content would adapt to the screen resolution and orientation of a mobile browser. In addition, the user was proven to register successfully and access the shop page to add premade products to the cart in mobile view. Afterwards, using the mobile browser successfully displayed the checkout transaction (See Appendix K) and the ordered item. However, the customize page was restricted to the mobile view due to compatibility issues as it was considered as a limitation during the analysis phase of the SDLC.

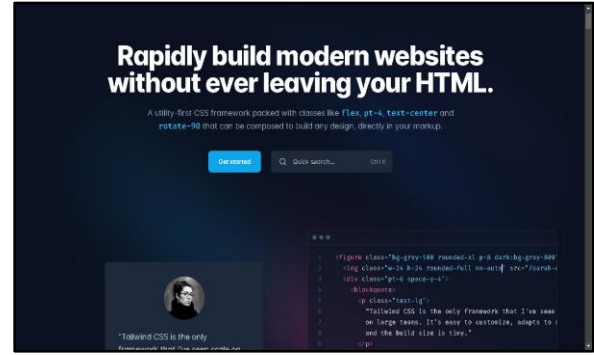


Figure 10: Tailwind CSS Official Documentation

After the translation of the diagrams into a functional system, the researcher finally designed and developed C.A.R.T.S web system that would be used by the customers of EJ Ezon Sportswear, and the owner would be the admin, a dedicated user manual was also published (See Appendix N). The system features the following on the customer panel: profile update, add-to-cart and ordering of premade products, customization and reservation of jersey, and notification through the system and SMS when order is shipped or reservation is done. While the admin has access to the following: user management, product management, fabric management, category management, order management, reservation management, and sales management, and is capable of notifying customers.

Finally, upon acceptance of board of panelist, capstone adviser and technical adviser in completion of "C.A.R.T.S: Customization and Reservation Tailoring System for EJ Ezon Sportswear" Capstone project, the researchers developed a web-based content management system that would be freely accessed at the website domain address of <https://ej-ezon-carts.com>.

DISCUSSIONS

After a careful and critical evaluation of the results of the capstone project, the researcher was able to synthesize the data, draw inferences, and provide study suggestions.

Conclusions

The capstone project focused on the design, development, and the results of C.A.R.T.S web system. Based on the results and discussions of the web-based prototype objectives, the researcher produced the following conclusions:

First, C.A.R.T.S was successfully designed and developed based on the specifications and objectives. The software tools were instrumental in translating the diagrams and backend server into a working and functional web-based prototype.

Second, the pre-made products and jersey templates of EJ Ezon Sportswear were successfully rendered in 2D. As a result, the developers were able to use the 2D-rendered images in the shop and customization feature.

Third, the admin and customer functionality test cases produced the desired results. These results proved that the web-based prototype passed the requirement specifications, which indicated that it now could be used in the live environment.

Fourth, mobile responsiveness was achieved on the majority of the web system's contents. The customer user was successful in performing certain processes using mobile phones. However, the customization feature was limited only for desktops.

Lastly, the C.A.R.T.S web system was successfully deployed with a unique domain address. Therefore, with all of the evidence, the researcher concluded that the overall objective of the study and system acceptance were achieved.

Recommendations

- 2D Customizable Jersey

The researcher was tasked to implement a 3D visualization of the premade products and customizable jerseys. However, the software used was still in beta mode which resulted in bugs and compatibility issues on the web browser. As a result, the panels agreed to render the pre-made products and customizable jerseys on 2D.

- Notification with Date and Time

The web system features notification in which customers and admins are notified about the activities done (e.g., registrations, orders, refunds). It has been recommended during the final defense to include a readable date and time for every notification received by either the admin or customer.

- Product Quantity

The quantity of a product displays once the customer clicks the "cart button". Considering user experience, it has been recommended during the final defense to render the

quantities for each product the moment a customer lands on the shop page.

- GCash API

In the ordering process, a functional yet hard-coded GCash payment method was implemented. It has been recommended during the final defense to integrate GCash API for the future improvement of the web system.

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DOLAYT: Door Lock and Home Lighting Monitoring and Controlling System

Jay Paulo Austria
Shadora Ann De Jesus
Dharren Mendez
Jimica Mhay Naron
Kathrene Tiamzon
Engr. Robbert M. Bamba, MEECE (Technical Adviser)

ABSTRACT

This research presents the development of an IoT based Smart Door Lock and Home Lighting Monitoring System. DOLAYT is a system prototype that uses smartphone and internet for opening and closing the door, switching on/off and as well as adjusting the dimmer and setting time/schedule for the lights. It focuses primarily on the importance of ensuring security and preventing breaches at home. This system allows users to easily control and monitor their home environment all at once even with a manual switch and dimmer. It also allows users to keep an eye on the situation at far distances from inside the house through the internet using the mobile application. A detailed process is made on the development, building and testing of the prototype. The final phase of this research is to fully develop and deliver a functional DOLAYT prototype along with its mobile application and a secure flow of the system.

INTRODUCTION

One of the advantages of modern technology are the possibilities that it can create for newer technologies to emerge. On the other hand, modernization offers room for improvement for existing technologies such as light bulbs and door locks.

Most of the time, convenience is the driving force of progress. That is why most products and services nowadays offer what is easily accessible, efficient and reliable. Gaining easy access makes things simpler and less complicated. Oxford defines efficiency as achieving maximum productivity with minimum wasted effort or expense. Given that it takes minimum effort to use efficient technologies, reliability comes easy.

Modern Age Technology has paved its way towards society, creating a great impact on every individual's daily living and improving day-to-day lifestyle. The rapid progression of Modern Technology led to the growth of IoT which introduces a new area of communication, where objects communicate with each other without human intervention such as cell phones, personal computer and other communication devices. The establishment of Internet of Things has led to the development of home automation in order to help and assist people over their household

lifestyle [1]. According to the Authors of "Home Automation using Cloud Network and Mobile Devices", they proposed a smart home application using Internet of Things that is a combination of portable devices, cloud computing, wireless sensor nodes that allows the user to control appliances within the house like lights, fans, door locks etc. [2].

According to "Characteristics and Challenges of the Internet of Things in Entrepreneurship", the Internet of Things is an interface that supports material things or devices that are linked to the internet on a regular basis and can be associated with other devices. Which means that people can control things as long as they have a device with an internet connection, [3]. From connected cars to connected wearables to home security, the Internet of Things is rapidly marking its presence in every field. The IoT has enabled home automation and security devices that can be controlled from anywhere in the world using the Internet of Things. [4]

Embedded physical devices, such as household appliances are becoming smarter and smarter. They are equipped with embedded microprocessors and wireless transceivers, offering limited communication capabilities and providing good behavior, Everyday objects fitted

with small, cheap mobile processors, sensors, and actuators [23].

With the rapid increase of availability of modern sensing, analysis and rendering equipment and technologies, computers are becoming more and more intelligent. Technology has been improving and enhancing any manual work that is needed to be done [24]. Any day-to-day, repeatable process is automatable with smart home applications. The greater the control and flexibility of these processes, the more energy and cost savings the resident experiences, which are factors anyone who pays utilities strives to moderate. The smart home revolution is likely to be more of an evolution, with the incorporation of one or two home systems at a time, gradually automating our households through smart mobile devices [22].

The Smart Home System provides a connection between various important functions about safety. Smart home gives people multiple benefits on their homes such as providing security, less energy consumption and detecting temperatures, light status, ventilation and etc. [25]. A Smart Home can be described by a house which is equipped with smart objects, a home network makes it possible to transport information between objects and a residential gateway to connect the smart home to the outside Internet world [26].

Background of the study

The researchers decided to create this product for security purposes for every home and establishment. Security provides protection and comfort in life and assets. Ensuring safety of peoples and their valuable things is very important for the prevention of illegal breach and handling. Hence, mainly focusing on door lock security or gate security is very important to avoid the further problems in monitored areas. Even with the use of mechanical locks, crime and robberies still happen due to the fact that such locks are easily broken. So, there is a need to invent another kind of lock which cannot be as easily broken. Many authors present different kinds of digital door locks, automatic password-based door locks, software-based door locks etc. which have been widely used in houses and offices.

In recent years, lighting controls have evolved with two additional capabilities: adjusting light

source colour, including shade of white light; and/or generating data via measuring and/or monitoring. Lighting controls play a critical role in lighting systems, enabling users manually or automatically to turn the lights ON and OFF using a switch; and/or adjust light output up and down using a dimmer. This basic functionality can be used to generate these benefits for the lighting owner flexibility to satisfy user visual needs; and/or automation to reduce energy costs and improve sustainability.

Objectives of the study

The general aim of this study is to develop a prototype that can control the door lock and the light bulb monitoring system through mobile application with the following set of objectives:

- To develop a mobile user interface application that has the following specific functionalities:
 - manually and simultaneously turn on/off the light bulbs,
 - simultaneously turn on/off all the light bulbs,
 - manually dim the light bulb,
 - set the time to turn on/off the light bulbs individually,
 - set the time to turn on/off the light bulbs simultaneously,
 - set the mobile application user interface password,
 - change the user's mobile application interface password,
 - retrieve the user's password via email,
 - and notify the user when the mobile application is minimized.
- To design a prototype hardware that will include the following tools with corresponding specific functionalities:
 - a physical button to capture a visitor's image that will automatically be sent to the mobile user interface application for homeowner verification prior to unlocking the door remotely,
 - a keypad that will let the homeowner input the door lock password,
 - an individual physical on and off button for each light bulb,

- To verify the functionalities of the mobile user interface application through test cases based on the specific design requirements.
- To verify the functionalities of the individual hardware/s included through test cases based on the specific design requirements.
- To integrate the mobile application user interface functionalities within the hardware design requirements.

Scope and limitation of the study

The coverage of this study focuses on developing a functional door lock and lighting monitoring system that can set time schedules and door lock passwords to further enhance home security. The entire idea and concept of a smart door lock and home lighting control system is to provide security and add convenience for lives. Smart door locks provide security at home, it helps control the door of your house. The digital and keyless locks provide a sense of protection. On the other hand, Lighting Control gives you ease of access and customization for your lights. Users can set their own time and brightness intensity based on their personal preferences.

The study does not cover any human errors that could damage the functionality of the device/prototype. Hence, that includes the interference of any third-party network. In addition, the mobile application will not function without the connection of data and internet. The application itself is also only limited to one user and will not be extended to more than one device.

SYSTEM DEVELOPMENT METHODOLOGY

In this section, the researchers decided to use SDLC as a methodology strategy to ensure that the prototype that is being developed is optimized for the users based on a set of requirements. This strategy is commonly used in software development projects which involves several steps which includes: Requirements Gathering, System Design, Built A Prototype, Evaluation with Users, Refine the Prototype, and lastly, the Final Product. The

building process of the prototype can be easily envisioned by using this type of methodology. By following the process, each step ensures that the prototype and application actually meets and addresses the needs of their users.

Procedures

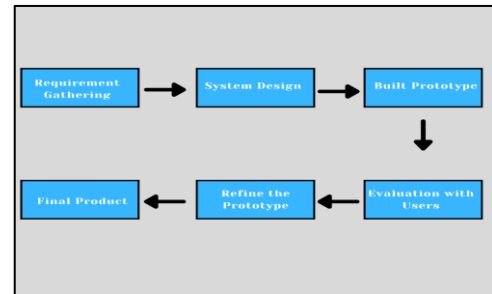


Figure 1. Prototype Model

Requirement Gathering

The requirement phase required gathering ideas and detailed notes to know the purpose, concept and on what the system should do. This includes online meetings, discussions and research about every study that is possibly related to the system and conducting interviews to local people in regards to their problems about home safety, door locks and lights in their household.

System Design

The System Designing phase defines the process and procedures of analysis, interfaces and blueprint data of the prototype system. This phase is where the detailed understanding of the hardware components and set up installation for the development of the prototype system. In this stage of progress, the researchers developed and designed a mobile application interface for the prototype system with the use of MIT App and Arduino IDE software. It includes the features of the mobile application and how the user will interact with the system and the application.

Built a Prototype

The Built a Prototype stage is where the researchers produce a working sample of the system prototype. Testing abnormalities and errors in the hardware components are also

part of the procedure. In this stage, the researchers developed the system prototype and conducted test cases to determine its problems and functionalities as well as the mobile application. Assembling wire connections and doorlock and light bulb installation have been conducted in between the required set of components. Verification of individual hardware components and mobile application interface were also included. In the development, a physical button for the camera, manual dimmer and a keypad have been added and installed in the prototype connecting to the mobile application. The researchers applied the set of recommendations given by the panelists such as security password for mobile application interface and password retrieval.

Evaluation with Users

Evaluation with users provides detailed information on the problems that users have experienced in the prototype system and mobile application and suggestions in regards to the system. This stage covers the initial in-depth evaluation required for the hardware prototype and any additional information given by users for further enhancement of the system. The system prototype's features were assessed using the test cases created by the researchers to check possible problems in the capture image and notifications of the mobile application and solutions in order to meet all the necessary requirements in the system. See Test Cases Table 1. for User Evaluation Test Cases.

Refine the Prototype

Refine the Prototype is the stage where the researchers applied all of the required recommendations given by the panelist in order to finalize the hardware prototype and mobile application interface. The given feedback were applied to modify all the flaws in the application, prototype and documentation as well as several adjustments and changes on the coding process and design. A number of tests have been carried out to ensure the system's operation.

Final Product

The final product is the last phase of the system prototype where the researchers finalized all the prior steps and several initial evaluation repetitions completed in accord with the requirements. Maintenance and Implementation is additionally achieved along in the progress. The researchers ensured that everything in the system is working properly and successfully avoided any unnecessary fixings in order to not damage any of the components.

RESULTS AND OUTCOMES

The researchers were able to achieve the system prototype recommendation, requirements and the objectives of the study. The DOLAYT Mobile Application now has a security application password for user login. The password is the key to their mobile application. Once the password was set by the user, they will be able to log in to the DOLAYT Mobile Application. In addition to this, the user will also receive notifications on their mobile application whenever someone presses the button for the door lock and will be sent an image of that person.

System Design

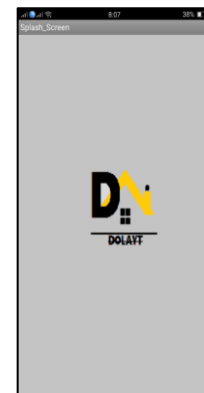


Figure 2. DOLAYT Splash Screen

Figure No. 3 shown above is the mobile application interface of the DOLAYT mobile. This is where the logo and title of the system is present. The Splash Screen is typically used by the particularly large application to notify the user that the program is in process of loading.

This splash screen is for retrieving data from the microcontroller such as ESP Cam and NodeMCU. Once the splash screen cannot detect the IP address, the splash screen will move to another screen and the user can see the text label.

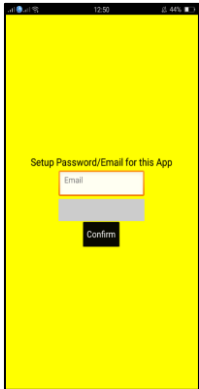


Figure 3. User Set Up

The User Set Up Password/Email Screen is for security purposes in the DOLAYT mobile application where the user can set up their own personalized password. Once the application is installed on the user’s device after they set up the password, it will remain there even if the user uninstalls the application.

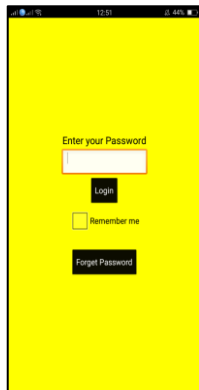


Figure 5. User Log-In

The User Log-In screen shown in Figure 6, depicts the process of logging into a database after the user has created their own password. The security of the DOLAYT application will be displayed on this screen. The “Remember Me” check box will allow the user to save the

password and will automatically connect to the app without re-entering the password. Furthermore, the forget password option is used to recover the user’s mobile app password.

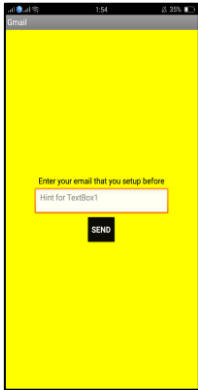


Figure 6. Email Screen

Figure No. 7 depicts the E-mail screen, where the user must enter their own email address to receive their app's confirmation code.

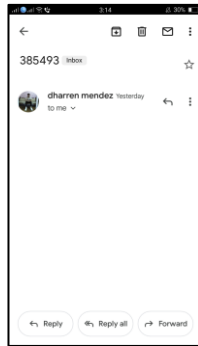


Figure 7. Email receive

The procedure of transmitting code via E-mail account is shown in Figure No. 8, and this code is the one that the user needs to input in Figure No. 9.

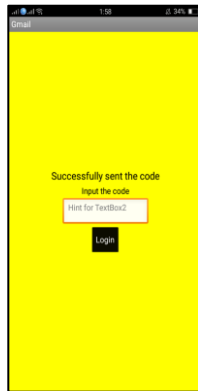


Figure. 8. Input Login Code Screen

Figure No. 9 above shows the “Input Login Code Screen.” It is where the user must input the code that they received in g-mail in order to access the DOLAYT mobile application. If the code is incorrect, the user will be unable to use their mobile app and will see the text label "Incorrect Code."

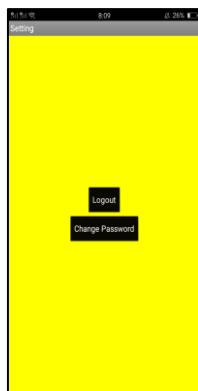


Figure 9. User Action Page

The Figure No. 9 shows a User Action Page where the user can choose whether or not to logout of the program or change their own password.



Figure 10. Change Password Screen

The “Change Password Screen”, as illustrated in Figure 11, is where the user can change and enter a new password on their own preference. This is strongly recommended to avoid breaches to the user's mobile application. After updating the password, the user's previous account details for the password will be deleted from the Firebase database and the new password will take its place.



Figure No.11 Captured Image Screen

The image above is where the screen shows the captured photo by the esp camera after an unknown guest presses the manual button of the door lock. Upon pressing it, the user will be given a notification/alert on their mobile device regarding the person outside the door.



Figure 12. Main Screen

The image shown above is the "Main Controller Screen" of the DOLAYT mobile application. This is where the user can switch on/off the light bulbs on their own accord and set their own personalized time schedule. Upon an arriving guest pressing the door lock button, the user can also open the solenoid door-lock after viewing the captured image of the person outside the door. The user can also see the status of the lights and door on the top.

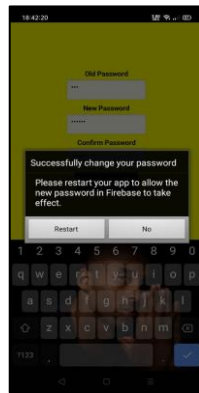


Figure 13. Restart Notification Pop Up

Figure No. 13 shows the Restart Notification Pop Up when the user successfully changes their password in the application.

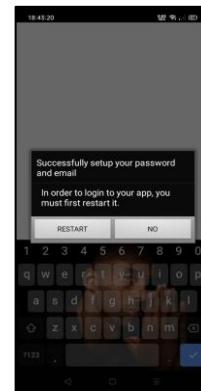


Figure 14. Log in Restart Pop Up

Figure No. 14 shows the Log in Restart Pop Up after the user sets their email and password in the application.

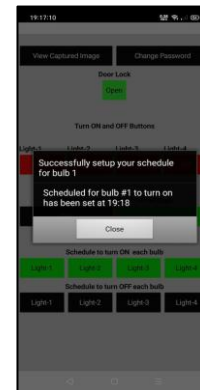


Figure 15. Schedule Turn on Notif for All Bulbs

The image above shows the Schedule Turn off Time Pop Up after the user sets the schedule for all the bulbs to turn on.

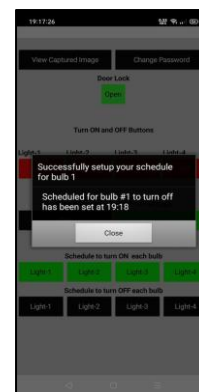


Figure 16. Schedule Turn off Notif for All Bulbs

The image above shows the Schedule Turn off Notif after the user sets the schedule for all the bulbs to turn off.

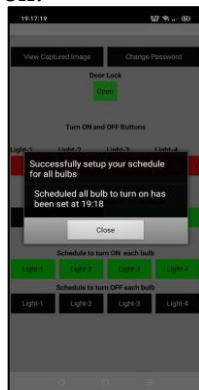


Figure 17. Schedule Turn on Notif for each Bulbs

The image above shows the Schedule Turn off Notif after the user sets the schedule for each bulb to turn on.

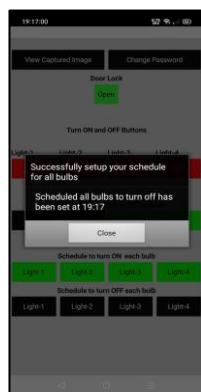


Figure 18. Schedule Turn off Notif for each Bulbs

Figure No.19 shows the Schedule Turn off Notif after the user sets the schedule for each bulb to turn off.

Gathering Data

The researchers created a system prototype aligned to the panel's recommendation and 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 19. DOLAYT's IoT Hardware Components

The image shown above displays the initial parts of the prototype of the study. It has the Microcontroller, Arduino uno Board, Relay Module, AC Motor Dimmers, Door-Lock, Batteries for the door-lock, Manual keypad and the ESP Camera Button.

The ESP32-CAM is a small sized, low-power consuming camera module based on ESP32. It comes with an OV2640 camera that provides an onboard TF card slot. The ESP32-CAM can be widely used in various IoT applications such as wireless video monitoring, Wi-Fi Image upload, QR identification, and so on. The ESP-CAM in the system prototype, which will be used for capturing images, is connected to a manual button and the power supply. The manual button for the ESP-CAM is connected to the image capture button, while the power supply is necessary to turn on the device. The Arduino code will be the one who commands the keypad to put in the password of the door lock to unlock. On the other hand, the LCD will be displaying the password that the user typed into the keypad. The Relay Module is connected to Arduino for the pin of the door-lock and the 5v of the relay will connect to NodeMCU. The Solenoid door-lock will support the relay to open and close. Solenoid Relays are switches

that open and close circuits electromechanically or electronically. The Relays control one electrical circuit by opening and closing contacts in another circuit. When a relay contact is normally open (NO), there is an open contact when the relay is not energized. The 12V battery gives the solenoid power while the NodeMCU will be the one that controls the four light bulbs that are connected by the four channels relay module. The positive wire of all bulbs will be in one wire while the negative wire will be connected to NO (Normally Open of relay). And then the com of all the relay will also have one wire of the bulbs and the relay will be the output of the outlet to get power supply

Built A Prototype

The researchers integrated the previously mentioned locally bought products into a wooden house design. The light bulb fixture was attached inside the miniature house. A small door was also installed outside of the wooden house. Also, a lock and keypad was provided for trial purposes.

With the use of MIT App and the Arduino IDE software technologies, the researchers were able to develop the DOLAYT mobile application. Through these things, the researchers focused on the functionality as well as the inner workings of the application itself making sure that there are no mishaps and the execution is as polished as possible.

Evaluation with User

The researchers presented the system prototype to the capstone panellists and discussed the functionalities and concept. An in-depth evaluation was made to verify and analyze the functionalities of the system prototype. The panellist's had foreseen flaws and deficiency regarding about the prototype. Recommendations and suggestions were taken note to enhance and make solutions to better improve the system. At the end of the capstone defense presentation, the system prototype was accepted with major revision on both prototype, mobile application and the documentation by the panelists'.

Refining the Prototype



Figure 20. Refining DOLAYT Prototype

The illustration above illustrates the final prototype of the study. The researchers successfully modified the device again to fit the panel's recommendation. Multiple testings were made to ensure that the prototype is working accordingly.

Final Product and Test Cases



Figure 21. Final Installation Setup of the DOLAYT's Prototype

The image shown above is the setup and installation of the DOLAYT's prototype. The plywood was made and customized to form a small house with two small doors in front and a roof. Inside the wooden house, are the light bulbs as well as the prototype inside. In front of the door was the keypad and the esp cam button attached on it. There are also wires attached inside the prototype.

Test Cases Results Mobile Application User Interface

Table 1. Functionality Test Cases Results for Mobile Application User Interface

No. of for each prototype testing = 5

Category/Characteristics = Functional Suitability

Trials		
User Interface Test Cases	YES	NO
Does the mobile application display the dim adjustment of the light bulb?	5	0
Does the mobile application turn on and off button for lights?	5	0
Does the door lock notification work?	5	0
Does the user able to receive the Notifications?	5	0
Does the mobile application able to set time/schedule?	5	0

The table shown above is the result of test cases to check the functionalities of the DOLAYT mobile application. A maximum of five Test Trial Cases were made in order to ensure that the mobile application is working properly according to the test cases listed above. The researchers had verified that the Notifications are able to send alerts for when someone presses the door lock button and was able to send the image of the person outside the door via DOLAYT mobile application. Users are also able to set their personalized time schedules for the lights and are able to adjust the brightness of the bulbs.

Test Cases Results Prototype

Table 2. Functionality Test Cases Results of Dolayt Prototype

No. of trials for each prototype testing = 5

Category/Characteristics = Functional Suitability

Hardware	YES	NO
Does the door lock/unlocks?	5	0
Does the light dimmer work?	5	0
Do the lights turn off/on based on the	5	0

given schedule?		
Does the manual dimmer work?	5	0
Does the keypad inputs password?	5	0

The table shows the test cases of each of the functionality of the system prototype. Each of the components is tested at maximum of five times to verify that it was working properly.

Table 3. Usability Test Cases Results of Mobile and Prototype

Category/Characteristics = Usability

System Feature	YES	NO
Is the mobile application easy to understand?		
Is the system easy to maintain?		
Is the system easy to operate?		
Is the mobile application user interface appealing?		
Is the mobile application working on any android versions?		

Table 3 shows the usability of the system prototype. The researchers wanted to make sure that the mobile application interface and design is user friendly and easily accessible without giving confusion on the usage. The lead developer of the group modified the application to make it look appealing to the user with simple yet aesthetic colours as well as matching the vibes and theme of our concept.

Table 4. Reliability Test Cases Results of DOLAYT

Category/Characteristics = Reliability

Expected Results	YES	NO
The mobile application displays notifications upon a person pressing		

the door lock
button
The Prototype
System is
consistent enough
in sending
Notifications to
the user.
The Lights can turn
off and on when the
user commands it.
The door lock
opens when the
correct password
is input

The table that is shown above displays the reliability of the DOLAYT system prototype. The researchers conducted multiple test cases findings in order to show that the system is successfully working.

DISCUSSIONS

This section discusses the summary of findings and results based on the test cases that were found on the DOLAYT System Prototype:

Summary of Findings

To successfully achieve the prototype objectives, the researchers conducted multiple trial and error processes to verify its consistency. Some of the errors encountered by the researchers were mostly from the connectivity of the wires of the Arduino from the door lock to the IoT components. It was found that the wire does not have a good grip in order to keep it connected to the board. There were two ways to solve this issue, either using tape or soldering it to the component. The researchers decided to use packing tape to secure the wires since soldering may cause a lot of issues instead of minimizing errors. Based on the test case results the initial system prototype seemed to work properly. It only shows that the method used by the researchers was effective.

After the evaluation with users and getting all the recommendations from the panellists, the researchers quickly modify the system. It was

found out that refining the prototype to make it more an effective secure door lock with home lighting system device is a good recommendation. Furthermore, while conducting the test cases, the researchers discovered that the quicker the home occupant interacts with the mobile application, the faster they can detect if someone wants to open the door.

The researchers performed trial and error experimentation in order to check the integrity and functionality of both Prototype and Mobile Application. Panellists suggested heightening the security levels by providing the user a login and password registration which was achieved by the programmers. The researchers also added time scheduling and user password for the mobile application which was recommended in the previous defense.

Conclusion

The researchers were able to build the system prototype of the study. Basic functionalities that were needed were achieved, such as dimming of lights via manual, time schedule and lock/unlock of the door lock. The researchers were able to make a prototype design for the system using plywood, paint and other required hardware components. They were also able to assemble the mentioned parts in order to form a small house and door design for the system. The researchers were additionally able to make a mobile application interface with the use of MIT App Inventor that allows the user to control the light bulbs and door lock with an internet connection.

The researchers conducted multiple test cases in order to check the prototype and the mobile app functionalities. According to the test case results, both the prototype and mobile application are working properly. The researchers were able to achieve the requirements for the system prototype. It was tested and it was able to lock/unlock the door, input password via keypad, manual dimming of lights, button and notifications for ESP-CAM for mobile application, set time scheduling and switching the lights off/on in DOLAYT mobile

application. The researchers also conducted trial and error tests for input password in the keypad. Mobile Application is also able to receive alerts and send images to the mobile application once the button for the door lock is pressed.

The researchers were able to design a working mobile application with the use of MIT App Inventor. It notifies the user whenever there's a detection from the three sensors. It also allows the user to manually operate the water sprinkler using the on and off buttons. The team has also decided that manual installation of bulbs and door locks will be provided to the user as well as inputting their data in order to set up and connect the bulbs to the mobile application.

Recommendations

The following are the recommendations to improve the developed DOLAYT system prototype:

Adding User Login/Password for Users.

Improved Interface of the Mobile App

Password Retrieval

Set Device Password for App Security

Time Scheduling and Dimmer

Pop up notification for time scheduling, set up password/email & change password and Label for buttons

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Dr. Kid: First Aid and Calamity: First Aid Instructional Mobile Application with Potential Hazard Information Awareness for Kids

Rafaela May Cuenco
Nestle Gift De Leon
Marco Flores
Louella Dawn Guanzon
Christopher Kim Juco
Ronald T. Domingo, MSIT (Technical Adviser)

ABSTRACT

The researchers of the "First Aid Instructional Mobile Application with Potential Hazard Information Awareness for Kids" developed a mobile application named Dr Kid. The primary purpose of this study was to teach the users how to perform first aid, especially during calamity and other unexpected situations. Moreover, it could serve as guidance in increasing the children's knowledge about first aid and calamity. The content of the mobile application was based on real-life situations. The study's objective was to develop a Dr Kid mobile application with a first aid scenario consisting of fifteen (15) stages and calamity composed of three (3) stages with different scenarios. In every scene, there were tutorials, an assessment that tested the user's learning, and a video demonstration on how to perform the correct answer to teach the users what is the right thing to do. Lastly, based on the assessment's performance, the scoring stars will appear before the stage ends. The settings consisted of volume, language, English or Filipino, and gender of Dr Kid, male or female. The methodology of the study was prototyping to guide and track Dr Kid's mobile application phase development. The test cases consisted of five (5) trials to measure the mobile application functionality, usability, and portability. Based on the test cases result, the mobile application passed in terms of functionality, usability and portability test. The developer of the study created a 3D video demonstration and made the four characters 3D to be more attractive to the users.

INTRODUCTION

Every person knows that accidents are mostly not predictable, and it can happen anytime and anywhere. Accidents can cause a threat to the life of the victim. Additionally, most people are not aware of the first aid and potential hazards awareness in daily life, and it is significant for everyone, especially those prone to illness and accidents. Therefore, first aid must be practiced by everyone since it is essential to everyone's life.

In a crisis, every minute matters. However, no matter where you are in the globe, competent medical assistance may not always be available right away. We can save countless lives by acting quickly and effectively with first aid. In most circumstances, passers-by—usually members of the public—who see an accident or disaster provide first aid. People who have been taught can administer basic medical treatment to treat minor injuries and save lives until professional medical aid comes. We think that providing first aid is a humanitarian act that is

critical to fostering healthy and resilient communities. It should be open to everyone and everywhere without distinction.[1]

Furthermore, the First Aid App is not intended to replace first aid training; rather, it is intended to supplement first aid training and, more broadly, to improve first aid understanding and encourage the use of first aid training.[2]

Every person should know how to give first aid, and it should be given before appropriate emergency services arrive. Numerous studies prove that rapid reaction and immediate rescue action taken by witnesses of the event increases the chance of survival several times. [3]

The most of the kids did not have a strong understanding of first aid. The study also identified key areas where first aid knowledge was lacking. First aid is administered to injured or ill people in any health-threatening situation in order to save lives, prevent further deterioration of the situation, or contribute to

the care of the patient before professional medical care is available.[4]

First aid education is a must to teach at some point in everyone's life. As

stated in the study of [5], leading a person who suffers from an injury and other persons near or with the victim in terms of first aid emergency can avoid the condition from worsening until medical assistance comes.

Accidents that need medical emergencies are natural to everyone's life.

Therefore, learning first aid is very necessary as an emergency treatment to help others. With the knowledge obtained, bystanders will have the courage to perform the emergency treatment to the victim, and paramedics will gain more time to save the wounded person.

In the article of [6], approximately 140,000 people every year die in situations where their lives could have been saved if somebody had known to perform first aid. It is essential to apply first aid learning all around the world to reduce casualties. As a consequence, everyone will be able to learn how to give first aid, and they will no longer feel powerless if they are in need of it, and everyone will gain confidence that will prevent panicking when there is an emergency.

Furthermore, [5] asserted that the level of knowledge of first aid among the majority of the students is lacking. As the consequence, hundreds of thousands of children die each year due to injuries from violence, while millions of others suffer the consequences of more minor or non-fatal injuries. However, due to modern technology and new ways of learning, it is efficient to create a First Aid Application that gives some instructions for primary taking care of people in Android Smartphones. [5] Mobile applications are the fastest in terms of evolving in modern technology, and it is also the most interesting in learning, gathering data, and communicating.

With the rapid advancement of technology, mobile applications are one of the most efficient ways to learn. These mobile applications support the teaching-learning process by using mobile devices and tablets. Also, this type of learning can be convenient in some ways such as learning at any time and learning whenever they want as long as it is a safe location. [7]

stated that learning through mobile applications has positive outcomes.

The researchers created a single user First Aid Instructional Mobile Application with Potential Hazard Information Awareness for Kids. There are real-life accident situations and natural calamities on this application that will teach the children what is right to do with the given scenarios. A tutorial is given before the assessment starts, and a video demonstration of the first aid is provided after the assessment. These incidents that claim their lives or damage them are unavoidable – but we can teach our children how to respond successfully in crises and give support to other children or their families if required.

Even at a young age, children have demonstrated to the world that first aid is need to be learned, and this skill is frequently preserved while growing up to become valuable members of society and their communities. In summary, whatever resources we can devote to their first aid training will one day result in a more resilient society with capable and healthy individuals. Definitely, this is true across the world, and our attention should be on ensuring that this learning process begins at a young age. Citizens from all countries should, in fact, lobby their governments to make first aid training and education for teachers and students to be mandatory in schools

Background of the study

The purpose of this mobile application was to teach the children to perform first aid and hazard prevention for unexpected situations. Due to the modern world, the rate of accidents increases, and many individuals are losing their lives for not having emergency treatment. Many people do not know the first aid that causes a reduction in the victim's survival rate. Numerous advantages to this mobile application include giving proper knowledge in performing first aids that can be used in the long term and help boost the children's confidence. Learning first aid should be taught to kindergarten at the age of four-five years (4-5) old as first aid training for children can also increase knowledge, skills, and motivation to provide first aid. [11]

The target users of this mobile application are children at the age of five years old and above. An independent study of primary school

students found that six-year-old kids can administer basic first aid to an unconscious patient. Children as young as five years old can learn and administer basic first aid. Many of the students demonstrated their talents in a first aid scenario. When witnessed in play settings in ordinary life, first aid knowledge and skills are demonstrated.[12]

Objectives of the study

The general objective of this study was to develop a First Aid Instructional Mobile Application with Potential Hazard Information Awareness for Kids with different scenarios about first aid and calamity. This study will spread awareness on what to do in emergencies encountered by children.

In line with this, the study aimed to follow specific objectives:

- To gather data and relevant information through internet, articles, journal, related system, and interviewed professionals;
- To identify software development tools;
- To design system using designing tools such as storyboard and character model;
- To integrate random algorithm;
- To create a mobile application with a first aid and calamity instructional feature; and
- To test the mobile application in terms of Functionality, Usability, and Portability using researchers-made test cases.

Scope and limitations

This study covered the First Aid Instructional Mobile Application with Potential Hazard Information Awareness for Kids as a teaching method to improve their skills and broaden their knowledge.

Furthermore, the researchers gathered data and relevant information in internet, articles, journals, related systems and interviewed professionals (see Appendix E) to build the mobile application prototype.

The software development tools used to produce the mobile application were Unity, Visual Studio, Animaker, GIMP, and Photoshop. The researchers used ELSA Speak: Online English Learning and Practice application and Learn Tagalog applications. To visualize the flow of the Dr. Kid mobile

application, the researcher provided a storyboard (see Appendix B). Additionally, the researchers used Blender, Dollify, and Live Home 3D to provide 3D character models (see Appendix A) and a 3D animation video demonstration in the mobile application.

This mobile application had five characters that have different roles. Those were Dr. Kid, male or female, as narrator in the first aid category, Cindy and her mother as the role players, and Rescuer Princess as the narrator in the calamity category. Additionally, before the stages of the first aid category start, the user will choose the gender of Dr. Kid whether Dr. Kid male or Dr. Kid female. Still, the user can change the gender of the Dr. Kid in the option. See Appendix A for the character model.

The screen resolution of the mobile application is 1280x720, 1920x1080, and 2160x1080. The mobile application can be used in landscape mode by the user. In addition, the user can play the mobile application with or without an internet connection.

The researchers developed two-stage categories. First, the first aid stage consisted of fifteen stages, and second, the calamity stage consisted of three stages with different scenarios. In this mobile application, there were scenarios (see Appendix C) that have tutorials in every stage that will teach the user what is right to do, an assessment that will test the user's learning, and a video demonstration on how to perform the correct answer. Lastly, the scoring stars will appear before the stage ends based on the assessment's performance. The bases for the stars are: a.) Zero wrong answers are equivalent to three stars, b.) One to two wrong answers are analogous to two stars, and c.) three or more than three incorrect answers equal to one star. See appendix B for the storyboard.

The mobile application tested its functionality, usability, and portability (see Appendix G, H, and I) using test cases for the mobile application's more stable performance and better usage.

Due to design constraints, this study did not cover downloading on an IOS device.

On the other hand, the mobile application can be downloaded on android mobile devices and tablets.

SYSTEM DEVELOPMENT METHODOLOGY

In this section, the researchers used a Prototyping Methodology that showed the development of the First Aid Instructional Mobile Application with Potential Hazard Awareness for Kids and the tools used for this study. The researchers chose Prototyping Methodology to improve all the requirements and know what is needed to change depending on the user's want. In addition, with the prototyping method, the researchers can detect the error within the development and help to find the missing functionality in the application. Lastly, the researchers can provide a prototype of the application that the target users can use.

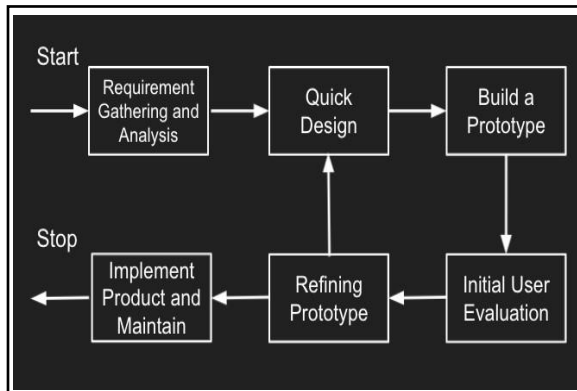


Figure 8: Prototyping Methodology

Requirements Gathering and Analysis Phase

Requirement analysis was the first stage in developing a prototype model. In this phase, the researchers gathered all the information and requirements needed for the mobile application. During this phase, the researchers found studies and works of literature on the internet and other related studies of the other researchers connected to the study.

Moreover, the researchers designed three (3) questionnaires validated by a pediatrician, nurse, and fire department volunteer (See Appendix D for Validation of Questionnaires). The researchers conducted an interview using the validated questionnaires to a pediatrician, MAPEH teacher, and fire officer (See Appendix E to the Interview results). After the consultation, the researchers identified the scenarios and materials needed for first aid and calamity applicable to the study's target user

(See Appendix C for the Scenes and Materials). The software and hardware development tools required for creating the application were also prepared. The researchers designed three (3) questionnaires validated by a pediatrician, nurse, and fire department volunteer (See Appendix D for Validation of Questionnaires). The researchers conducted an interview using the validated questionnaires to a pediatrician, MAPEH teacher, and fire officer (See Appendix E to the Interview results). After the consultation, the researchers identified the scenarios and materials needed for first aid and calamity applicable to the study's target user (See Appendix C for the Scenes and Materials). In addition, the researchers also studied the development tools and computer specifications that were used to develop the application (See Appendix J for the

Hardware specification). Researchers used Unity for the development platform, Visual Studio for the script, Blender for the 3D videos, Live home for 3D backgrounds, Dollify for the 3D characters. For the images, there were Adobe Photoshop CC, GIMP, and Animaker (See Appendix K for the Hardware and Software specification). These tools developed and created the functionalities and features of the application. Also, the researchers used two applications that can be downloaded on the Play Store: ELSA Speak: Online English Learning [67] and Practice Application and Learn Tagalog by Dalubhasa[68]. They were used to check the proper pronunciation of the sentences.

Quick Design Phase

In the quick design phase, the researchers presented the user with a storyboard of the mobile application to help them comprehend the concept and envision the design of the application prototype (See Appendix B for the Storyboard). The researchers created four animated 3D figures with accountabilities (See Appendix A for the character model). In the first aid category, characters such as Dr. Kid, whether the user or the storyteller, might be male or female. On the game option, the player may still alter the gender of the Dr. Kid. Cindy and her mother performed the roles of the other characters. Finally, in the calamity category, Rescuer Princess performed and served as another narrator.

Build a Prototype Phase

The Dr. Kid: First Aid and Calamity had multiple features which can make the application entertaining. As for the starter, the application had a 3D background and background music to give the user a better experience. In this mobile application, there were two categories, and those were the First Aid and Calamity. Before the user can proceed to the stages in First Aid, there were two-button choices that the user needs to choose, and that was the gender for Dr. Kid that will be guiding the user on what they need to do. In addition, the gender of the Dr. Kid can be changed anytime on the options button in the main menu. It also had two languages that can be chosen on the options menu, and the two languages were English and Tagalog. These languages were for voice narrations and dialogs.

Furthermore, the mobile application consisted of fifteen stages in First Aid and three stages on Calamity. These stages had different situations, background images, dialogs, and kinds of first aid materials that will reduce the boredom of the user. In addition, every stage had a tutorial that will teach the user what to do and an assessment to apply the user's learning. In the assessment, there were four choices that the user can choose, and the user cannot proceed to the next stage until they chose the correct answer. However, every wrong choice of the user will reduce their star score. Conversely, if the user chose the correct answer, there will be a 3D video demonstration of the material on how to use it.

Initial User Evaluation Phase

In this phase, the researchers evaluated the application's user evaluation if the application functionalities were working correctly. Before the mobile application was presented and used by the target user, the researchers conducted the unit testing, system testing, and integration testing where the researchers provided test case questionnaire to test the overall functionality in which the 50% of mobile application was functional when application prototype was achieved. Then, the acceptance of board of panelist let the researchers proceed to capstone 2 for the next phase of acceptance testing. See Appendix for the test case questionnaire.

Refining Prototype

The researchers updated the mobile application if the user was unsatisfied with the current prototype. The changes were based on the user's comments and suggestions. Furthermore, the panelists recommended a 3D animation for the video demonstration to make the mobile application more informative and exciting for the target users. However, the developer resolved the panelist's recommendation. The developer and tester performed unit and integration testing to test the Dr. Kid mobile application (See Appendix L).

The mobile application developer sent the APK file to the testing team to check the mobile application functionalities with their phone (See Appendix M). The tester checked all the features on the Dr. Kid: First Aid and Calamity if they were all working. Also, if there were errors on the testing, they listed down the errors, and the developer fixed all of the errors. Then, the latter relayed the APK file again for testing.

Finally, upon the acceptance of a board of panelists in developing the mobile application, the Dr. Kid mobile application was 100 percent functional and met the prototype's functionality.

Implement Product and Maintain

Once the mobile application of Dr. Kid: First Aid and Calamity was thoroughly tested and done, the researchers put the final prototype into production, and if the application finished and passed all the phases, it is ready to be used by all the target users of the study. The researchers performed maintenance on the application to save delays, prevent massive breakdowns and add more features to make the application more useful.

Deployment

After completing the previous phases and several initial evaluation repetitions, the researchers created a working prototype. Product implementation had finally been completed, and the mobile application was ready to be used by the target users and could be downloaded by this link: <https://ckjuco.itch.io/dr-kid-first-aid-and-calamity>

RESULTS AND OUTCOMES

This section showed the results and outcomes based on the study's objectives, and the research output must be presented in an organized and presentable manner. These discussions and conclusions were based on the study's objectives, completed analysis, and testing of the developed application prototype.

The study covered primarily the design, development, and testing of the application prototype entitled "First Aid Instructional Mobile Application with Potential Hazard Information Awareness for Kids" with different scenarios about first aid and calamity. This mobile application would spread awareness on what to do in emergencies encountered by children.

The gathered data from internet research, and interviews gave the researchers enough ideas, information, and a deep understanding that would help develop the application prototype.

The researchers identified the application requirements and the time needed to finish each task. The researchers discussed and documented each development phase and work and ensured all task targets were achieved at the most expected output of the developed mobile application. The researcher's developer used software development tools to create the mobile application such as Unity, Visual Studio, Animaker, GIMP, and Photoshop. The researchers also used ELSA Speak: Online English Learning and Practice application and Learn Tagalog applications. These applications are available on the Play Store. Furthermore, the researchers used Blender, Dollify, and Live Home 3D during the development phase of 3D character models and a 3D animation video demonstration of the mobile application.

The researchers shared a collaborative idea and developed an application through designing, programming, testing, and debugging. The researchers used the storyboard to illustrate and understand the concept and visualize the design of the application prototype. The researchers successfully designed and created four animated 3D characters with different roles (See Appendix A for the character model). Narrator Dr. Kid gender can be chosen based on the user preferences in the first aid category selection. The user may still change the gender for the Dr. Kid gender on the option. Other

characters, Cindy and her mother who act as the role players. Lastly, Rescuer Princess acts and serves as another narrator in the calamity category.

Mobile Application User Interface on the Characters



Figure 9: Dr. Kid Mobile Application Character

To monitor the study's progress on the development, the researchers conducted the regular virtual meeting. During the scheduled virtual meeting, the researchers received a series of tasks to perform. The researchers used the prototyping methodology (see figure 8 and Appendix F) to guide and track mobile application phase development. With this, the researchers successfully achieved and created a mobile application in which there were tutorials at every stage that would teach the user what is the right thing to do. The mobile application had an assessment feature to test the user's learning. Using playable video demonstration would educate users to perform the correct steps and procedures. Lastly, the scoring stars would appear before the stage ends based on the assessment's performance. Perfect answers are equivalent to three stars, one to two mistake answers are analogous to two stars, and three or more mistake answers are equal to one star.

Mobile Application User Interface on the different kind of features

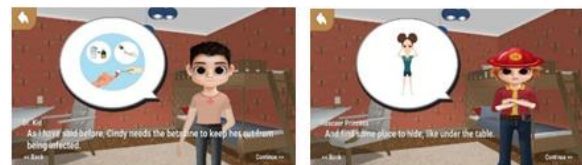


Figure 10: Tutorial and Instruction

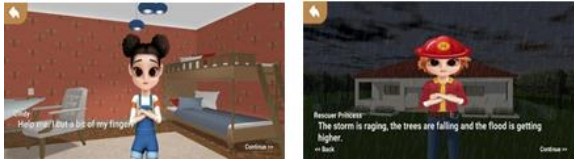


Figure 11: Assessment



Figure 12: 3D Video Demonstration



Figure 13: Star Scoring Point

The researchers developed two-stage categories. First, the first aid stage consisted of fifteen stages, and second, the calamity stage consisted of three stages with different scenarios. The scenarios of all stages were based on the researchers' interviews (See Appendix E for the interview and Appendix C for the list of materials and scenarios in first aid and calamity categories).

Mobile Application User Interface on the Two Categories



Figure 14: Two Categories first aid and calamity

Mobile Application User Interface on the Fifteen stages in first aid and Three stages in calamity



Figure 15: Fifteen stages in first aid and Three stages in calamity

DISCUSSIONS

The researchers created a test case (see Appendix G, H and I) to measure the developed mobile application's functionality, usability and portability across a set of actions or conditions and to verify the expected result for its more stable performance and better usage. For quality resolution output of the mobile application, the researchers recommended using smartphones or tablets with a screen resolution such as 1280x720, 1920x1080, and 2160x1080. The mobile application could be used in landscape mode by the user. To identify the process and design of the Dr. Kid mobile application, the researchers created a user manual (see Appendix N).

Finally, upon acceptance of board of panelists in completion of mobile application, the researchers developed a mobile application that could be freely downloaded at the website domain address of <https://ckjuco.itch.io/dr-kid-first-aid-and-calamity>

Functionality Test Cases

The researchers provided functionality test cases (see Appendix G) to verify the responses accordingly. The test cases consisted of five trials to measure the mobile application's functionality. Based on the test cases result, the said application passed in the functionality test. Such test involved the installation and uninstallation of mobile applications. Furthermore, the starting point, button, and material used in the Dr. Kid mobile application were tested as well.

Usability Test Cases

Usability test cases (see Appendix H) were used to evaluate user's experience. The mobile application passed the usability test based on the results. The researcher used the Dr. Kid mobile application to verify the user experience and expectations.

Portability Test Cases

The researchers tested the mobile application using a portability test (see Appendix I) to determine if they could correctly transfer it from another device. The researchers provided such test to estimate how easy the mobile application would be into different systems. The portability test case result had one failed test while the others were all passed.

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E-RacEvent: An Online Event Management System for Drag Race Philippines

Dominic P. Manaloto

Edmar M. Montoya

Ralph Dunhill C. Musni

Kier P. Tiatco

Lester C. Tuazon

Dennis L. Tacadena, PCpE, DIT (Technical Adviser)

ABSTRACT

Information technology has improved the ability to exchange knowledge and accelerate the flow of information and communication. From event registration and check-in to promotion and reporting, this platform assists event planners in achieving success in all parts of their events. That is why the researcher of this study aimed to develop an online event management system for Drag Race Pilipinas. With this web application, it can manage event information and event schedule with ease and efficiency. The system can inform and update about the upcoming events and generate a QR code sent to participants' registered emails, which serve as ticket entry for the venue. It also makes the system response that can adapt to mobile view and simple access features. The chosen methodology is an iterative model, and it primarily focuses on preliminary growth and design, then gradually develops until the final software is wholly constructed. By following the necessary methods and procedures, the researchers successfully provided "E-RacEvent: An Online Event Management System for Drag Race Pilipinas" that the users can access online using a desktop or mobile browser. The integration testing was completed successfully, with no errors being generated in user functionality, portability, usability, reliability and continuing to work typically. The web application met all the requirements written in the objectives and scope of this study. Future researchers may broaden the locale's content, create apps for various platforms, and add new features like an online payment application program interface.

CCS Concepts: • Computer systems organization → Embedded systems; Internet of Things • Mobile Application Development → Android Application

General Terms: Design, Performance

INTRODUCTION

In practically every industry, such as education, event planning, business, health, and government, the advancement of increasingly advanced and efficient information technology has spread. The freedom to share knowledge and the flexibility with which information and communication flow has improved as a result of information technology. [1]

The event management software can be used by event organizers who use information technology. From event registration and check-in to promotion and reporting, this platform assists event planners in achieving success in all parts of their events. In general, live event managers can use event management software

to communicate with guests, educate them, and generate fresh content. [2] Event planners have grown in popularity to help them automate their next event while saving time and avoiding overspending on traditional event management processes such as a lot of paperwork or a long line at the registration counter [3].

Organizers can advertise their events, send email invitations, clarify the situation, and even build an online registration for athletes/participants using the latest event management software technology. Most participants could only enroll on the day of the event if organizers had to print and transmit files in an old-fashioned way. As a result, the registration area may be packed, and people may have to wait for a long time. Registration task consumes much time and is imprecise due to copying manually, archiving, and digitizing data. Organizers needed eager people who worked well to collect registrations payment fees and tabulate the required data.

The DRP uses online social media such as Facebook. They have a community page called Drag Race Pilipinas group. They use it for advertising and promoting their products and sending registration dates for a particular drag race event, provided with the necessary details. Facebook becomes the primary method of informing members about upcoming events and making announcements. However, the researchers do not have a definite database to store information, primarily the collected, registered participant. Without a database, sorting and arranging data is highly time-consuming, even when typing it one by one to transfer it to other stores. There is also a chance that the files would vanish or be deleted. Anyone can register for the event without proper validation, so they do not entirely control and manage the attendance. Lastly, the researchers found that they have to print all of the entries and manually verify whether the applicant has paid or not paid the registration fee.

To tackle this problem, the researchers propose to develop an online event management system. With this web application, it managed event information with ease and efficiency. The system can inform or update about the upcoming events for them to join through the use of a web browser along with an internet connection. The system would be responsive and adaptive to smartphone users if the participant has no PC, making it easy to access. All the data information would be stored securely on the dedicated database instead of paper to record manually.

Background of the study

One of the well-known sports for motorcycles is motorcycle drag racing in other countries. It is a sport where a competitive use of motorcycles occurs, and both professionals and amateurs do it on roads, closed circuits, and terrains. Globally this sport is widely introduced. Locally, this sport is usually done illegally by unauthorized groups of people in different areas of the Philippines, which urged the government; specifically, the Congress in approve the anti-drug racing bill or the House Bill 8916 due to an increasing number of severe injuries and even deaths with this illegal activity [4]. Also, drag racing for motorbikes is regarded as a sport in the Philippines; when

they hear drag racing, the first thing that springs to mind is the criminal nature of the activity owing to unregulated and uncontrolled events. Drag racing became a criminal offense when it was organized and conducted without permission on public streets and roads, disregarding the safety of motorists and innocent spectators. There are some sponsored clubs and sports associations. Organizers of sports events are legal drag racing events in a variety of and much more safe racing circuits that focus on the safety of spectators and riders. One of those event organizers is the "Drag Race Pilipinas." This organization promotes the legality of drag racing events in the Philippines; the locale provided some papers to verify that the said organization is legal.

Drag Race Pilipinas was filed last February 4, 2021, and was registered on September 19, 2021, by the founder, Justin A. Villanueva. Their main office is located at 3088 Bagong Anyo St., Duquit, Pampanga, Philippines. Most of the events were executed often at Pampanga, such as in Mawaque, Mabalacat, and San Simon. Due to demands from interested aspiring racers outside Pampanga, incoming events are being planned to be conducted in other cities in Luzon Visayas and Mindanao.

Under the statement of the locale, the traditional way of doing events regarding drag racing has been the most used method where physical setups during the preparation, registration, and completion of requirements, payments, and scheduling occurs. On the other hand, promotional tools and items are usually online, such as posting incoming events, merchandise, and updates via Facebook. Unfortunately, at this moment, where restrictions arise due to the pandemic situation, most of the events being planned are canceled. Since health and safety protocols are monitored, the management is experiencing difficulty organizing events. In this case, researchers thought it would be more convenient to both management and the participants if the event settled the whole process through a management system. Therefore, researchers focus on developing a management system for Drag Race Pilipinas, aiming to improve communication and transaction of the event organizers and players

to maintain the competitive environment for the whole organization.

The whole process of Drag Race Pilipinas comes first in registration online on different social media platforms; due to pandemic, on-site registration is limited. Each event's roster has a specific time frame to follow for every participant after the registration ends. All participants are required to print their online registration form and payment transaction slip, apply, and pay online. On the main racing event, every category has a different number of legs as a part of the race. The dominant team in every leg is the winner in the said category, and awarding would always occur after the event.

Objectives of the study

The study's general objective is to develop an "E-RacEvent: An Online Event Management System for Drag Race Pilipinas."

Specifically, the study aims to achieve the following objectives:

- To obtain information by conducting online research, interviews and practice programing by watching instructional videos.
- To design a web system using designing tools such as use case diagram, context diagram, a website map, and entity relationship diagram.
- To identify hardware and software specification and requirement,
- To create and develop a web-based event management with scheduling system.
- To test the web-application using test cases in terms of functionality, usability, portability, and reliability.
- To publish the web-application system through a hosting service platform.

Scope and limitations of the study

To develop this system, the researchers used different software and hardware tools, including Laravel Framework, HTML, JavaScript, CSS, PHP, XAMPP, Mail Trap, Visual Studio Code, Adobe Photoshop CS6, Laptop, and Personal Computer, and a mobile phone. Each of them has contributed significantly in making this website.

The Laravel framework is the primary PHP framework tool used for building the web application. HTML was used to structure web

pages and CSS for designing the web pages to make them presentable for the users. JavaScript was used to make each webpage interactive. The Visual studio code is the IDE used when coding the website. The Chrome browser was used for trial and error while coding, and was used to run the output of the web applications. PHP was used for the database of the system, and XAMPP is the one who utilized the server and database functions of the system.

Along with creating notifications, Mailtrap.io has become the trial in sending an email to the users. The web-application design is based on the provided graphics collection of Drag Race Pilipinas by using Adobe Photoshop CS6. Hardware tools such as the Laptop, Personal Computer, and Mobile Phone were used in coding and testing the output. The researchers used web designing tools such as use case diagram, context diagram, website map, and entity relationship diagram to design this system.

The system focused on managing a web application for Drag Race Pilipinas. An online Web Application for Drag Race Pilinipinas would process entries from manual to online. The passing of entries for the particular drag race event is accomplished using the web application. The system would allow the admin and staff to manage events, and the participant would be able to join and pay online.

The system has four user levels: the user, team owner, Admin, and Staff. The system has the functionality wherein users can register, log in, create their team. The team owner is most likely the user; once the user tries to make the team, that would be the time to be called the team owner. It would grant the team owner a new feature to manage its team. The team owner has an option to invite and remove members. The user must be team-first before they can join events, whether they are a team owner or a member. The user must only have one team; they cannot create or join another team if they have a couple already.

The Admin can add, view, edit, and delete Events and Products. The Admin can create, view, and delete a Staff account. The Admin can also view and delete the User's account and team. The admin can view and update the scoreboard; adding scores is manual. However,

they can correct it if there is a problem with the score. The Admin can view the request to join from the participants and accept or decline the request.

The staff can view the list of user accounts and teams, add events and products, and update events and product descriptions. However, the Staff could not delete an event, but products could. The staff can only view the scoreboard and cannot update the scores. The staff can also view the participants' requests to join. However, the staff cannot accept or decline a request. The researchers conducted a test using test cases in terms of functionality, usability, and portability.

SYSTEM DEVELOPMENT METHODOLOGY

This section identified the methodologies used by the researchers to develop the propose study. In this section, the theoretical methods and diagrams were also added to explain the function and complement the process flow.

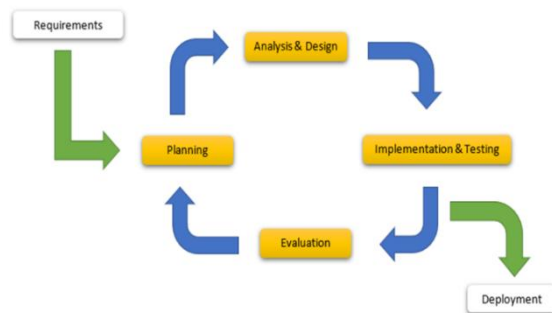


Figure 1. Iterative Model Screenshot (Source: <https://www.w3schools.in>)

Software development is depicted as a life cycle in the popular iterative model. It focuses largely on preliminary growth and design, then builds momentum as more sophisticated and needs are addressed until the final software is completed. The iterative development methodology, in a nutshell, divides any large software development project into smaller pieces. The goal of this SDLC technique is not to generate a detailed specification plan. On the other hand, this architecture is expressly designed to start with the most basic requirements and build a fraction of the program. The prototype is then reviewed once more for any additional requirements. The

technique was then performed iteratively to create a new version of the application. [22]

Requirements

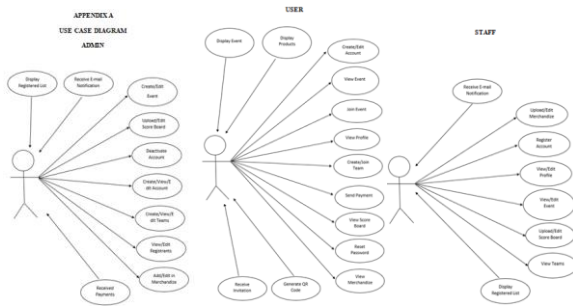
The researchers gathered information from the locale via face-to-face interviews, messenger chat, and an SMS message in which they provided us with the necessary data and business requirements such as "what are the main business processes?", "who will use the product?" and "how will they use it?". The study's goal with the chosen locale is to gain access from their point of view to incorporate in the system. It also necessitates the details of the system's users.

Planning

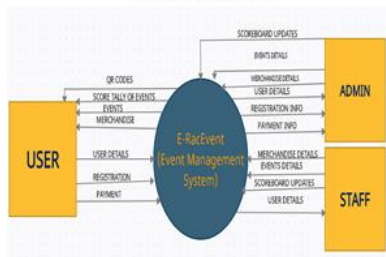
The team met via Google Meet, Messenger, and face to face about the operation and design of the system's implementation. The team conducted preliminary research on web applications and other necessary inputs. The programmer practiced using the programming software by watching instructional videos. The researchers chose an adviser who could help them with the technical aspects of the analysis. The researchers aim to pass the study by the suggested deadline of the school.

Analysis and design

The group executed the plan and reached out on what had been studied. The specifications defined in the previous phase are used to create the system and software design. The team considered the appearance and the layout of the product. The adviser and the panelists recommended the researchers make some necessary diagrams. The first diagram is a Use Case Diagram. It represents the controls and capabilities of each system user based on the discussion of the system's scope and limitations. The researchers also created a Context Diagram; It depicts the flow of information between the system and external components to understand the details and boundaries of the system. The Web Map visualized the flow and process of the web application for each module. Lastly, the ERD (Entity Relationship Diagram) is a flowchart that shows how "entities" within a system, such as people, things, or concepts, interact.

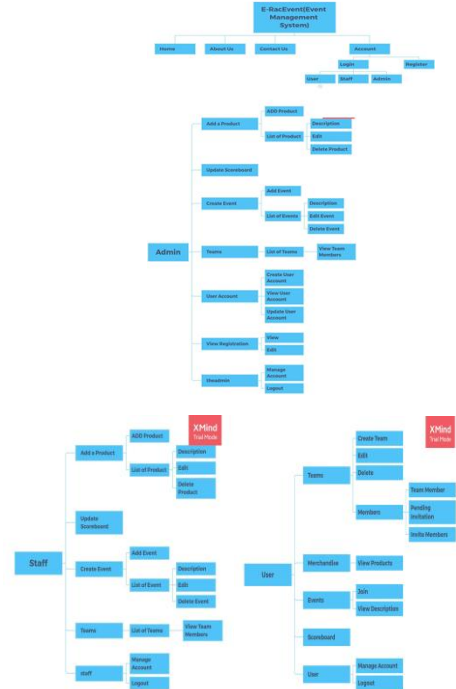


APPENDIX B
CONTEXT DIAGRAM



APPENDIX C

WEBSITE MAP



Implementation and test

The design phase was done through arranging and visualized, and the researchers proceeded in the Implementations and Test, which is all about creating the system using software tools as indicated above on one of our objectives and

testing features of the system based on the layout design. The user interface and modules were coded and built before being included and tested into the system.

These are the hardware and software specifications that the researchers used in developing the web application to understand further.

Table 1. Hardware Specification for developing web-app

Hardware	Description
500GB HDD	STORAGE FOR DATA
4GB RAM	MEMORY FOR THE SYSTEM
Intel(R) Celeron(R) N4020	PROCESSOR

Table 2. Software Specification for developing web-app

Software	Description
VISUAL CODE v1.56	Use to develop the program.
NODE.JS v14.16.1	Use for backend services.
BOOTSTRAP 4	Use for frontend services.
GOOGLE CHROME v 90.0.4430.212	Used to view the output of the source code.
XAMPP v 7.3.28	Use to run PHP code and create MySQL database.
LARAVEL v8.16.1	Use to improve the system.
MAILTRAP.IO	Use for testing email notifications.
COMPOSER	Use for PHP software and required Libraries.
ADOBE PHOTOSHOP CC 2018	Use to design the graphic related for the system.

Evaluation

The researchers have verified and validated user inputs and output feedback of the system using test cases on functionality, portability, usability and reliability. This is the stage in where the researchers added, eliminated unwanted system bugs, and improved the features or elements of the system that needed

to be updated to ensure it would meet all of the requirements for catering to the demands of the users and achieve all of the study's objectives.

Deployment

The system here is fully developed and has undergone refinement; the researchers moved on to this phase which is the actual implementation of the system. The E-RacEvent web application was uploaded to the domain for web hosting using GoDaddy to access it via online internet using a web browser. The domain name where the web application can be accessed is through "http://dragracepilipinas.com/".

RESULTS AND OUTCOMES

This section discusses how the study's main objective was met: to provide a web-based online event management system for Drag Race Pilipinas that users can access online either using a desktop or mobile browser. It also includes the discussion of the requirements gathering, design and development, and testing results in this chapter.

The study covered primarily the design, development, and testing of the web application entitled "E-RacEvent: An Online Event Management System for Drag Race Pilipinas." The web system focused on managing a web application for Drag Race Pilipinas.

The researchers successfully gathered data from internet research. They contacted local owners through messenger chat and interviews which provided enough ideas, information, and a deep understanding that would help develop the web application. The researchers used the internet to hold brainstorming sessions through virtual meetings and gather scholarly ideas. During the scheduled virtual meeting, researcher members would be given a series of tasks by the project leader to perform.

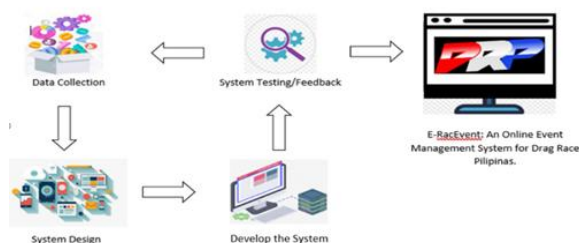


Figure 2. Conceptual Framework of E-RacEvent

First, the researcher identified and used the required hardware (see Table 1) and software (see Table 2) in the development process of the web applications. The researchers used the Iterative methodology (see figure 1) to guide and track the web 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 web application. A conceptual framework is used in study to outline possible courses of action to present a preferred approach to an idea or thought. The figure 5 illustrates the conceptual framework of the study that requires processing tasks to transform data gathering into the implementation of the E-RacEvent.

Second, the researchers designed and illustrated the system using a design tool to overview the system's appearance and layout. Using the Use Case Diagram, the researcher viewed each user actor's controls and capabilities of each system user dashboard. Using a Context Diagram would show the flow of information between the system and external components to understand the details and boundaries of the system. Using Web Map, the researchers have visualized the flow and process of the web application for each module. Lastly, the researcher used ERD (Entity Relationship Diagram) to create databases tables, identify primary and foreign keys used, and show how "entities" within a system, such as people, things, or concepts, interact.

Third, the researcher used the software development tools (see Table 2) to translate designed diagrams into a working system. To do this, the researcher used Laravel Framework, HTML, JavaScript, CSS, PHP, XAMPP, Mail Trap, Visual Studio Code, and Adobe Photoshop CS6. The research developers used the Laravel framework as its primary PHP framework tool for building the web application. The HTML was used to structure web pages, and CSS was used to design the web pages to make a presentable layout, colors, and fonts for the users. JavaScript was used to make each webpage interactive. The Visual studio code is the IDE used in coding the website. Initially, the Chrome browser was used for executing, testing, and debugging to

output view the initial and final web application. PHP was used for website scripts for the backend server and its MySQL Database Management Software for system databases. The researcher developer used XAMPP to utilize the server and database functions of the system. During the system development, Mailtrap.io was used for sending an email to the users. The web-application design and logo were based on the provided graphics collection of Drag Race Pilipinas. To enhance some website-attached images, the researcher uses Adobe Photoshop CS6.

Fourth, the researcher developer successfully developed and created a web application and system using the required hardware (see Table 1) and software (see Table 2). The system has four user levels: the user, team owner, Admin, and Staff. The developed system would have the functionality to register, login, create their team. The user may create and manage a team to level-up accounts as a team owner. The team owner account has a feature that may invite and remove members. The user must enter the team; first, they could be either team owners or members. The user may be able to join one section only. Features to create or join another team will be disabled if they have their team already.

The researchers developed admin features that would empower admin to create events, add products, view and modify the details of each event and product. The admin would be able to develop its user account and staff account, view the list of accounts, update accounts information and even deactivate user and staff accounts, manage team, view the list of teams, update team information, generate QR code, and send automatically to the registered email of participants, and view and update the scoreboard.

The features of the admin staff account would be able to view the list of user accounts and teams, add events and products, and update events and products description. The staff would be able to view the score and edit the scoreboard.

The passing of entries for the particular drag race event would be done using the web application. The system would allow the admin and staff to manage events, and the participating user would be able to join and pay

online. There are no limitations set in the number of participants that could register for as long as the events are not ended.

The system-generated QR code would be used as an entry for the venue. The system-generated QR code would be sent to the registered email of the participating users. Using system generated QR code, the staff would scan the QR code to fetch user information of participating users to verify and validate before entering the event venue.

The researcher created a test case to verify and validate the developed web-application system, functionality, portability, usability and reliability across a set of actions or conditions to confirm the expected result for the more stable performance of the web application and better use of the user. Also, the researcher created user manual as evidence for the results of actual system input-output and test system functionality.

Finally, upon the acceptance of board of panelists, capstone adviser, and technical adviser in completion of E-RacEvent web application, the researchers were developed web-application would be freely browsed at the website domain address of <https://dragracepilipinas.com>.

Web-Application Sample Screenshots

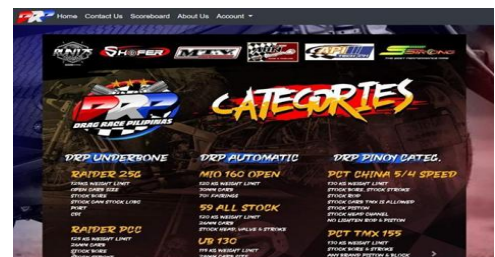


Figure 3. Home Webpage



Figure 4. Admin Dashboard

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FireDozzer: An Arduino-Based Home and Kitchen Fire Prevention Device with Smoke and Gas Leak Detection

Shaira V. Bacani
Rafael P. Castro
Nicolas Rei Gaña
Kenneth C. Mallari
Adriane D. Ong
Engr. Ernie Lee E. Pineda, MIT (Technical Adviser)

ABSTRACT

The Internet of Things (IoT) has become the primary resource of technological innovations worldwide, including the field of fire alarms, wherein this kind of system is considered one of the main focuses of smart home technology. This research analyzed the importance of fire alarms and how the system can contribute to the home occupants. This research focused on building a fire alarm system prototype that will address fire accidents at home. The researchers used the evolutionary prototyping model as a guide to complete the system prototype and its mobile application. The system prototype has three sensors to detect a gas leak, smoke, and fire. Upon detecting these flammable substances, the LED and buzzer will turn on. In addition, the home occupant will also receive an SMS text and fire notification on the mobile application. The researchers also included a water sprinkler that can be triggered through the manual and automatic operation of the system. The manual operation can be done by the on and off buttons of the mobile application. At the same time, the automatic operation will precipitate when the specific time frame is over. The researchers conducted test cases to ensure that both mobile application and system prototype worked properly. The FireDozzer prototype met the study's objectives based on the collected results. The researchers recommend creating another mobile application that will notify the Firefighters and use another solar panel to accommodate all IoT components used in the FireDozzer prototype.

CCS Concepts: • Internet of Things; • Mobile Application Development → Android Application

General Terms: Prototype, Arduino

INTRODUCTION

The world heavily depends on its energy in the form of fossil fuels. Most of these fuels, such as alcohol, coal, and gasoline, are being used by people in their everyday lives. People bathe, cook, do laundry and drive using different types of fuels, and everyday people suffer from significant fire occurrences from simply doing these chores [1]. Stanford Children's Health Organization said that the leading cause of fire accidents is from home cooking and smoking materials like cigarettes. Therefore, fire alarm systems will play an essential role in protecting human life and people's property. There are many different brands of fire alarm systems,

and each has a different principle, but experts say the location of installation should be considered. One out of three home fires begins at the kitchen more than any other place inside the house. According to Home Monitoring and Security, kitchens are the top priority when choosing a location for fire alarm systems. In line with this, Occupational Health and Safety added that fire detection and alarm systems are all built and introduced to work with the same functionalities. This includes discovering a fire, effective alarm, warning, and giving alerts to first responders [2].

According to Stanford Children's Health Organization, fire deaths are caused mainly by smoke inhalation, more so than heat and flames. A combination of particles and chemicals caused by smoke and gases can lead to tissue layer irritation to swell, respiratory distress, and airway collapse. As reported by the National Fire Protection Association and

the U.S. Fire Administration, the home use of smoke alarms ascended from less than 10% in 1975 to at least 95% in 2000. The number of house fire deaths decreased almost by half. In line with this, the Northeast Document Conservation Centre concluded that the smoke alarm component dominated the success rate in fire safety near the end of the 20th century, the technology alone represented a highly effective fire safety system with the ability to face most of the fire death problem that was being used nearly universally [3].

According to Sam Kubba, fire alarm systems were designed and engineered to warn occupants of fire to evacuate themselves quickly when it happens [4]. Hence, an added feature called automatic sprinkler systems reduces the chances of dying in a residential fire by approximately 73%. Stanford Children's Health also added that combined smoke alarms and sprinkler systems could reduce fire-related deaths by 82% and injuries by 46% [2]. The Agssecure Fire and Life Safety stated that early fire detection decreases the risk of fire damage. This includes property damage which can require a large sum of money and a great deal of time to repair. According to IFSEC Philippines, in the past decade, the country lost thousands of lives and billions worth of assets because of seemingly inescapable fires. In addition, the BFP is short of firefighters, with a ratio of only one firefighter for two thousand people or population. If not reciprocated, their response time in need of fire accidents can lead to significant challenges and destructive outcomes [5].

Background of the study

The researchers decided to conduct the study relative to fire safety and prevention because fire preventive devices are the primary life safety system for every home and greatly benefit from addressing first aid rescue during fire accidents. Having the system installed at home, particularly in the kitchen, will help alert occupants of a fire and give them early warning notifications to a specific contact on the first sign of smoke and gas leak detection.

This way, the proposed study will help avoid property damage and reduce the risk of losing a human life. The system is embedded with different components to detect and alarm people by visual and audio methods, fire notification in the mobile application, automatic and manual operated water sprinklers. However, the fire alarm system has not only been recent. Several studies and systems were made, but still, due to faulty problems and the modernization continuously evolving, such systems should keep upgrading to perform to their necessary specifications and standards effectively. The researchers decided to build a fire preventive prototype to provide early warning to home occupants when fire emergencies arise.

Objectives of the study

The general aim of the study is to design a fire prevention device to give an early warning to home occupants when fire emergencies arise.

In line with this, the study aimed to achieve the following specific objectives:

- To study different factors contributing to actual output fire prevention devices using related literature.
- To develop a mobile application that will receive fire notifications and control the on and off buttons of the water sprinkler.
- To develop a fire preventive device to detect leakage gas and smoke for early fire detection, an alarm system with audio and visual signals, and SMS text to notify the home occupant.
- To test the initial system prototype and mobile application functionalities.
- To construct an automated water sprinkler as a first-aid rescue from the household water source.
- To create a package for the FireDozzer's prototype.
- To evaluate the device and mobile application using the ISO 25010 test case criteria.

Scope and limitation of study

The study covered making an effective fire prevention device to detect fires in their early stages and notify the home occupants. An mq2

sensor, mq6 sensor, and flame sensor were used to detect gas leaks, smoke, and fire. The developers also used buzzers and LEDs as an audio and visual signal, a GSM module to send notifications on the mobile application, and SMS text to the occupant. In addition, an automated and manual water sprinkler was constructed using a relay and water pump. The mobile application made by the researchers can receive notifications and can control the water sprinkler. Moreover, the Arduino IDE and MIT App Inventor are used in programming IoT devices and mobile applications. The power source of the Arduino Uno and GSM module is through a solar panel. ISO 25010 will be used to assess the consistency of the fire prevention device.

The household's water source was used for the water sprinklers. The researchers included a solenoid valve to regulate water to the water pipes. A solenoid valve is responsible for the opening and closing of the water sprinklers. The automated water sprinkler will precipitate once the time frame given by the researchers is over. The user has two minutes and thirty seconds to turn off the fire notification. If not, the water sprinklers will trigger. This feature allows effective fire prevention at home when fire accidents arise and the home occupants are not using the mobile application. The manual water sprinkler will prompt turn on and off buttons via the mobile application.

The solar panel and power bank were used for the power source of the Arduino and GSM modules. The LEDs, buzzer, and three sensors are connected to the Arduino. The system prototype has a gas leak, smoke, and fire sensor. When these sensors detect the following substances, the LED and buzzer will turn on. Then the user will receive an SMS text and notification on the mobile application. The redundant notifications from the system prototype aim to notify the home occupants in as many ways as possible. This feature was integrated into the system to make the FireDozzer an effective fire prevention device at home.

The study did not cover human errors that affect the functions of the fire preventive device and water sprinkler and third-party network services that interfere with the sending message warning from the GSM module. Hence, the system prototype will not cover notifying the firefighters. It is the responsibility of the home occupant when or not to contact them. The solar panel will not extend its power source to the water sprinkler. It will only be used in the Arduino Uno and GSM modules.

Conceptual framework

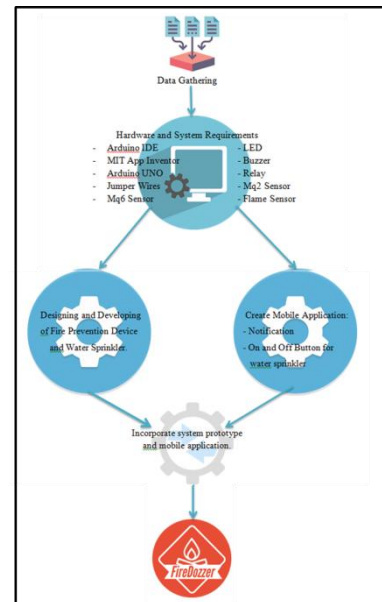


Figure 6. Conceptual Framework

Figure 6 describes the graphical idea of the study. The researchers read and collect data relevant to the study to organize ideas and start planning the system prototype. Purchased hardware components are needed in the system, including mq2 sensor, mq6 sensor, flame sensor, Arduino Uno, LED, buzzer, jumper wire, gsm module, and relay. The study also used Arduino IDE to program the IoT components and MIT app inventor to create and design the mobile app. After acquiring the needed hardware and software in the study, researchers began to put the devices together and program them to operate as one, including the mobile app. Lastly, after creating and

testing the system prototype, the study will produce the FireDozzer device.

SYSTEM DEVELOPMENT METHODOLOGY

The researchers decided to use evolutionary prototyping under the SDLC prototyping methodology. It is suitable for studies that require building and developing an actual prototype while the project progresses. The researchers presented the portion of the system and continued to develop it based on the feedback received. In this study, the fire prevention device started with minimal functionalities and added additional requirements after the panelist evaluation. Using this methodology makes it easy to foresee the step-by-step process of gradually building the prototype to meet the system requirements. Evolutionary prototyping has seven phases: requirement gathering, system design, building a prototype, evaluation with users, refining the prototype, feedback, and the final product.

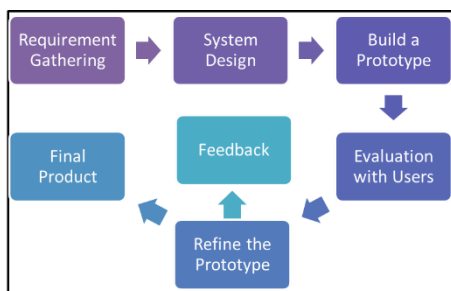


Figure 7. Procedures

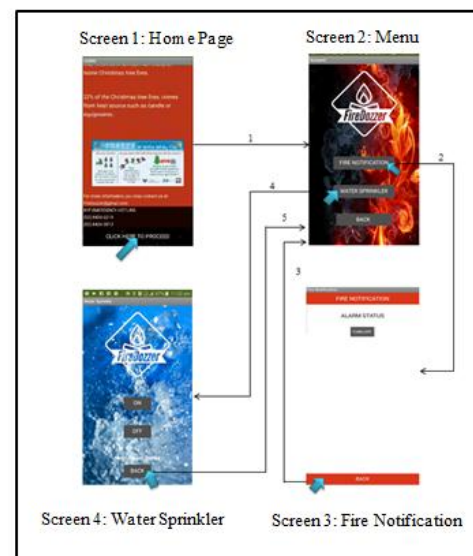
Requirement gathering

The requirement gathering phase is the brainstorming between the researchers on what the system should do. The meeting was held via the Google Meet platform discussing the whole plan to complete the study. The group was partitioned into two, one group consists of two members for the documentation part of the study, and the other has three members for the system prototype. The researchers read many literature reviews to deepen their knowledge about fire prevention devices and understand what specific requirements should be in the

system. The fire prevention device is essential to have installed at home because it is considered a life safety system that saves countless human lives each year. The researchers planned how to make the device that will alert home occupants by redundant notifications. Additionally, the study will also aim to make fire alarm notifications on a mobile application to prolong the warning to home occupants. Lastly, the researchers brainstormed how to build the water sprinklers from the household water source that the mobile application will control.

Appendix J

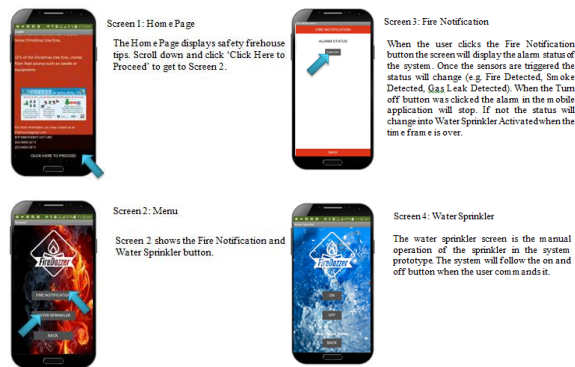
Mobile Application Storyboard



System design

The researchers purchased all hardware requirements in Shopee and Lazada online shopping platforms for easy access and lower prices with good quality products in the system designing phase. It was also decided that Arduino IDE is the programming software used to bring the hardware component together. In line with this, the team made a graphic visualization using a block diagram of the system prototype to envision its flow and determine where the system hardware requirements will be implemented. One member of the group documented the design while the others narrated the whole planning of

the prototype from beginning to end. The researchers also developed the mobile application user interface design and operation using MIT App Inventor. 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 to execute the system development better.



Build a prototype

The build a prototype phase is making the system design into existence. This is the 50% to 70% of the system prototype that was presented during pre-oral and prototyping defense. The researchers started by checking each hardware component to determine which is functional or non-functional. Once that was done, the system prototype team starts to connect all components such as the mq2 sensor, buzzer, LEDs, and other modules to the microcontroller. Furthermore, the team started coding to create a specific set of instructions for the IoT devices to communicate with each other and operate as one meeting the study's objectives progressively. The initial device was completed with 70% functionality and was ready to be presented to the capstone adviser and panelists. The device can already detect gas and smoke. With audio and visual signals and a GSM module to notify the home occupant further via SMS text.

Evaluation with users

The evaluation with users phase is when the initial prototype development is done and the researchers present it to the capstone panelists. After the presentation, an in-depth

evaluation was made between the researchers, capstone adviser, and capstone panelist. The additional requirement for the system prototype was discussed thoroughly to enhance the device. The initial presented device consisted of a gas sensor, smoke sensor, GSM module, audio, and visual signals. It aimed to alert and warn home occupants of fire providing early warning to evacuate quickly. When the panelist was satisfied with the initial device several recommendations to improve the fire prevention device were suggested to the researchers. The recommendations include adding a flame sensor, mobile application fire notification, alarm, a solar panel to prolong the device power source, and an automated and manual water sprinkler controlled via mobile application. The new features intend to fit the fire and safety trends to respond to the growing fire accidents rate in the community.

Refine prototype

In the refine prototype phase, the researchers incorporated all the recommendations made by the panelists to the initial device. The group programmer modified the source codes of the initial device to accommodate the new features of the system prototype. While the other members helped connect the additional hardware to the device, designed a cover, and extended the wires to accommodate a larger space. One member of the group also started to proofread and edit the document ensuring it meets the recommendations. Hence, the researchers assured to update each other regularly about the prototype's progress. Such as, what problems it encounters, how to solve them, and how much more money the study needs. The team performs all necessary attempts to verify the consistency of the device while one member tracks the progress and reports it to the capstone adviser. In assessing the device, anomalies started to show causing it to perform inconsistently. The researchers noted what causes the anomalies from IoT devices to coding. Eventually, while the team finds it challenging to solve the faults, considering the complex areas of the system

prototype, research continues, and constant teamwork makes the fire prevention device achievable.

Feedback

The feedback phase defines the comments and suggestions by the capstone panelists to the refined prototype. The refined prototype was presented during the final defense. The researchers accommodated the previous recommendations both in the system prototype and document. The capstone panelists said that the document has a lot of grammatical errors and spellings. A member has been assigned to edit the document, ensuring no more writing errors are to be found when the study document was presented again. In addition, it was also recommended to the researchers to re-cable the system prototype to make it look organized and clean.

Final product

The final product phase is validating and verifying the system prototype functions according to the panelist's recommendations. The researchers put the system prototype in a complete package to properly show how it operates. The system was put in a box for convenient and efficient testing. It was placed on top of two braces right above the kitchen's stove. 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 will accommodate possible scenarios in real-life fire accident situations. Then the group lit up a fire, made a smoke simulation, and opened the LPG tank to test the mobile application and other functionalities of the FireDozzer. The other members took a video and documented the test cases. After ensuring that the objectives and recommendations are met the researchers presented the final product to the capstone panelist.

RESULTS AND OUTCOMES

System requirements

The researchers were able to achieve the study's system prototype requirements and objectives. The FireDozzer device can now address fire accidents at home by detecting LPG gas leaks, smoke, and fire. The LED and the buzzer will trigger upon detecting these substances, allowing the home occupant to have a visual and audio signal. Furthermore, the occupant will also receive notifications on mobile applications and SMS text. The system prototype has a built-in water sprinkler. It can be manually operated using the FireDozzer mobile application. It is also automatically operated, whenever the user does not interact with the mobile application, turn off the alarm in two minutes and thirty seconds, the water sprinkler will automatically turn on.

System design

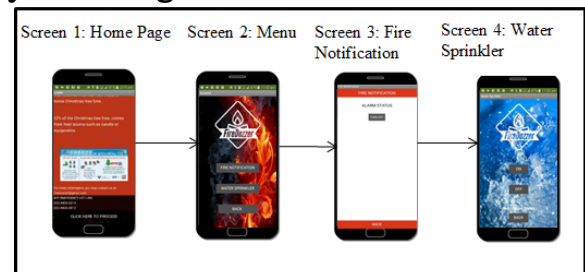


Figure 9. Mobile Application User Interface

Figure 9 above shows the mobile application interface of the FireDozzer. The developers used a vertical scroll arrangement on screen 1 to make a presentable home page with good content about safety house fire tips, how to use a fire extinguisher, and a brief history of fire alarms. While the second screen shows the fire notification and water sprinkler button, it allows the user to choose an action aligned to possible fire emergencies. The third screen shows the alarm status of the fire notification, the status will change when the three sensors are triggered (e.g. gas leak detected, smoke detected, and fire detected), when the user turns off the button (e.g. water sprinkler deactivated), and when the length of time has ended (e.g. water sprinkler activated). The fourth screen is the water sprinkler manual

operation, it has on and off buttons that control the relay of the sprinkler.

Build a prototype and processes

The researchers created a fire prevention device aligned to the panel's recommendation and study's objectives. When the group programmer completed the system's core functionalities, the other members conducted a series of testing to check if the device features were working consistently and effectively. Refer to the illustration below for the system prototype process and testing.

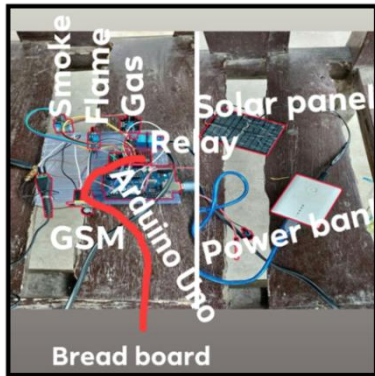


Figure 10. FireDozzer's IoT Components

Figure 10 displays the initial prototype of the study. It has three sensors such as mq6 gas sensor, mq2 smoke sensor, and flame sensor. The power of the GSM module and Arduino Uno is through the power bank, in which the power bank is connected to the solar panel to have a significant power source to supply the two IoT components. Furthermore, the GSM module links the relay and the water sprinkler. The relay holds the on and off operation of the water sprinkler. LED and buzzer are also incorporated into the prototype system for audio and visual signals and SMS text to notify the home occupant further.

Figure 11 presents the testing of the flame sensor's responsiveness and the mobile application's fire notification. A flame sensor is designed to detect a flame or fire and activate fire alarm systems to address fire emergencies. Aside from the LED and buzzer installed in the system, the home occupant will also receive a

notification through the mobile application and an SMS text to further the occupant's awareness whenever a fire emergency arises. Hence, the researchers found that the flame sensor's sensitivity can be modified through the Arduino code.

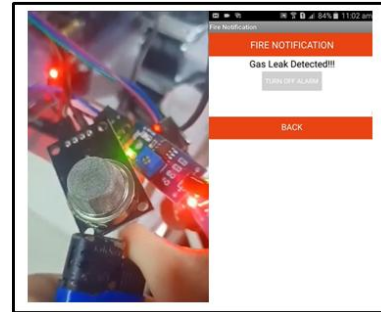


Figure 11. Testing of Flame Sensor
(video reference:

https://drive.google.com/file/d/1jdY5FNY7Ced_TRW71mxdi59557CPt6F8/view?usp=sharing)

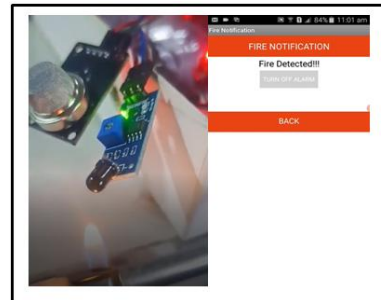


Figure 12. Testing of the MQ6 Gas Sensor
(video reference:

<https://drive.google.com/file/d/1smS7reMN9PUKyrVboBz-ufQC2Ejipqcp/view?usp=sharing>)

The MQ6 gas sensor detects liquefied petroleum gas (LPG) leaks. The researchers decided to incorporate this sensor in the system because it is one of the dangerous flammable substances at home. Hence, the researchers found out that the gas sensor is consistent in detecting LPG leaks, allowing it to be an effective fire prevention tool to reduce the risks of fatal accidents that affect the property and the people living in it.



Figure 13. Testing of the MQ2 Smoke Sensor
(video reference:

<https://drive.google.com/file/d/1tdIvfdkQvfaI0ID151Yx57TPE0DM9cTS/view?usp=sharing>)

While testing the smoke sensor, the researchers found out that when the smoke sensor is used consistently without cleaning the anti-explosion network, it will continuously detect smoke even without its presence. The researchers ensured that before using the sensor again, the AEN is already clean to maximize the effectiveness of the Mq2 smoke sensor. The mobile application will also display a notification whenever the sensor detects smoke.



Figure 14. Testing of the Manual Water Sprinkler
(video reference:

<https://drive.google.com/file/d/1lxeq6OGBJKhh7J9aMdo1xRH-HOnwRKMd/view?usp=sharing>)

The relay controls the on and off function of the water sprinkler through the mobile application. When the researchers tested the water sprinkler, it was found that the GSM signal would affect the sprinkler's responsiveness. For example, if the GSM has a poor signal, the water sprinkler will take a while to produce water, but the water will quickly supply the

sprinkler head to generate water if the GSM has a good signal. In addition, when the household's water source has low pressure, the system's sprinkler will only have a small amount of water to produce.

Evaluation with users

The researchers presented the prototype to the capstone panellists via video and live demonstrations. An in-depth evaluation was made to analyse the functionalities of the system prototype, answering questions such as, what does it do, how will it respond when a fire emergency occurs, discussing the mobile application's functionalities, and what is more needed to add in the system prototype. Recommendations and opinions were exchanged between the researchers, capstone adviser, and capstone panellist. Deliberation was made between the capstone panellists. The study was accepted at the end of the presentation with minor revisions on the system prototype and documentation. The final recommendation of the panellists is non-stop notification, automatic sprinkler, a presentable package of the prototype, comprehensive test cases, five trials for each test case, proofread the document, including a storyboard, and include the test cases

Refine prototype

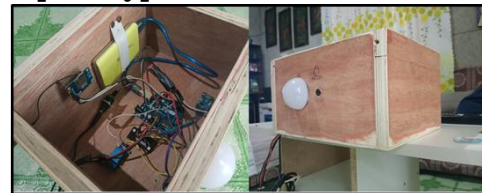


Figure 15. FireDozzer's Refined Prototype

The illustration above illustrates the final prototype of the study. The left picture is the IoT component of the study. It is responsible for processing the detection, water sprinkler, mobile application, and SMS text. The right picture is the LED and buzzer. It was incorporated in the box for convenient testing. The researchers successfully modified the device again to fit the panel's recommendation. Several testing were made to ensure that the

prototype was working accordingly before conducting the test cases.

Feedback

The researchers were able to edit the document using Grammarly, the software that can identify grammatical errors and misspellings. Moreover, the system prototype was re-cabled inside the box. The researchers successfully modified the document and system prototype again, using the capstone panellist recommendations as a guide towards completing the study.

Final product and test cases

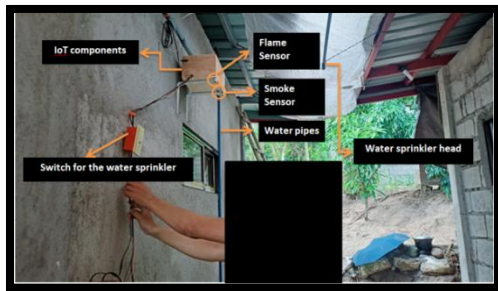


Figure 16. Installation of the FireDozzer's Prototype

The illustration above is the installation of the FireDozzer in the dirty kitchen. The box was placed right at the top of the stove with two braces to support it. The flame sensor and mq2 smoke sensor were also situated at the bottom of the box with the LED and buzzer. Water pipes and the water sprinkler head are placed accordingly, and the water switch is stationed near the FireDozzer's prototype to avoid damping it. See Appendix A for better and more angles of the system prototype.



Figure 17. Manual Water Sprinkler and Switch
(video reference:

https://drive.google.com/file/d/1rPzG1qzLdb5QyyG6QdgG2H0LtrP_reCi/view?usp=sharing)

The picture shown above is the manual operation of the water sprinkler through the mobile application. When the user clicks on the button of the water sprinkler the relay will process the command and the sprinkler head will generate water. Then the mobile application will return a notification (e.g water sprinkler is activated or water sprinkler is deactivated.), the switch was incorporated into the system prototype so that whenever the automatic water sprinkler is triggered the home occupant can turn it off through the switch if the user's cellphone is not around. For example, the home occupant invited some friends over for a Christmas party. He, then, can turn off the switch so that whenever the sensors are triggered the automatic water sprinkler will not stimulate. See Appendix B.



Figure 18. Gas Sensor and Notification
(video reference:

<https://drive.google.com/file/d/1cHPGkNFRSpGhChCtss2U01TYEG4rpKzj/view?usp=sharing>)

The picture shown above is the Mq6 gas sensor and notification testing. The researchers used the household's LPG tank to get an accurate system prototype. It was found that the distance between the gas sensor and the LPG tank affects the detection speed. The researchers recommend placing the gas sensor as near as possible to the LPG tank. While conducting the test cases, the researchers always get an accurate result from the gas sensor. It only shows that the system prototype is an effective safety measure to reduce the risk of fatal accidents at home. See Appendix C.



Figure 19. Flame Sensor and Automatic Water Sprinkler

(video reference:

https://drive.google.com/file/d/12IL_tTNXvkGQ-whbeJMeA2ZRR8kMqsTU/view?usp=sharing)

Figure 19 shows the testing of the flame sensor and how the mobile application will respond once the sensor detects the fire. If the user didn't turn off the fire notification in the mobile application in two minutes and thirty seconds the water sprinkler will automatically turn on. But if the user interacts with the mobile application and turns off the notification before the specific time length the water sprinkler will not stimulate anymore. The prototype will also send an SMS text to the user's contact number (e.g fire detected, water sprinkler activated, water sprinkler deactivated). See Appendix D.



Figure 20. Smoke Sensor and Automatic Water Sprinkler

(video reference:

<https://drive.google.com/file/d/1g2LWjLyPjIh9cqzXkPcjoL5UBwZzfPrW/view?usp=sharing>)

The figure shown above is the actual testing of the smoke sensor and automatic water sprinkler. The concept of this substance is the same as the flame sensor. Once the mq2 smoke sensor detects smoke, the counter on the Arduino code will already be set off. If the user did not turn off the notification in the given time frame, the water sprinkler would turn on. But if the user turns off the notification before the time length, the water sprinkler will remain

off. The researchers found that the smoke sensor's sensitivity can be modified between 150 – 1000 ppm. The lower the ppm, the sensitive the smoke sensor is, but the higher it is, the less sensitivity. See Appendix E.

Functionality Test Cases Results of FireDozzer Prototype

Test Cases Results Prototype

Table 1. Functionality Test Cases Results of FireDozzer Prototype

No. of trials for each prototype testing = 5

HARDWARE	YES	NO
Category/Characteristics = Functional Suitability	5	0
Does the mq2 smoke sensor work?	5	0
Does the mq6 gas sensor work?	5	0
Does the flame sensor work?	5	0
Does the manual water sprinkler work?	5	0
Does the automatic water sprinkler work?	5	0
Does the switch for the water sprinkler work?	5	0
Does the solar panel and power bank provide a power source to the Arduino and GSM module?	5	0

The table shows the test cases of each functionality of the system prototype. Remember that each hardware functionality is tested five times to ensure that the IoT components are working accordingly. While conducting the test cases, the researchers found out that the water sprinkler will depend on how intense the household's water pressure is. In the end, the researcher's dirty kitchen set-up has good water pressure to support the water sprinkler system. The sprinkler can be either activated through a manual or automatic operation. The manual operation can be done through the turn-on button on the mobile

application. At the same time, the automatic operation is done when the specific time length is over. Note that the researchers tested the automatic operation through the three sensors. The switch also gave an accurate result when testing the manual water sprinkler. It was tested five times to ensure that it gave the expected outcome.

The three sensors, including the mq2 smoke sensor, mq6 gas sensor, and flame sensor consistency, were captured and achieved through recorded videos. The researchers screenshot some of the test cases for presentation and documentation purposes. Note that the testing of the three sensors was done intentionally by making fire, smoke, and using the household's LPG tank. After conducting five trials for each sensor, the system's core functionalities were working correctly. However, there are cases that some of the jumper wires are getting disconnected to the IoT components causing the system prototype to malfunction. But the researchers used packing tape to secure the wires to the IoT components before installing the FireDozzer in the dirty kitchen.

The researchers found that the solar panel and power bank give enough power sources to the Arduino and GSM modules. The solar panel was already placed on the household roof while conducting the test cases for the three sensors and water sprinklers. After conducting all the necessary test cases, it was discovered that the system prototype achieved all the recommendations and objectives of the study.



Figure 21. Smoke Detection Test Cases with the Invited Neighbor (Respondents)

Test Cases Results from Mobile Application User Interface

Table 2. Functionality Test Cases Results for Mobile Application User Interface

No. of trials for each prototype testing = 5

UI TEST CASES	YES	NO
Category/Characteristics = Functional Suitability	5	0
Is the mobile application displays fire, smoke, and gas notification?	5	0
Is the mobile application turn the on and off buttons for the manual water sprinkler working?	5	0
Is the fire notification turn off button working?	5	0
Is the user able to receive the SMS text?	5	0
Is the time frame on the mobile application code working?	5	0

The table shown is the test cases to verify the functionalities of the mobile application. Five trials are made for each test case to ensure that the mobile application responds according to its corresponding features. Upon detecting substances like fire, smoke, and gas leak the application displays the proper notification. It will keep displaying the notification until the user sees it. The fire notification turn-off button also works effectively, when the user clicks it before the time frame, the automatic water sprinkler would not stimulate. Furthermore, the researchers intentionally did not turn off the notification upon the detection to show the length of time parameter. The two minutes and thirty seconds time frame was also achieved, it was tested five times to ensure that it works properly.

The researchers also verified the functionality of the manual water sprinkler button. Upon turning it on, the sprinkler correctly responds to it, and when the user turns it off, the mobile application acknowledges the command. On top of that, the SMS text is also consistent in sending fire notifications. Note that it also

sends a notification whenever the water sprinkler is activated or deactivated. Eventually, by conducting consistent test cases, the researchers were able to verify the effectiveness and capabilities of the mobile application.



Figure 22. Flame Detection Test Case with the Invited Neighbour

Table 3. Usability Test Cases Results of FireDozzer

SYSTEM FEATURE	YES	NO
Category/Characteristics = Usability		
Is the mobile application easy to understand?		
Is the system easy to maintain?		
Is the system easy to operate?		
Is the mobile application user interface appealing?		

Table 3 shows the usability of the system prototype. The researchers ensure that the FireDozzer mobile application is easy to use without constant confusion from the user. Aside from it being easy to use, the application was also designed to appeal to the user. The mobile application developer of the group included pictures, an appealing colour palette, readable context, and minimalist buttons to keep it simple and easy to operate. Although the application is simple and easy to use, the researchers ensure that it performs effectively. Table 4. Reliability Test Cases Results of FireDozzer

EXPECTED RESULTS	YES	NO

Category/Characteristics = Reliability		
The mobile application should display fire notifications upon the detection of the sensors.		
The system should be consistent in sending SMS texts to the home occupant.		
The manual water sprinkler should turn on and off when the user commands it.		
The automatic water sprinkler should be operating when the time frame is over.		

The table displays the reliability of the system prototype. Note that the researchers conducted twenty test cases to prove that the system is working properly. While conducting the test cases, the notification from the mobile application always displays the substance detected from the three sensors. Furthermore, the user will also receive the SMS text upon obtaining the notification from the application. The manual operation of the water sprinkler also works consistently whenever the user commands it. While the automatic water sprinkler will be activated after the time frame declared by the researchers in the Arduino code. It was found that it also works consistently and effectively after trying it five times.



Figure 23. Mobile Application and SMS Text Test Cases Results

DISCUSSIONS

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

FireDozzer: An Arduino Based Home and Kitchen Fire Prevention Device with Smoke and Gas Leak Detection.

Summary of Findings

To complete a fire prevention device, a specific set of IoT components to use and to analyze deeply must be identified as to how it can contribute to the overall functionality of the system prototype. For example, at the beginning of Capstone 1, the researchers purchased the water sprinkler without reading the requirements. Confidently incorporating the water sprinkler into the system prototype and attempting to trigger it using the mobile application, the sprinkler only produced an inadequate amount of water (e.g., sipping water from a bottle). The researchers then discovered that the water sprinkler is used for aquariums, specifically for fishes to get enough oxygen using the sprinkler. Incorporating this component into the system prototype will not effectively address first-aid rescue at home. Nonetheless, the researchers could purchase the right water sprinkler to incorporate into the system prototype.

The mobile application developer of the group successfully links the application and prototype through the GSM module. Through the MIT App Inventor in designing and constructing the codes, the FireDozzer's application was made to operate efficiently. The researchers considered maximizing the use of the GSM module in the system prototype. Not only is it the link between the application and prototype, but it is also a way to send an SMS text to the home occupant's cell phone number. After conducting the test cases, the researchers learned that integrating the module into the prototype is an effective method to notify the user upon detecting the sensors.

To successfully achieve the objectives of the system prototype, the researchers made a lot of trial-and-error processes to verify its consistency. Some of the errors encountered by the researchers are mostly from the connectivity of the jumper wires to the IoT components. It was found out that this kind of

wire does not have an excellent grip to keep it connected to the modules. There are two ways to solve this issue: either tape or soldering it to the component. The researchers decided to use packing tape to secure the wires because soldering may cause many issues instead of minimizing the errors. The initial system prototype seems to be working correctly based on the test case results. It only shows that the method used by the researchers is effective.

When the researchers presented the system prototype to the capstone panellist, it was found that the initial FireDozzer prototype met the recommendations and objectives of the study. The researchers were able to achieve the core functionalities of the system prototype, which underwent a series of test cases to prove the consistency and effectiveness of the FireDozzer. After the presentation of the group, the panellist accepted the study with minor revisions. Making the water sprinkler automated was one of the recommendations on the system prototype. It was revealed that it is also an effective way to address first-aid rescue at home.

After the evaluation with users and getting all the panellist's recommendation, the researchers modified the system. It was exposed that refining the prototype to make it more an effective fire prevention device is a good recommendation. Furthermore, while conducting the test cases, the researchers discovered quickly that the home occupant interacts on the mobile application during fire emergencies, the immediate action to aid the emergency, and the quickly to aware the user. In times of fire emergencies, a prototype like the FireDozzer is essential to install because it helps minimize the casualties brought by fire accidents.

Feedback

The researchers found that the capstone panellists' feedback is essential because it aims to address the lacking areas of the study in general. The researchers tend to miss small details that need to be considered to make the study presentable for future researchers.

Final Product

While installing the prototype in the dirty kitchen, it was found that it is easier to install it when the IoT components, except the three sensors, are placed in a box. Aside from it being organized and clean-looking, it is much more convenient and efficient for the researchers to install it. Each functionality of the system prototype was tested five times to ensure that it worked consistently. The researchers learned that it is also important to have a two-way street relationship between the user and the system. The more the user interacts with the system, the more immediate it is to notify the user. Nonetheless, the system prototype has an automated water sprinkler to aid the fire emergency when the user did not interact with the fire notification. It will still play a role in minimizing fire accidents at home.

Conclusion

The researchers used test cases with the ISO 25010 criteria to test the system prototype and mobile application functionalities. Based on the results of the test cases, both are working correctly. Furthermore, there are twenty trials conducted, five trials for each of the system functionality. The following conclusions are anchored on the objectives of the study:

The researchers were able to identify the requirements needed to construct a fire prevention device. The gathered related literature and studies were used to deepen the researchers' knowledge to help construct the FireDozzer system.

The researchers were able to design a working mobile application with the use of MIT App Inventor. It notifies the user whenever there is a detection from the three sensors. It also allows the user to operate the water sprinkler manually using the on and off buttons.

The researchers were able to build the initial prototype of the study. The system core functionalities are achieved including, fire notification, SMS text, power source from the solar panel, and manually operated water sprinkler.

The researchers conducted a series of test cases to ensure that the initial system prototype worked correctly. Based on the results, all IoT components integrated into the system prototype are performing effectively.

The researchers could modify the system again aligned with the capstone panellists' recommendations. The automated water sprinkler was also incorporated into the system prototype. When the home occupant did not turn off the fire notification in two minutes and thirty seconds, the water sprinkler will automatically turn on.

The researchers were able to include the additional recommendations from the panellist in both the system prototype and document.

The researchers were able to install the complete package of the FireDozzer system in a dirty kitchen setup. It allows the capstone panellists to correctly see the system in a real-life setup.

Recommendations

The following are the recommendations to improve the developed FireDozzer system prototype:

- Create another mobile application to notify the firefighters following the proper protocols when the system can contact them.
- Include a database on the firefighter's mobile application that will allow them to see the location and information of the home occupants.
- Use another type of solar panel to extend the redundant power source in each of the IoT components used and will be used in the system prototype.

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GALLINIS-TERRAMATIC: Automation of Food and Waste Disposal Monitoring System for Broilers

Alvira Lyn Ferrer
Mary Jean Galo
Kenneth Bruce Grospe
Naomie Martin Sanita
Vergel Sengseng
Frederick D. Santos (Technical Adviser)

ABSTRACT

The researchers created the "Gallinis-terramatic" automated poultry monitoring system which includes two ultrasonic sensors and a temperature sensor. In addition to monitoring humidity and temperature, feed and water status, and waste disposal, a mobile application that allows users to use their smartphones to manually operate the water spray intended to turn on the cooling system and clean the chicken's waste was also developed. The temperature, humidity, water level, and feed condition are all displayed in real time through the mobile application. It is necessary to start the cooling system which consists of a water spray as soon as the temperature hits 30.5 degrees Celsius. Furthermore, the manual water spray is equipped with on and off controls, allowing users to regulate when the spray is activated, and when it is turned off. In the mobile application and system prototype, there are a number of test cases that have been completed. The researchers conducted ten trials for each functionality to check if the device met the objectives and the requirements of the system. The Gallinis-terramatic prototype and associated mobile application were developed by the researchers with the use of a prototyping model as a guide.

CCS Concepts: • Computer systems organization → Embedded systems; Internet of Things • Mobile Application Development → Android Application

General Terms: Design, Performance

INTRODUCTION

In today's society, it is impossible not to find something unautomated. The dictionary defines automation as "the technique of making an apparatus, a process, or a system operate automatically." [1]. The main objective of automation in the industry is to reduce the influence of humans in technologies and increase production speed and quality.

When people think of automation and technology, the terms "chickens and turkeys" do not usually come to mind. On the other hand, the poultry business constantly employs innovative technologies to increase animal welfare and environmental sustainability [2].

Poultry is a term that refers to birds that have been raised to breed and grow in cages that have turned into commercially valuable items. Chickens, turkeys, ducks, quail, and

pheasants meet the above criteria. According to a study conducted by Navaneeth (2015), customers' demand for chicken products continues to rise, necessitating the need for small and medium-scale poultry farmers to meet that need as farmers supply the vast majority of the market's requirements, particularly in developing countries. There is a need to produce chickens that meet the market standards in the shortest amount of time possible without burdening the poulterers' time and resources. An attempt was made in this project to create a time-saving, automatically controlled feeder, drinker, and waste cleaner that will maximize poultry monitoring [3].

In large-scale poultries, automatic equipment is used to feed the chickens. However, incorporating small-scale equipment into medium-to large-scale rooster operations is hard or now no longer possible. Farmers in city areas generally perform medium and large-scale poultry. Chickens are fed with a feeder which necessitates regular refilling of food in medium and large-scale poultry operations. This consumes a whole lot of time and exertions from the poulterers. It was proposed

to layout and assemble an automated meal and waste tracking device to make feeding chickens in small-scale poultry operations less complicated and extra effective [4].

According to Johnson (2019), all living things need water, and its use by humans and livestock must be sustainable and responsible. Water consumption can be considered an ideal trait in chicken broilers. Broiler water intake efficiency encourages broiler production sustainability by influencing energy (ventilation) and water usage and maximizes broiler health, welfare, and production. The water monitoring system does not only act as the broiler's drink but also as a helpful way of cleaning chickens' wastes [3].

Due to chickens' high sensitivity to temperature change, extreme weather conditions in tropical regions of the world have proved to be generally detrimental to livestock development. One of the main factors that poultry owners are concerned about is the chickens' health and development. Other than food and water consumption, environmental temperatures are the most common factors that harm the health of poultry [3].

As stated in Chicken Cage (2019), if you plan to operate a poultry farm and keep chickens or if you are already in the business, you have probably found that the manure and feces removal method is one of the most time-consuming and unsanitary tasks to do. Cleaning time and costs may be reduced and improved work quality by creating an automatic waste disposal monitoring system [3].

Poultry automation will save time, effort, and workforce. In poultry production, efficient feeding and waste monitoring are necessary. Gallinis-Terramatic, a device with an application, automates the feeding, watering, temperature, and waste monitoring system. This project uses hardware components such as an Arduino to ensure that the functions run smoothly with high accuracy.

Background of the study

In today's poultry industry, high production and excellent quality at a low cost are the top priority. When looking at the agricultural side of some provincial areas in the Philippines, it is clear that there are many poultry enterprises

with at least 500 to 1000 chickens in a single cage.

Furthermore, since poultry farming has become an essential part of the life of Filipinos in rural areas, some birds are raised in backyards to give a considerable quantity of meat and eggs. It is necessary to provide animals with the right commercial food and a clean and sufficient water supply. When it comes to feeding chickens nowadays, however, the utilization of modern technologies has overtaken the old-fashioned practice of filling containers with grain, feed, and water manually [5].

Good quality feed, either homegrown or purchased from a trusted source, should be provided to the chicks. According to PinoyBisnesIdea (December, 2020), intermittently fed chicks are more efficient at utilizing their nutrients. Feed troughs should not be left empty for more than 1-2 hours at a time. During the first few days, vitamins, minerals, and antibiotic supplements can be added to the drinking water to help the body recover. In addition, always check to ensure that feed and freshwater are always readily available to animals [7]. To acquire these qualities, the poultry owner should breed chicks to ensure chickens are ready for slaughter. Also, proper food management is required to create healthy chicks.

As with other poultry farms, the researchers' asked local poultry owners about the common concerns or issues that the broilers are experiencing: failing to reach the desired weight by the date of harvest, the number of chick deaths is increasing, and chickens are susceptible to a variety of diseases and health problems including respiratory disease and stress caused by heat, crowded space, and noise. Inappropriate sanitation and waste management practices can cause sickness in individuals who work on poultry farms if farmers inhale bacteria from the hens' feces. Salmonella and Campylobacter are two common public health threats that can be transferred by contact with chickens. These bacteria are carried by healthy chickens and can be transmitted to people through close contact or exposure to excrement. Diarrhea, vomiting, fever, and aandal cramps are symptoms of infection [6].

The most challenging aspect of using this strategy is the requirement to feed food constantly to be awake and aware of the amount of food remaining in the cages. The feeds and water levels given to the chicks should be calculated accurately even if the temperature or the poultry owner will not achieve the targeted or ideal weight of the broilers. They could even get illness for lack of water. It is also difficult to tell whether or not the amount of food offered is sufficient. It is a complete waste of time and resources not to mention being uneconomical. Growers also find it difficult to successfully manage operations because growers must spend a significant amount of time near the cages to monitor the birds.

The poultry industry's growth will be helped by an IoT-based system that maximizes productivity and effectiveness in producing a high-quality product. Gallinis-terramatic uses an IOT-based system to support broiler chickens' food feeders and water drinkers. The system can keep the right amount of food, water, temperature, and sanitation in the chicken house.

Objectives of the study

The general objective of this study is to develop a smart device intended for broilers. This device will save time, effort, and workforce and make poultry production more efficient in feeding, drinking, humidity, and waste management. The following are the specific objectives of this study:

User Interface

- Create a mobile application using the following software and tools:
 - Gallinis-terramatic was developed with the help of the MIT App Inventor V2, which the researchers used. It allows the developer to create applications for Android phones using a web browser and either an actual phone or an emulator connected to the computer.
 - The researchers used Adobe photoshop 2019 in creating the logo of Gallinis-Terramatic, which can be seen on the Mobile Application.
 - Monitoring Dashboard

- Humidity Output
- Temperature Output
- Water Status Output
- Feed Status Output
- Waste Monitoring
- Manual Control
- Manual Feeding
- Manual Watering
- Manual Waste Cleaning
- Create a prototype using the following software and tools:
 - The researchers used Arduino IDE to write code, compile the code to check any errors, and upload the code to the Arduino.
 - The developer used the C++ programming language to modify the components used in developing the Gallinis-Terramatic prototype.
- Create a prototype that automates the following:
 - Automatically activates the cooling system.
 - Automatically wash the chicken waste.
 - Automatically starts feeding the chickens.
 - Automatically detects water status when the water container.
- Create an IoT device using the following tools:
 - Arduino Microcontroller
 - Arduino Modules
 - Hardware:
- Create a poultry platform.
- Create a hardware and software prototype.
- Evaluate the prototype and mobile application functionalities using test cases.

Scope and limitations of the study

In chicken broilers, it is essential to ensure that all birds have unrestricted access to water for them to drink freely. The age of the broiler determines the recommended flow rates for nipple drinkers. If the broiler is 14 to 21 days old, the appropriate water flow rate is 80 milliliters per minute.

The chick's age determines the amount of standard feed used by broilers. Assuming the broiler is between weeks 1 and 4, the broiler

can ingest 0.167kg and 0.945kg. The broiler chicken birds spend around 6% of their time drinking and feeding.

For the first four weeks of a chicken's life known as the brooding stage, 36 square meters of floor area is required to rear 100 broiler chicks effectively. Depending on the materials chosen, the brooding house for 100 broiler chicks could be 9m by 4m or 12m by 3m in size.

The study covers the development of Gallinis-terramatic. The prototype includes a mobile application that was created with the help of MIT APP Inventor and Photoshop. The mobile application has five (5) different monitoring parameters including the status of the humidity and temperature, the feed and water, and waste disposal.

The controlling capability of the proposed IoT device is to activate its monitoring parameters. When the cage hits 30.5°C or higher, the cooling system with a water spray is automatically triggered. It will wash the chicken feces automatically when there is a lot on the ground. It will automatically feed the chicks in the morning and night. It will automatically recognize when the water container is full or when the water level in the container exceeds the critical level.

A monitoring system for eggs and an automatic distribution of vitamins for the broilers were not included because of design constraints. The system only allows Android devices to be used to control the device. With the help of a Microcontroller and other tools, the device is only suitable for use by poultry personnel. The project will keep track of the status of feeds, water volume, cage temperature, and poultry waste.

SYSTEM DEVELOPMENT METHODOLOGY

This section contains the methodology and design to explain the parameters and process for the development of the study. The theoretical methods and diagrams were also added to explain the function and complement the process flow.

The research design used for this study was the prototype model. Prototyping methodology enables the prototype to be developed, tested, and improved until acceptable. This method was utilized by the

researchers to study Gallinis-Terramatic, and it provided precise information on the system's operation. The figure below illustrates the aforementioned design model. The processes necessary to achieve the final product are depicted in Figure 15.

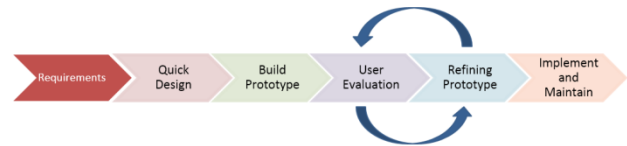


Figure1. Prototype Model for Gallinis-terramatic

(Source:

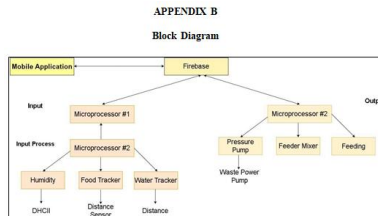
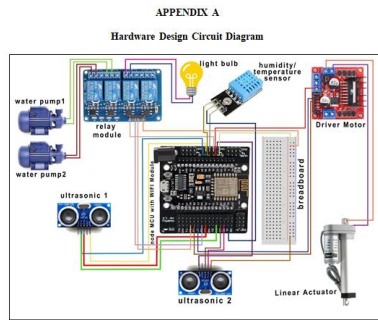
<https://www.theengineeringprojects.com/2021/05/what-is-prototyping-meaning-types-process-tools-and-examples.html>)

Requirements gathering and analysis

A requirement analysis is the first step in developing a prototyping model. The system's requirements are defined in detail during this phase. Users of the system are interviewed as part of the process to determine what the users expect from it. The researchers were able to put their knowledge from the related literature and studies to use. Similarly, after gathering concepts and ideas from related studies, the researcher came to the conclusion that an additional mobile application interface was required. The researchers discovered that the MIT APP creator, who is a mobile application developer, was a good candidate for user interface creation after brainstorming and reflecting on previous lessons learned. The researchers were able to create their own prototype design with the assistance of the technical adviser in terms of electronics technology and electrical knowledge as part of the study. Finally, the system's software and hardware requirements were established.

Quick Design

The second phase is a preliminary design or a quick design. A simple system design is created at this stage. It is, however, not a complete design. It gives the user a quick overview of the system. The prototype development is helped by the quick design. Please refer to the storyboard in appendix E for the interface application development plan, while appendix F will show the initial design concept of the prototype.



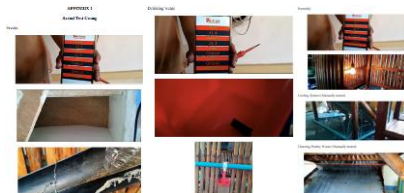
Build a Prototype

This phase utilizes the data acquired during quick design to develop an actual prototype. It is a small working model of the required system. The researchers investigated two different motors: a water pump motor and a linear motor as a starting point. After this evaluation, the researchers discovered that the function of the linear motor was simple to operate and ideal for opening and closing the feeder container of the prototype. Detection of the feed status within the cage is achieved by the ultrasonic sensor. In addition, an ultrasonic sensor which is attached to the water storage is capable of detecting the status of water contained within the cage itself. A direct effect of this discovery was that researchers discovered that the ultrasonic sensor may be adjusted using code from the Arduino software. Through the use of the humidity sensor, users can detect and measure changes in humidity levels in the environment.

Water Pump 	This removes bird feces. Opening at 06:00, 12:30 and 06:00 to wash the birds' feces. The researchers believe they cannot determine hen poop. Even around lunchtime, there is often a lot of feces on the ground. In this situation, start the water pump manually. This water pump also triggers the cooling sprinkler.
Linear Actuator 	It is either a rotary actuator or a linear actuator that allows the user to regulate the angular position of the actuator before using it. It is capable of opening the passage for food of the chickens, and it also automatically closes the passage once enough food is distributed.
Humidity and Temperature Sensor 	The humidity sensor measures and tracks the environmental humidity. The water spray cooling system is activated when the temperature hits 30.5°C. As soon as the temperature dips below 22.5°C, the cage's light bulb automatically opens to let in heat.
Ultrasonic Sensor 	The ultrasonic sensors detect the feed and water status of the container if it reaches a critical level (6 inches), average level (10 inches), and safe level (16 inches).

Initial user evaluation

This stage included the mobile application and prototype test cases which were done or responded to in order to ensure that the functionalities of the prototype and mobile application user interfaces were met. The evaluation with users' phase is where the initial prototype development is completed, and it is during this phase, the prototype is presented to the capstone panelists. After the presentation, an evaluation was performed between the researchers, the capstone adviser, and the panelists in attendance. Further discussion was held about the additional requirement for a system prototype and documentation to improve the device.



Refining prototype

Once the particular requirements of the user have been completed, this phase will also be considered complete. If the user is unsatisfied

with the prototype, it must be improved depending on the feedback and recommendations received from the user. During this step, the researchers test the hardware to identify any faults, mistakes, or application failures that may have occurred. The proponents revise and reassemble the program in order to reduce the number of defaults that have been detected and, if applicable, to incorporate the user's thoughts. The researchers made changes to the initial device in order to include all of the recommendations given by the panelists. The group's developer made changes to the source codes of the initial device to accommodate the new features of the system prototype. The researchers agreed to keep each other informed about the progress of the prototype. The group did all of the necessary testing to ensure that the device was consistent, and they provided an update to the capstone adviser. During the process of assessing the device, errors began to show up, leading it to function in an inconsistent manner. The researchers noted everything from IoT components to coding that was causing the issues. Even if the team found it difficult to identify and fix problems because of the complicated features of the prototype's design, the research continued, and continuous teamwork has made the automation of poultry monitoring achievable.

APPENDIX G

Initial Design



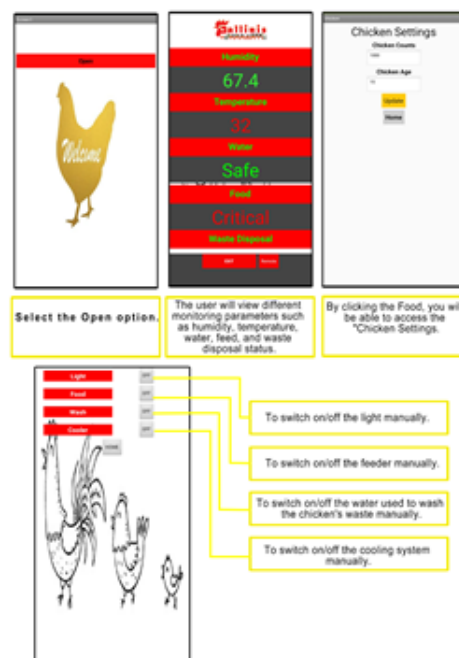
Implement Product and Maintain

After it has been developed on the basis of the final prototype, the final system is thoroughly tested and then put into service in production. Routine maintenance is performed on the system regularly to prevent system delays and the likelihood of significant malfunctions.

Because the development of a prototype is limited to the final presentation to the panelists, it is not worth wasting time. The scope of the study does not include product implementation or maintenance. However, for the purposes of this discussion, this stage has already been discussed.

APPENDIX F

Users' Manual



Final Product

The researchers created a working prototype after completing the preceding steps and several initial evaluation repetitions. The researchers organized the system to show how it performs in a clear and concise manner. The system was placed inside the cage that the researchers had constructed. The researchers conducted a series of test cases to prove that all of the system's functionalities are working. Product development has finally been accomplished. The final mobile application interface and prototype products are described in detail in appendices E and G.

APPENDIX H

Final Design



RESULTS AND OUTCOMES

The majority of the information required on the efficient and exact components that were used to design and develop a reliable and user-friendly automated food and waste disposal Monitoring system for broilers was found on the internet or through other sources. The development of a manual control allows the system to function in accordance with the wishes of the user such as manual feeding and manual watering for example. Developing an Internet of Things device that automates the cooling system, feeding system, water level detection system, and waste disposal system necessitates the use of precise and efficient components to develop an automated sub-system that functions as intended by the researchers. Developing a mobile application with the help of the following software (Arduino IDE, C++, MIT app Inventor V.2, and Adobe Photoshop CC 2019) results in a logical combination of software tools critical to developing a mobile application as demonstrated in the following video. The instruments that are used to create an Internet of Things device are the instruments that necessitate the possession of appropriate knowledge and skills by the researchers.

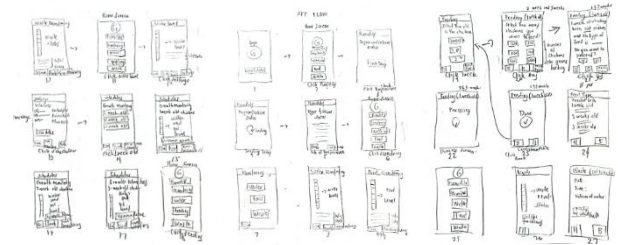


Figure 2. Mobile Application User Interface

The user interface of the Gallinis-terramatic mobile application is shown in the figure above. The first screen of the application displays the application's welcoming page. The second screen shows several monitoring parameters including humidity, temperature, water, food, and waste. The first screen displays the current time. Except for the water, all of the monitoring parameters are clickable. The third screen has the chicken settings which allow the user to specify the age of the specific chicken and the number of chickens in the cage.

The researchers developed an automated poultry monitoring system that was in accordance with the panel's recommendations and the study's objectives. As soon as the developer finished developing the system's main functionalities, the other members went through a series of tests to ensure that the device was functioning properly and effectively as intended. Refer to the figures below for more information on the system prototype and testing process.

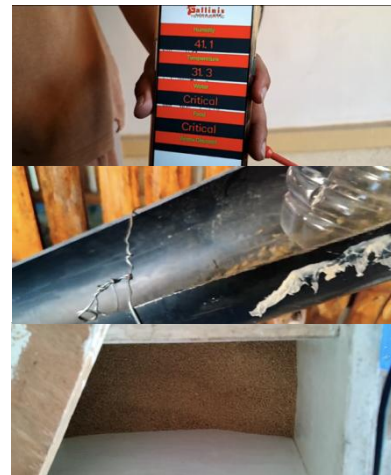


Figure 3. Testing of the Feeder

Tests were conducted on the feeder as shown in Figure 17. The feeder is intended for the purpose of feeding the chickens. A feed storage and a linear actuator are included. The actuator is capable of opening the passage to allow food to reach the chickens as well as automatically closing the passage once the chickens have received enough food. The ultrasonic sensor can detect the feed status inside the cage. When the feed level within the storage hits 16 inches, it is at safe level. When the height is 10 inches, the level is average. When it reaches 6 inches, it is a critical level. As a result, the researchers discovered that the ultrasonic sensor can be modified through the Arduino code.

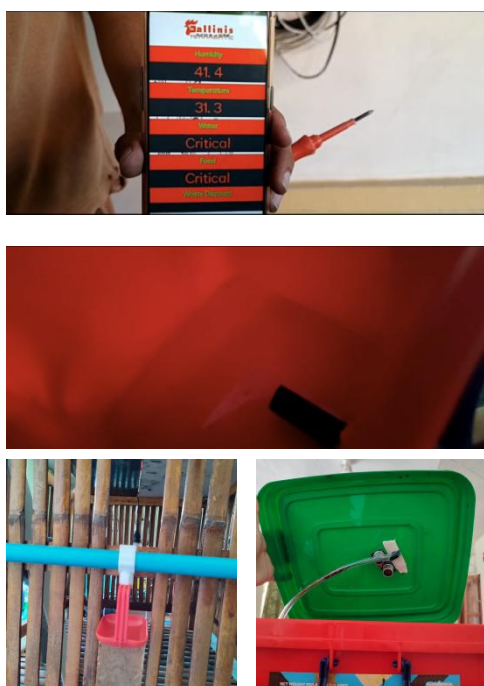


Figure 4. Testing the Water Drinker

Figure 18 presents the results of the chickens' testing of the water drinker. There is also a water storage container and a nipple drinker included. The ultrasonic sensor which is attached to the water storage tank can detect the status of water present within the cage itself. When the water level within the storage hits 16 inches, it is at a safe level. When the height is 10 inches, the level is average. When it reaches 6 inches, it is at a critical level.

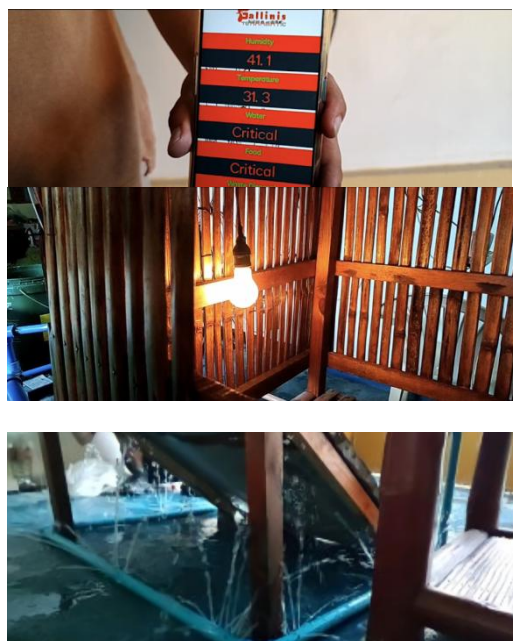


Figure 5. Testing the Humidity and Temperature

Figure 19 shows humidity and temperature testing. The humidity sensor detects and tracks humidity movement in the surrounding environment. When the maximum temperature of 30.5 degrees Celsius or higher is reached, the cooling system, the water spray, is activated immediately. The system can detect the temperature in real-time if the temperature drops to 22.5°C or lower. The light bulb inside the cage will automatically open to allow some heat in to neutralize the temperature and keep the chicken warm.



Figure 6. Testing the water washing the chicken's waste

Figure 20 shows how the water washed the chicken's wastes. This will spray water on the birds to clean and get rid of their poop. It will open at 6 a.m., 12 p.m., and 6 p.m. to wash the hens' waste. The researchers say they cannot tell when the hens will poop at any given time. Many times there is a lot of waste on the ground even though it is not yet 12

o'clock. In this case, you can turn on the water pump by yourself.

Development and Testing Results

Table 1. Functionality Test Cases Results for Gallinis-terramatic prototype

No. of trials for each prototype testing = 10

Category/Characteristics = Functional Suitability

Prototype Test Case	YES	NO
1. Does the water motor pump turn on when the temperature reaches 30.5°C and above?	10	0
2. Does the water motor pump turn off when the temperature is below 30.5°C?	10	0
3. Does the water pump activate when there is a lot of chicken manure inside the cage?	10	0
4. Does the humidity sensor display the accurate temperature inside the cage?	10	0
5. Does the LINEAR ACTUATOR activate to open the feeder to feed the chickens?	10	0

Testing the functionalities of the prototype submodules will be represented by the test cases shown in the table above. It should be noted that each of the function buttons was tested more than ten times to ensure that each prototype submodule performs in accordance with its intended function. After conducting preliminary tests on the prototype's functionality, it was discovered that the speed of Wi-Fi connectivity impacts how quickly the system responds.

The researchers discovered that the water spray submodule's water pump pressure is sufficient to distribute water throughout the chicken cage even though the water pipe is positioned below the cage. It should be noted that the water pump automatically activated the motor pump water supply when the researcher intentionally raised the temperature of the chicken cage's surface to a temperature value greater than forty degrees Celsius. The water pump stops from distributing water when the temperature is no longer 30.5 degrees and above.

When the poultry waste is being cleaned, the water pump is activated. It does not automatically identify waste when the container is full, but it does through the system's mobile application which allows for the cleaning of garbage to take place. Using the application, the user can press a button that will cause water to be released to clean up poultry waste. Water is released manually every morning and evening to clear the poultry waste, and this is done automatically as well.

The researchers found out that the linear actuator works appropriately. It can open the channel for the chickens' food and automatically close the tunnel once the chickens have had enough food. It can be manually controlled through the use of the mobile application precisely like the other functionality of the system. However, unlike the other functionalities of the system, the aforementioned feature automatically starts and stops on its own every morning and evening.

Prior to the development of the automated poultry system by the researchers, the production rate for chicken was approximately 70%. Following the installation of the developed system, the prosecution rate increased to 85-90 percent.

After completing the prototype wire connections and ensuring that the mechanisms were properly oriented, it was discovered that all of the modules responded in accordance with the user interface buttons and were found to be functional.

Table 2. Functionality Test Cases Results for Mobile Application User Interface

No. of trials for each prototype testing = 10

Category/Characteristics = Functional Suitability

Mobile Application User Interface Test Case	YES	NO
1. Does the mobile app UI display the water status?	10	0
2. Does the mobile app UI monitor the water level?	10	0
3. Does the mobile app UI activate the water pump (sprinkler) when the chicken's cage reaches the maximum temperature?	10	0
4. Does the mobile app UI set the	10	0

feed amount for the feeding system?		
5. Does the mobile app UI automatically increase the feeding system for its age?	10	0
Does the mobile app UI monitor the status of the feed?	10	0
Does the mobile app UI display the accurate temperature inside the cage?	10	0
Does the mobile app UI show the real-time monitoring system?	10	0

The test cases for the features of the mobile application interface are shown in the table above. For each test case, more than 10 trials were carried out to ensure that the hardware prototype responded in the manner dictated by the corresponding button. It should be noted that all buttons and screens operated in accordance with the system's design components and button placements.

The researchers were able to create a user interface for a mobile application that displays the water level in the tank whether it is safe or it is critical. In real time, the ultrasonic sensor detects and records the status of the water in the tank. As a result, the user interface of the mobile app displays the actual status of the water inside the tank. The water pump for the sprinkler will be engaged automatically when the cage reaches the maximum temperature, but it can also be activated manually using the mobile app's user interface.

The amount of food which may be manually set through the mobile app's user interface and that will be released per feeding will be determined by the number of hens in the cage. The number of feeds which will be manually updated and based on the age of the chickens in the cage and that will be supplied per feeding will automatically rise. The researchers rely on the age of the chickens to determine the amount of food that will be required as the chickens mature and expand.

It is possible to monitor the status of the feeds inside a container using ultrasonic sensors connected to a real-time database, and this information can be shown in the mobile app's user interface when the feeds are in a safe or critical condition.

The mobile app UI displays the accurate temperature and humidity inside the cage with the help of a humidity sensor which helps to monitor the humidity and temperature inside the cage. Because the data are saved in real-time in the database, the mobile app UI displays the accurate temperature and humidity inside the cage. All of the information gathered by the sensors are saved in real-time in a database that is accessible to the mobile app's user interface through the internet.

Finally, the user interface access test case was run ten times to ensure that the mobile application's security access was not compromised.

Water Pressurized Pump



This will pour water to clean and eliminate the feces from the birds. It will automatically open at six o'clock in the morning, twelve o'clock in the afternoon, and six o'clock in the evening to wash all of the hens' waste. According to the researchers, they were unable to predict when the hens would poop at any specific time. At times, even though it is not yet 12 o'clock, there is already a significant amount of waste on the ground. It is possible to turn on the water pump in this situation manually. These water pumps also function as the ones to release water from the sprinklers to cool the chicken's cage.

Feed Storage Level



In this case, the container's capacity is already determined. If the container reaches its maximum capacity, the light will turn green (12

inches). To convert the distance filtered data to % capacity, researchers shall employ an arithmetic solution to the problem. A yellow light will show when the food level reaches 2 inches, and it will show red when you need to refill the container, or the feed level reaches the critical level of the vessel.

Humidity and Temperature



The humidity detects and tracks the movement of humidity in the surrounding environment. As soon as the maximum temperature of 30.5 degrees Celsius or above is achieved, the cooling system which is the water spray is turned on immediately. The system can detect real-time temperature. If the temperature reaches 22.5°C or below, the light bulb inside the cage will automatically open to let in some heat to neutralize the temperature and for the chicken to not feel cold.

Drinker storage level



It will decide the amount of water that can be held in the container's capacity. When the container has reached its maximum capacity, the light will turn green (18.9 liters). The indicator light will become yellow if the water level in the container exceeds 12 liters. It will turn red if you need to refill the container, or if the water level surpasses the container's critical level.

Conditional Functioning



It is either a rotary actuator or a linear actuator that allows the user to regulate the angular position of the actuator before using it. It can open the passage for the food of the chickens and automatically closes the passage once enough food is distributed.

DISCUSSIONS

This section consists of the summary of findings, conclusions, and recommendations based on the results of the study GALLINIS-TERRAMATIC: Automation of Food and Waste Disposal Monitoring System for Broilers.

Summary of Findings

The phases of a prototyping methodology was followed by the researchers to achieve the prototype Gallinis-terramatic and mobile application integrated final product.

Requirements gathering and analysis

The researchers were able to use what they had learned from the related literature and studies. Similarly, the researchers concluded that an additional mobile application interface was required after gathering concepts and ideas from relevant studies. After brainstorming and reflecting on prior lessons learned, the researchers determined that the MIT APP creator, a mobile application developer, was a good option for user interface construction. The researchers were able to construct their own prototype design using the IoT components

that were incorporated into the system namely the Node MCU 8266 as well as with the support of the technical adviser in terms of electronics technology and electrical understanding as part of the study. Finally, the software and hardware requirements for the system were established.

Using the Node MCU ESP8266 module, the group's mobile application developer successfully links the application and prototype. MIT App Inventor was used to design and construct the programming for the Gallinis-terramatic application which was designed to be simple to use. The researchers investigated optimizing the use of the Node MCU ESP8266 module in the system prototype. It acts as a bridge between the application and the prototype. Following the completion of the test cases, the researchers discovered that adding the module in the prototype is an effective way to control the device via a mobile application.

The researcher investigated two different motors: a water pump motor and a linear motor. The researchers determined that the linear motor's function was easy to use and appropriate for opening and closing the prototype's feeding container. The ultrasonic sensor detects the feed status within the cage. An ultrasonic sensor attached to the water storage can also detect the status of the water within the cage. The researchers also discovered that the ultrasonic sensor can be modified using Arduino code. The humidity sensor detects and measures changes in the environment's humidity. The initial system prototype appears to be operational based on the test case findings.

The initial prototype development is completed during the evaluation with users phase, and the prototype is presented to the capstone panelists at this phase. When the researchers presented the capstone panelist the system prototype, they discovered that the initial Gallinis-terramatic prototype achieved the study's recommendations and objectives. The researchers were able to complete the requirements of the system prototype which was conducted to a series of test cases to demonstrate the functionality of Gallinis-terramatic. After the presentation, an evaluation was performed between the

researchers, the capstone adviser, and the panelists. The additional requirement for a system prototype and documentation to improve the device was discussed further.

It must be improved based on the user input and panelist recommendations. The researchers examine the device for flaws, errors, or application failures. Researchers revise and reassemble the program to reduce defaults and, wherever applicable, integrate user feedback. The researchers modified the initial device to include all of the panelists' suggestions. The group's developer modified the initial device's source codes to accommodate the system prototype's additional features. The group completed the required testing and updated the capstone advisor. Errors began to appear throughout the device's assessment, causing it to malfunction. The flaws ranged from IoT components to code according to the researchers. Even if the team finds it difficult to identify and fix problems because of the complicated features of the prototype's design, the research continues, and continuous teamwork has made the automation of poultry monitoring possible.

The final system is thoroughly tested before being put into production and after being designed on the basis of the final prototype. Routine maintenance is performed in the system on a regular basis to avoid system delays and the possibility of major problems. It is not worth wasting time developing a prototype because it will only be used for the final presentation to the panelists. The study's scope excludes product implementation and maintenance. This stage, however, has already been considered for the purpose of this study.

After completing the prior stages and multiple first evaluation repetitions, the researchers constructed a functional prototype. The researchers designed the system such that it could be demonstrated in a clear and accurate manner. The system was installed inside the cage that the researchers had built. The researchers ran a series of tests to ensure that all of the system's functions were operational. Product development has now been completed.

Conclusions

Based on the findings, the following are the conclusions of this research study:

- Most of the information needed was on the efficient and exact components that were used to design and develop a reliable and user-friendly automated food and waste disposal Monitoring system for broilers.
- Developing a manual control enables the system to function according to the users' wants like manual feeding and manual watering.
- Creating an IOT device that automates the cooling system, feeding system, water level detection, and waste disposal system requires the researchers to use accurate and efficient components to develop an automated sub-system that functions accordingly.
- Creating a mobile application using the following software (Arduino IDE, C++, MIT app Inventor V.2, and Adobe Photoshop CC 2019) provides a logical combination of software tools that are very much needed in developing the mobile application.
- The tools used to create an IoT device are instruments that require suitable knowledge and skills that the researchers possess.

Recommendations

Based on the findings, the following recommendations are made:

- New features and functionality are being added to the system to create a high-quality automated poultry farm such as the ability to count eggs and send messages to users through mobile applications.
- Improve the system's mobile app UI design for more accurate and reliable monitoring as well as a more detailed response to the prototype system's manually controlled function.

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I-Monitor: Instructor Monitoring System using RFID and IP-BASED camera for Mabalacat City College

Briones, Aira Joy M.
Buniel, Christopher B.
Cortez, Jaiine N.
Esguerra, Regh C.
Sta Maria, Rhiana Nicole P.
Lorenzo C. Macam (Technical Adviser)

ABSTRACT

With the sudden shift of the medium of instruction brought about by the pandemic, schools and universities have shifted from the traditional ways of monitoring attendance to the use of QR Codes, Biometrics, etc. However, accuracy and efficiency have been at stake and remained as problems. With this, the researchers aimed to develop a monitoring system using RFID and ESP32 camera to assist in monitoring instructors swiftly, accurately and efficiently. The system also provides reports in regards to instructors daily logs, real-time viewing inside the classroom, room availability and their schedule. The prototyping methodology was used in this study to build, test and rework until an acceptable outcome is achieved through a trial-and-error process between the developers and the users. Through test cases and series of modifications, the researchers ensured that the database's functionality, usability and security were thoroughly tested and followed the specified requirements. Based from the findings of the study, the researchers suggest the development of a mobile app with QR code to further enhance the functionalities of the system and the use of IP Camera to future researchers.

CCS Concepts: • Computer systems organization → Embedded systems; Internet of Things; Arduino • WEB Application Development → Android Application

General Terms: Design, Performance

INTRODUCTION

The world has witnessed an IT revolution since computers and the internet. Nowadays, everything is available online. It is easy to get a piece of information or get a call from across the country with information technology. In a fraction of a second, people can search millions of websites, collect and organize data, connect with hundreds of individuals, and exchange knowledge worldwide. Everything, from the essentials and other commercial products can be bought online just by sitting in the room, thanks to modern IT breakthroughs like e-commerce. It can track packages, communicate with others, have video conferences, and even purchase tickets. The world has shrunk dramatically since the advent of information technology. People can receive instant access to

information worldwide and share, see, and interact with people who are a thousand miles away. Business transactions, space exploration, movie watching, and digital book purchases have all become much easier than before, all with the click of a mouse. [1]

Over the next decade or two, enormous IT-related challenges and opportunities will develop for research institutions, the most knowledge-intensive enterprises of all. However, there is a sense that academic administrators, teachers, and people who support or rely on the institution's activities are unaware of some of the most pressing challenges. This study focuses on information technologies expecting to evolve soon (within a decade) and potentially substantially impact research universities. Instructors' continuous attendance in class is crucial for performance evaluation and quality control in today's educational system. Most organizations still use conventional signing time cards, which is time-consuming and insecure. This study shows a high-tech instructor monitoring system using RFID and an IP-based webcam.

"I-Monitor: Instructors Monitoring System using RFID and IP-based Camera for Mabalacat City College" is a web application that uses RFID tags to track the time-in and out of the instructors. The project also allows the administration to keep track of the teaching staff at Mabalacat City College, including all professors at the Institute of Business and Computing Education. [2]

Background of the study

Mabalacat City College (MCC) is a higher education institution established by the Local Government Unit of Mabalacat City in 2007. Considered a Local University and College (LUC), MCC is steadfast in promoting high-quality education for the community and executing exceptional academic experiences for learning, intellectual development, discovery, companionship, and discourse. Along with its co-LUCs, MCC aims to help advance the community by shaping the students' pursuit of solidarity, justice, freedom, equality, and level-up literacy, which cultivates high standard leadership qualities and interpersonal skills driven to preserve the nation's welfare and the greater good.

Monitoring the instructors is one of the challenges faced by many schools, specifically the Mabalacat City College. The Mabalacat City College is currently using generated QR Codes. Some of the problems that few instructors encountered while using QR Codes are as follows:

1. Because the QR code's sticker is just a piece of paper when wet, the scanner cannot read it.
2. The name recorded by the scanner is not always correct.
3. If the QR code is not clear, the scanner will take some time to scan it.
4. The print of the QR code can fade over time.

In order to give a solution to this problem, I-Monitor: Instructor Monitoring System using RFID and IP-based Camera is an excellent solution for the school. The proposed project will help the users do their job faster, accurately, and efficiently. The discussion of the other

aspects of this system will be in the following sections.

Objectives of the study

The study's general objective is to develop an "I-Monitor: Instructor Monitoring System Using RFID and IP-Based Camera for Mabalacat City College," which would help enhance the traditional monitoring of the instructor's attendance.

In line with this, the study aims to achieve the following objectives:

- To gather reliable information in identifying initial requirements for the system development;
- To design the system using Visual Table of Contents, Use Case Diagram, Context Diagram, and Entity Relationship Diagram;
- To develop a web application for monitoring instructor's attendance at Mabalacat City College, specifically to the Institute of Business and Computing Education, with the following features,
 - To monitor the time-in and time-out of the instructors using RFID.
 - To have real-time viewing of the instructors inside the classroom using ESP32 camera.
 - To create features for the room availability, and schedule of the instructors.
- To test the web application using test cases in functionality, usability, security, and database.
- To upload the web application online through a cross-platform application.

Scope and the delimitation

The researchers designed and developed a study for Mabalacat City College that focuses on monitoring the attendance, time-in, and time-out of instructors, viewing of schedule, and real-time viewing of the Institute of Business and Computing Studies' teaching personnel's activities with the campus.

The following are the scope and delimitation of this study:

The users of this web application are the MIS (Management Information System), VPAA (Vice President of Academic Affairs), Institute Dean,

Assistant Dean., FOSH (Field of Study Head), and Faculty Members. Each faculty member has a unique passive RFID (Radio-frequency Identification) tag assigned individually.

The MIS, VPAA, Institute Dean, FOSH, Assistant Dean, and Faculty Members should input the registered email and password to log in. The MIS shall handle the Admin account that adds, deletes, and suspends user accounts. Only the admin can create and update the schedule and accesses the daily logs and the real-time viewing of the IP camera. The admin account can create only (1) one user for the VPAA but could add multiple users accounts for the Institute Dean, Assistant Dean, and Faculty.

On the other hand, the VPAA, Institute Dean, Assistant Dean, and FOSH could access the daily logs, faculty schedule, and the real-time viewing of the IP camera. In contrast, the faculty members can only access the daily logs and view their schedules.

Furthermore, account users can reset and personalize their passwords, to which then the system automatically sends a link to their registered email addresses. ESP32 Cameras are installed inside the classrooms and placed at the rooms' rare side to get a real-time view of the classroom activities. The cameras installed could monitor the instructors and the people inside but cannot capture and save photos. The ESP32 cameras installed by the researchers are used for prototyping purposes only but shall use IP cameras for implementation.

The researchers conducted several tests using the test cases to ensure that the system's features worked consistently and effectively in terms of functionality, usability, security, and database.

A disclaimer, due to the design constraints, the study shall vary in the strength of the local area internet network and the electricity supply of Mabalacat City College if the coinciding as mentioned earlier during the implementation, the traditional way of monitoring the teaching personnel should be applied. In addition, the researchers are not accountable for the loss or damaged RFID tags.

The web application was published in a cross-platform application called the Ngrok. Ngrok is a cross-platform application that exposes local server ports to the Internet.

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.

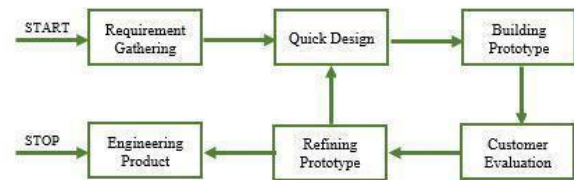


Figure 1: Prototyping Model

(Source: <https://www.geeksforgeeks.org/advantages-and-disadvantages-of-prototype-model/>)

The Prototyping Model used in this study is shown in Figure 2. In this model, an end-product prototype is first created, then tested and improved based on input until a final satisfactory prototype is created, which then acts as the foundation for the development of the final product.

Requirements gathering

The researchers held several meetings and discussions. They used the internet to gather information, categorized past research relevant to the Monitoring System, and interviewed. The researchers compiled a list of all the issues based on the information received and developed a procedure for improving the monitoring system features that are required. The researchers also sought more information from their Technical Adviser to enhance the project's functionality. As a result, to properly comprehend their research, the researchers outlined the study's benefits, goals, risks, and concerns, which aided the researchers in determining and concluding their web application research.

Quick design

A quick design, often known as a preliminary design, is created in this phase, which provides the user with a brief overview of the hardware and software, assisting the researchers in designing and developing the system. After finishing all of the essential criteria to produce a design for their project, the researchers needed to analyze all of their needs, but it wasn't a complete design. This can provide researchers with a rough sense of how their system will work and appear. The following diagrams are created in this phase: The Visual Table of Contents (VTOC) (see Appendix A), the Context Diagram (see Appendix B), the Use Case (see Appendix C), and the Entity Relationship Diagram (ERD) (see Appendix D).

Building prototype

The actual prototyping, coding, and programming required by the researchers to develop the system were based on the identified requirements and the gathered design information in the quick design. And, for it to function correctly, the software and hardware resources listed should operate as one. During this step, the researchers had to find system bugs and errors as soon as possible to fix them before moving on to the user evaluation. This process had to be repeated until the researchers were satisfied with the results based on the system's defined functionalities. The researchers used all of these software and hardware requirements in building their prototype.

PHP is used for coding logical functions, and HTML is used for the Graphical User Interface (GUI) with the help of Bootstrap for the front-end design. For server and database communication, XAMPP and MySQL were utilized. To develop the system, Visual Studio Code is used as the code editor.

Customer evaluation

During this phase, the system will be thoroughly tested before being wholly implemented in its final form. The researchers gathered feedback and suggestions to refine the prototype, identifying the system's bugs or defects based on conditions, validations, and variables, including

test cases. Test cases are used to determine whether a system in the test phase complies with the requirements or performs correctly. After successfully constructing an utterly functional design, the researchers needed to run a series of tests using the test cases to check if the produced system had any issues. This phase would last as long as there are faults or errors to be fixed or all of the user's indicated functionality and needs are satisfied. Before going on to the refining step, the researchers needed to rebuild the framework, considering their adviser's and committee's ideas and recommendations. The researchers also need to test the compatibility of the web application using Test Case (see Appendix E).

Refining prototype

All of the difficulties had to be evaluated and assessed by the researchers in this phase, depending on the findings of the researchers' assessment using test cases, for possible adjustment of these faults. The researchers went back to the short design process to uncover these problems or bugs while adding new functionality and correcting system features based on user input and suggestions throughout the usage, mistakes, and failures. As a consequence of all of the information and recommendations, the researchers intended to upgrade and improve the hardware and software. As a result, any defect or failure in the system or mobile application will be fixed before being distributed to the public.

Engineering product

The final deployment procedure began when the testing and assessment phase was done, and there were no residual bugs or system problems. This phase also includes the maintenance procedure, which provides for rectifying missed mistakes during the previous stage. To ensure that no flaws or issues remain, the system must be changed to handle changes. The final deployment procedure will begin if it is completely functioning, allowing the user to observe the system's built-in and configurable capabilities. An internet connection is also required. The web application is only applicable

to Mabalacat City College. This app has features of faculty's daily logs, real-time viewing inside the classroom, and creating a schedule.

RESULTS AND OUTCOMES

Requirements

The researchers conducted brainstorming. While exchanging ideas, the researchers found out that Mabalacat City College needed a monitoring system for the instructors' attendance. The researchers gathered information at the locale. To accomplish this project, they examined the problems of monitoring instructors. As the researchers found out their challenges, it was immediately planned, and all ideas were shared and came up with a research project. The researchers held frequent meetings and brainstorming sessions to test and monitor their research progress throughout the process. After finalizing the requirements of the project prototyping, the researchers identified the hardware and software specifications to be used. For the time-in and out of the instructors, the researchers used an RFID scanner, RFID tags, Wifi Module, and LED for the physical indicator to know if it is successfully log-in or log-out. For real-time viewing, the ESP32 Camera was used. For software, the researchers used Visual Studio Code for coding and designing the system and PHP MySQL for the system's database. The researchers used Ngrok, a cross-platform that exposes local server ports to the Internet.

System design

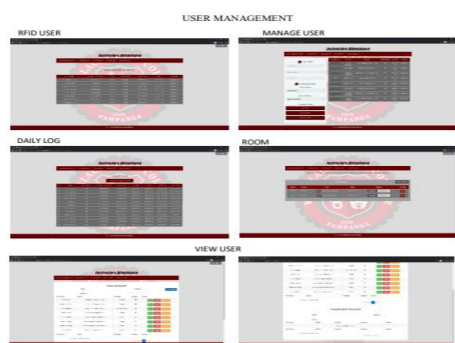


Figure 2: User Management



Figure 3: View Camera

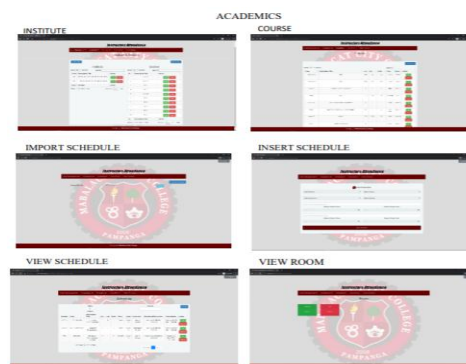


Figure 4: Academics



FIGURE 5: LOG IN & LANDING PAGE

The pictures above show the web application interface of the I-Monitor. The figure 1 is the User Management, and it includes the RFID user, manage user, daily log, room, and view user. These features are only accessible through the MIS (Management Information System). The system also has the institute and course under the Academics and Import, Insert and View Schedule features under the "Schedule" on the figure 3. The View Room shows the room availability, while the View Camera (figure 2) shows the real-time viewing of the instructors inside the classroom. On figure 4 are the log-in and landing page. To log-in, the user needs to input a registered account for log-in; they can reset their password if forgotten. In contrast, the landing page shows the school's Mission, Vision, Core Values, and the administration's names

Table 1. Functionality Test Cases Results of I-Monitor Prototype

DESCRIPTION	I-Monitor Prototype
CATEGORY/CHARACTERISTIC	Functionality
DATE	04-Feb-22
TESTER	Regh Esguerra

Table 2: Hardware Test Cases Results of I-Monitor

LOGIN	YES	NO
Admin can login	✓	
USER MANAGEMENT		
Admin can view RFID users	✓	
Admin can add RFID user	✓	
Admin can update RFID user	✓	
Admin can remove RFID users	✓	
Admin can view the time in time out of the users	✓	
Admin can create a room	✓	
Admin can delete a room	✓	
Admin can view all the users	✓	
ACADEMICS		
Admin can add institute	✓	
Admin can edit the institute	✓	
Admin can delete an institute	✓	
Admin can search the institute	✓	
Admin can add section	✓	
Admin can edit the section	✓	
Admin can delete an section	✓	
Admin can search the section	✓	
Admin can add course	✓	
Admin can edit the course	✓	
Admin can delete an course	✓	
Admin can search the course	✓	
SCHEDULE	YES	NO
Admin can upload a schedule	✓	
Admin can download the template	✓	
Admin can select a section	✓	
Admin can select course	✓	
Admin can select instructor	✓	
Admin can set the start and end time of an schedule	✓	
Admin can set the start and end time for consultation time	✓	
Admin can view the schedule	✓	
Admin can edit the schedule	✓	
Admin can delete the schedule	✓	
Admin can search for the schedule	✓	
Admin can export the schedule	✓	
VIEW ROOM	✓	
Admin can view the available room	✓	
VIEW CAMERA	✓	
Admin can select a room	✓	

Admin can view the camera	✓
EVENT LOGS	✓
Admin can view the event logs	✓
CHANGE PASSWORD	✓
Admin can change password	✓

Table 2: Hardware Test Cases Results of I-Monitor

DESCRIPTION	I-Monitor
CATEGORY/CHARACTERISTIC	HARDWARE
DATE	04-Feb-22
TESTER	Regh Esguerra

HARDWARE TEST CASE	YES	NO
Does the RFID scanner responds when RFID tag is tapped?	5	
2. Does the second RFID scanner responds when RFID tag is tap?	5	
3. Does the RFID scanner connect to the system?	5	
Does the wifi module connects to the system?	5	
Does the led responds when the RFID tags tap into the rfid scanner?	5	
Does the second led responds when the RFID tags tap into the rfid scanner?	5	
Does the camera connects to the system?	5	
Does the second camera connects to the system?	5	
Does the system accepts new RFID tags?	5	
When two rooms are being used, will the system be able to record data when both RFID scanner are being tapped at the same time?	5	
The system will not record data of unregistered RFID tags (daily logs)	5	
Does the system work on android browser?	5	
Does the wifi module connects to the system?	5	

DISCUSSIONS

This section discusses the summary of findings anchored on the objectives, Conclusion, and Recommendations based on the results of I-Monitor:

Instructor Monitoring System Using RFID and IP-Based Camera for Mabalacat City College.

Summary of Findings

The researchers used the ESP32 Camera for the real-time monitoring of the instructors inside the classroom. The researchers found out that it has a limited capacity. The viewing can only be accessed one a time. Therefore, the researchers recommend an IP Camera instead of an ESP32

camera for implementation. However, the researchers are not liable for the loss of the RFID card.

The researchers identified and compiled the requirements needed in developing the web application. The researchers used Visual Studio in developing and designing the web application. Arduino Uno, Breadboard, LED, Wifi Module, RFID scanner, RFID cards, and ESP32 Camera were used for hardware requirements. The web application and the prototype were successfully linked through the Wifi module.

For researchers to achieve the system prototype's objectives successfully, a number of trials and error processes were conducted. The researchers encountered a limited count of errors, mainly from the connectivity of the jumper wires of the IoT components. It was found out that the said wire does not have a good grip to keep it connected to the modules. A couple of solution found was either to glue or solder it to the component. In line to this, the researchers decided to use glue sticks to secure the wires because soldering may cause many issues instead of minimizing the errors. This method has shown to be working.

After the group's presentation, the capstone panelists reviewed the system's functionalities in-depth. The panelists deliberated to go through a major revision on both documents and the system. The recommendations were given to solve the identified system errors, such as the camera availability online, the user account roles, a visualization tool for room availability, and content on the landing page. The researchers modified the system based on the panelists' recommendations. A following deliberation has been made and found a few remaining errors, such as no filtering of schedule, no edit and delete option for courses, institute, and section, positions are repeated, VPAA belonging to any institute and no physical indicator for the RFID scanner. Lastly, the tables were suggested to have a background color, not just rows.

Institute of Business and Business and Computing Education Computing Studies I-Monitor Monitor

After evaluating the system and getting all the panel recommendations, the researchers quickly modified the system. The first option for the RFID physical indicator, researchers shall use the LCD. However, the researchers found out that the power supply was not enough. There are no sockets on the components for the power bank to be used as the power supply, so the researchers used LED instead. The researchers met the other recommendation. The researchers conducted a series of test cases to ensure that the panelists' recommendations were functioning.

The prototype was installed in a classroom-like miniature. The ESP32 Camera's placement is at the back part of the classroom to monitor the instructors at the front. Also, the RFID scanner is found inside the classroom for the log-in and out of the instructors.

The web application is up online. The researchers used Ngrok, a crossplatform application that exposes local server ports to the Internet. The link to the web application is <http://imonitor.ap.ngrok.io/>.

Conclusion

Based on the completed analysis, objectives, and test cases results conducted for the system and application in testing and evaluation, the researchers draw some conclusions. The researchers concluded that the web application met all the requirements written in the study's objectives.

The researchers successfully developed an instructor's monitoring system for Mabalacat City College to monitor the instructor's attendance. The system was successfully developed and had gone through many modifications and tests.

The system was designed and developed using Visual Studio. For the database of the system, PHP MySQL was used. The system was tested using Test Cases, and the results of the test case ensure that every feature within the project is working as expected. The system was also

validated if it is free of errors and working as per the users' expectations.

The web application performed very well for all the user accounts. The MIS successfully manages all the features of the system. As for VPAA, FOSH, Institute Dean, and Assistant Dean, they have access to the instructors' daily logs and schedules, the real-time viewing of the Camera, and the room availability. For faculty, they can access their schedule, daily logs, and room availability.

Recommendations

The following are the recommendations to improve the developed I-Monitor system prototype:

- Future researchers can incorporate QR (Quick Response) code to improve the system further.
- Future researchers may consider developing the system in mobile applications.
- The researchers recommend that future researchers enhance the system's development in terms of functionalities.
- Future researchers can use an IP Camera instead of an ESP32 Camera for implementation

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Institute of Computing Studies Laboratory Monitoring System

Marvin Karl Z. Lacsa
Michelle N. Layug
Regine Mae T. Sibal
Eriel Tonggol
Maximino Torres
Dessalyn J. De Castro (Technical Adviser)

ABSTRACT

The researchers developed ICS Laboratory Monitoring, web-based monitoring, and inventory system for the Institute of Computing Studies. The ICS Laboratory Monitoring System is a computer laboratory and inventory system that keeps track of what is in the laboratories, specifically what students use in the computer laboratories. It proposes a technical solution to improve the institute's inventory and laboratory monitoring processes. Login access, inventory, laboratory monitoring, and report generating are all included in the system. The system will be accessed by two users: the administrator and the custodian. The administrator has complete access to the system, whereas the custodian has full access to inventory. The laboratory monitoring is where the deployed equipment is stored in the inventory, and it will show the equipment's status. Non-deployed equipment can be requested for requisition, and deployed equipment can be reported as damaged. When reporting damaged equipment, the administrator or custodian can include a video file as evidence. The system will also include a class schedule. If the previous user committed the damage, the current user could report it to the custodian, who can identify the previous user by reviewing the students' class schedules and seat plans. The requisition will require a third-party intervention, which will be the admin. All reports can be printed or saved as pdf files. The integration testing went successfully; no errors were found, and the system was still functioning properly. The study's objectives were met, and the results are ready to be used. Future studies may broaden the scope of the locale, create a QR Scanner app, and add other features such as scheduling maintenance of damaged equipment.

General Terms: Design, Performance

INTRODUCTION

Technology is still changing. Every day, humans struggle with technological advancements. The objective is to develop a more modern technology capable of bringing significant improvements to the task. Modern technology has been an integral part of our everyday lives. It aids individuals and businesses in carrying out daily activities and routines, including transactions. The technology consists of devices and information systems that assist in completing transactions more quickly and reliably. Computers are the foundation of today's Database Management Systems in corporations and other institutions. Computer technology has significant and varied effects in all aspects of human life, such as assisting people in completing tasks more quickly, accurately, and efficiently.

Computer processes, such as the development of data records, storage, filing, and retrieval of data, have become much easier thanks to technological advancements.

Monitoring systems are in charge of monitoring a company's infrastructure (hardware, networks, communications, operating systems, and software, among other things) to analyze its function and performance and detect and warn about potential errors. Monitoring the equipment is necessary to ensure that it is always in its proper position. Many organizations aim to find an innovative mechanism for recording and monitoring items that are both precise and dependable. Due to weaknesses in object tracking, failure rates are also high in areas where many people access multiple items.

Manual monitoring is already being used for many years, and it is ideal for short-term monitoring systems. However, the traditional

manual method of maintaining track of objects is a time-intensive and inaccurate process; it can also take a lot of space; it is easily damaged and mislaid; it's harder to make changes with paper documents; paper document filing can be less secure than electronic filing systems. To be sure, manual monitoring could reduce the quality value of a laboratory, and naturally, it is very ineffective. Monitoring allows for data security, data collection, and overall equipment health. Although monitoring does not solve problems, it does make equipment safer and more efficient. It's also possible to keep track of what happens, how it happens, and how it happens, which can help you make better decisions and learn more. The process of assessing progress to goals is known as monitoring. As you may know, schools are made up of a variety of assets. Permanent and flexible I.T. are included. Equipment, classroom furniture, technological teaching aids, books and resources, and stationery and cleaning supplies are just a few of the things you will need. In larger contexts, hundreds, if not thousands, of assets can be tracked and controlled. In today's society, these could be expensive resources such as computers and printers. In order to manage school assets, you'll need a reliable inventory system. It aids asset managers in keeping track of the school's assets at all times. It also allows you to ensure that the assets are adequately cared for and utilized well to get the maximum use out of them before the need to be replaced. practice of keeping track of the list of things on a shelf at a warehouse, in a store, or in the ownership of other merchants and distributors is known as inventory management. That way, they can be sure to have the proper amount of units in the right place, at the right time, and at the right price. The study aims to develop an ICS Laboratory Monitoring System that will be easy to use, reliable, and effective.

Background of the study

The ICS Laboratory Monitoring System is proposed to be used at the Institute of

Computing Studies (ICS) Department in Mabalacat City College (MCC)

Mabalacat City College (MCC) is a higher education institution established by the Local Government Unit of Mabalacat City in 2008. Considered a Local University and College (LUC), MCC is steadfast in promoting high-quality education for the community and executing exceptional academic experiences for learning, intellectual development, discovery, companionship, and discourse. Along with its co-LUCs, MCC aims to help advance the community by shaping the students' pursuit of solidarity, justice, freedom, equality, and level-up literacy, which cultivates high standard leadership qualities and interpersonal skills driven to preserve the Nation's welfare and the greater good.

One of the programs being offered by the institution is Bachelor of Science in Information Technology, which requires the use of different types of equipment such as computer units and other electronic devices. Currently, there are three (3) computer laboratories and one (1) Cisco laboratory, and (1) a Mac laboratory that the ICS department is utilizing. The number of computers and electronic devices at MCC's ICS Laboratories is increasing. The

institution is modernizing the facilities by placing new pieces of equipment to support a newly built network laboratory.

The scheme is being supervised by the computer laboratory staff that monitors the equipment and devices inside a computer laboratory. Monitoring the said equipment and devices is done to ensure that all the peripherals of a computer unit are working correctly and that no devices are missing. Each laboratory equipment is manually monitored and inspected; that is why the laboratory administrator has a hard time keeping an updated record of all laboratory pieces of equipment placed in five (5) laboratories. This, however, complicates the system time-consuming and tedious. Human error is common in the manual procedure, which

requires a lot of paperwork and is susceptible to error; such as misuse of the equipment log records, loss of equipment, absences of an in-out transaction record, and misplacing of equipment. The study focuses on improving the process and providing a solution to address the perceived problem.

The researchers proposed to develop an inventory system that will help the institute of ICS monitor the inventory, laboratories, and the mentioned problem above.

The ICS Laboratory Monitoring System is a computer laboratory and inventory system that keeps track of what is in the laboratories, specifically what students use in the computer laboratories.

Objectives of the study

Generally, the objective of the study is to develop an efficient ICS Laboratory Monitoring System at Mabalacat City College. The researchers' goal is to create a laboratory inventory system that would assist the institute in recording and tracking the inventory's status.

The researchers aimed to develop a monitoring system to help the institute more efficiently and securely record items' requisition and damage reports.

In line with this, the study specifically aimed to achieve the following objectives:

- To obtain accurate data to assess system development's initial requirements.
- To design and develop a web-based Laboratory Monitoring System for the ICS at Mabalacat City College with the following features:
 - Inventory
 - Reports
 - Requisition Reports
 - Damage Report
 - Schedule Of Classes
- To assist the institute in keeping track of the laboratories and laboratory equipment's statuses.
- To test the system quality using ISO 25010 that comprises the following characteristics:
 - Functionality

- Usability
- Reliability
- Portability
- Performance Efficiency
- Security

- To publish the web-based server through a hosting service platform.

Scope and the delimitation

The study will focus on the design and development of the ICS Laboratory Monitoring System for Mabalacat City. The boundaries of the functionality, user system, and database are referred to as the scopes. To ensure that the system's scope does not exceed the system's limits, these elements must be present. The features of the User's scope are shown below. This system is a web-based application. It can be accessed via Internet so that the users can access it freely. It has security elements, whereas only authorized users can view the specific amount of the content of this web-based application based on the user level of the system. The database framework contains a frequency table that records the data history, information, staff details, and item details.

The Administrator can access the following:

- School admin uses this system to register, update, and remove the information of the Custodian.
- Admin can upload and update the class schedule and list (Schedule of Classes).
- Full access in Inventory Functions
Generate Report (Damage Report, Inventory Status)
- Add laboratories and laboratories instructors.
- Admin can be enabled/disable the requisition availability of the laboratories.

The Custodian can access the following:

- Inventory
- Add new item
- Generate QR Code
- Modify item description
- View inventory list and status
- Laboratory monitoring
- Input data from the laboratory monitoring form accomplished by the faculty to the system

- File Damage Report
- Generate Report (Damage Report, Inventory Status)
- View Schedule of Classes
- Custodian can edit own information

Due to design constraints, the study will not cover the following:

- The system has no password recovery.
- Q.R. Scanner will be a third-party app named Q.R. Code Scanner & Scanner App that can be downloaded from the Play Store.
- Q.R. code will be unable to trace the missing items in the ICS Laboratories.

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.

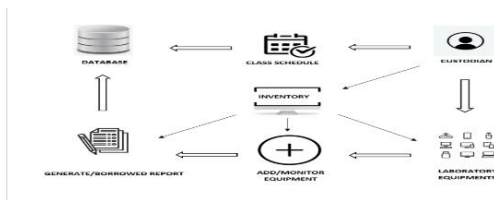


Figure 2: System Implementation

The system's conceptual framework has input, the contents of which are knowledge requirements and software requirements. For knowledge requirements, the researchers studied the monitoring process and database system, as well as the student list. In software requirements, the system is built with xampp, composer, Laravel, and npm. It also has a process that includes system requirements and system design, as well as an output that includes the monitoring system.

2.2 Procedures Data gathering instruments

The researchers have collected data with the use of different instruments. The collected data has given the researchers a broader

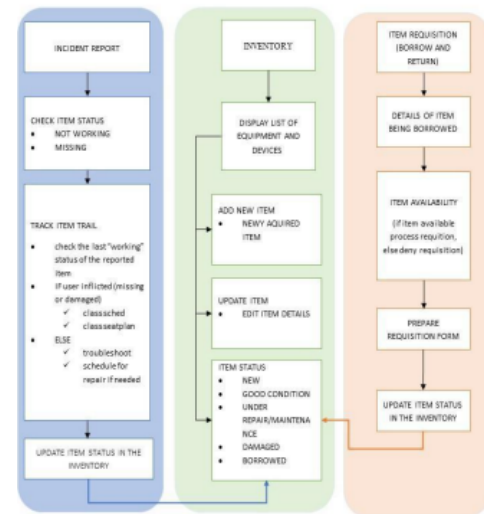
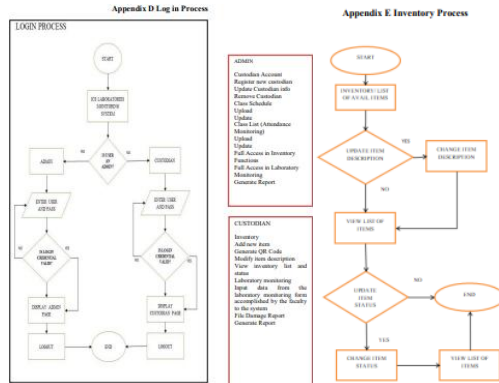
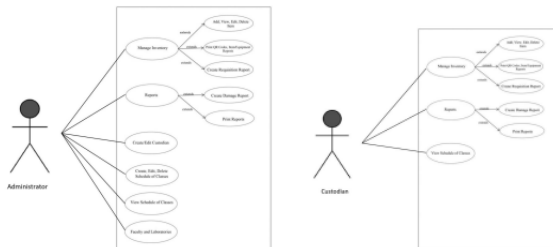
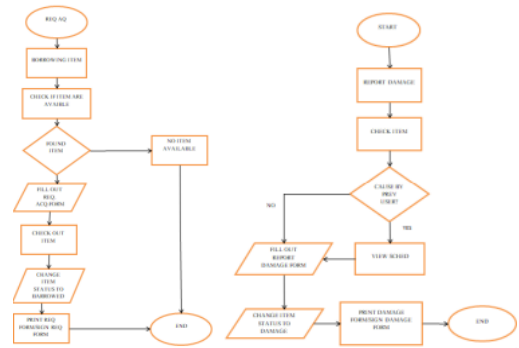
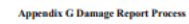
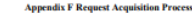
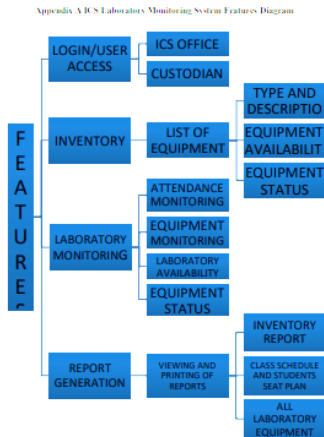
understanding of the system requirements that will be very essential for the development of ICS Laboratory Monitoring System

The instruments used by the researchers are as follows:

Interview - This instrument is a form of data gathering technique in which an interviewer will collect data from the interviewee through a verbal or written approach. A verbal interview requires both parties to communicate with each other and perform the question-and-answer session by talking with each other either in person or over the phone. A face-to-face and through chat interview is done by asking the sets of questions to the interviewee. The researchers have compiled a set of questions regarding the re-entry plan of the monitoring system of the ICS laboratories that will serve as interview questions that can help the researchers to identify the problems perceived. The researchers also compiled some questions regarding the condition of the inventory before the pandemic. The interview was conducted face-to-face and through chat to secure the necessary information needed in the study.

Design

After acquiring the data requirements that the researchers needed, 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 Feature Diagram. The diagram shows the relationships and the abstract of the system. (See Appendix A section for the Feature Diagram). Secondly, the Use Case Diagram is used to present the scope of the system and how users interact with it. (See Appendix B and C sections for the Use Case Diagram). For the process of each feature, the researchers use Data Flow Diagram. (See Appendix D, E, F, and G sections for the DFD) The Relationships Concept is also to present the process of the system. (For the Relationships Concept, see Appendix H and I.)



Finally, the researchers created an Entity Relationship Diagram to illustrate the logical structure of the ICS Laboratory Monitoring System database and the links between entity sets stored inside. (See Appendix J for the Entity-Relationship diagram).

Design and development phase

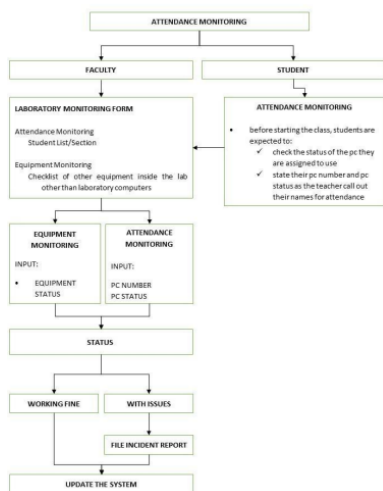
By designing diagrams such as Feature Diagram, Use Case Diagram, Data Flow Diagram, Relationship Concepts, and Entity Relationship Diagram, the researchers essentially illustrated every feature and flow of the system they intent to provide. The

researchers were able to gain a better understanding of how to design the ICS Laboratory Monitoring System by using these diagrams.

The researchers used Angular, JavaScript, Laravel, PHP, HTML/CSS, and Bootstrap to develop the system.

For the database development for and web-based server, the researchers used PhpMyAdmin.

Appendix I: Attendance Monitoring Concept



RESULTS AND OUTCOMES

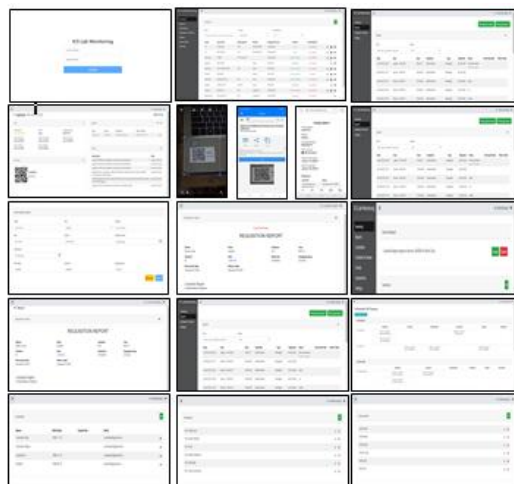


Figure 2: system implementation

Requirements

Researchers conducted the research by reading online scholarly related articles and online related systems, as well as conducting

interviews with the locale, before moving on to the system's development to acquire additional information that will benefit the researchers in constructing the system. After analyzing and researching the researchers came up with the idea of establishing a laboratory system as a result. At this phase, all issues were addressed in order to develop a reliable system that would handle the institute's new inventory and replace the paper/excel inventory procedure. Above image shown the results of the system implementation.

Development and Testing Results

In this phase the researcher used ISO/IEC 25010 for the standard of testing. The testing was done by Engineer Renzi Sam Pineda and Mr. Jener Mallari of MIS Office which will be the admin of the ICS Laboratory Monitoring System.

System Testing

In the first and second phases of component testing, the researchers decided to run it on a laptop for a while to fix and add more functions. In the third and fourth phase, the system still lacked functionalities, so the researchers continued to debug and repair it as the panelists and the MIS Office suggested more functions and pointed out what the system lacked. The researchers publish the system online as soon as it is complete and error-free. The system testing was done by the staff of MIS Office, Engr. Renzi Sam Pineda and Mr. Jener Mallari. The system was error-free, and the data had been effectively packed.

applicable to Mabalacat City College. This app has features of faculty's daily logs, real-time viewing inside the classroom, and creating a schedule.

Functionality testing

To ensure that the web-based system's features and operational behavior correspond to their specifications, the researchers conducted a functionality test (See Table 4 and 5 of Appendix H). The functionality test's goal is to put each web-based system's function to the test by giving adequate input and comparing the output to the functional requirements. The

functionality testing was conducted by Mr. Renzi Sam Pineda, one of the staff of the MIS Office

The functionality testing results have passed, indicating that the web-based system is working properly.

Usability testing

To guarantee that the system is easy to use, the researchers also conducted usability testing (See Table 6 of Appendix H). User interface issues such as correct content rendering (e.g. visuals, text editing format), as well as the clarity of messages, prompts, and commands, are all considered and validated in usability testing. The findings of the usability tests have all been passed, demonstrating that the web-based system is working as intended.

Reliability testing

To guarantee that the system is reliable, the researchers also conducted reliability testing (See Table 7 of Appendix H). The findings of the reliability tests have all been passed, demonstrating that the web-based system is working as intended.

Portability testing

To guarantee that the system is easy to use, the researchers also conducted portability testing (See Table 8 of Appendix H). The findings of the portability tests have all been passed, demonstrating that the web-based system is working as intended.

Performance efficiency testing

The researchers also conducted efficiency testing to ensure that the system is easy to use (See Table 9 of Appendix H). The researchers tested the time-dependent behavior of the features. The findings of the efficiency is that all the tests have passed, demonstrating that the web-based system is working as intended.

Security testing

The researchers also conducted efficiency testing to ensure that the system is easy to use (See Table 10 of Appendix H). The researchers used Hosted Scan Security to scan the laboratory system for security testing. It's a web-based service that helps businesses automate vulnerability testing. It has a wide

range of scanners that may be used to check for security threats on networks, servers, and websites. Dashboards, reports, and alarms can help you manage your risks [25].

Table 1: Functionality Testing Case of ICS Laboratory Monitoring System for Admin

DESCRIPTION	ICS Laboratory System
CATEGORY/CHARACTERISTIC	Functionality
DATE	January 30, 2022
TESTER	Engr. Renzi Sam Pineda

Test case I.D.	Feature	Precondition	Steps
Admin_Func1	Accessing the website as a admin	Admin_Func1 successful	1. Go to https://icslabmonitoring.com
Admin_Func2	Log in as admin	Admin_Func2 successful	1. "Sign in". 2. Enter the valid username. 3. Enter your password.
Admin_Func3	Viewing the Inventory	Admin_Func3 successful	1. Click the Inventory on the upper left side 2. Click Search Bar 3. Enter Type, Serial No., Description or Brand 4. Click the drop down for statuses. choose status 5. Click the drop down for availability

Admin_Func4	Adding Equipment/Item	Admin_Func4 successful	1. Click the green "plus" button located at the upper right side of the inventory 2. Add information of the item 3. Click the save button
Admin_Func5	Viewing the Item	Admin_Func5 successful	1. Click the "eye" icon located at the right side of the chosen item 2. Click the "print" icon located at the right of each column.
Admin_Func6	Editing the Item Information	Admin_Func6 successful	1. Click the "eye" icon located at the right side of the chosen item. 2. Edit item information 3. Click the "save" button
Admin_Func7	Create Requisition Report	Admin_Func7 successful	1. Click the "eye" icon located at the right side of the chosen item. 2. Click the "create requisition report" icon located at the right side of the reports column 3. Edit item information 4. Click the "save" button
Admin_Func8	Create Damage Report	Admin_Func8 successful	1. Click the "eye" icon located at the right side of the chosen item. 2. Click the "create damage report" icon located at the right side of the reports column

			3. Edit item information 4. Click the "save" button
Admin_Func9	Viewing Reports	Admin_Func9 successful	1. Click the "reports" located at the left side bar 2. Click Search Bar 3. Enter Type, Serial No., Description or Brand 4. Click the drop down for statuses. choose status 5. Click the print icon located at the upper right side of the reports column
Admin_Func10	Viewing Custodians	Admin_Func10 Successful	1. Click the "custodians" located at the left side bar
Admin_Func11	Adding Custodian	Admin_Func11 successful	1. Click the "custodians" located at the left side bar 2. Click the green "plus" button located at the upper right side of the custodians column
Admin_Func12	Editing Custodian Information	Admin_Func12 successful	1. Click the "custodians" located at the left side bar 2. Click the "eye" icon located at the right side of the chosen Custodian 3. Edit Information 4. Click the "save" button
			1. Click the

Admin_F unc13	Viewing Schedule of Classes	Admin_F unc13 successf ul	"schedule of classes" located at the left side bar
Admin_F unc14	Adding and Editing Schedule of Classes	Admin_F unc14 successf ul	1. Click the "schedule of classes" located at the left side bar 2. Click the green "plus" button located at the right side column of the chosen laboratories 3. Fill in required information 4. Click "save" button 5. Click the green "pencil" button located at the upper right side of each schedule to edit the chosen schedule 6. Click the red "trash can" button located at the upper right side of each schedule to delete the chosen schedule.
Admin_F unc15	Viewing the student seat plan	Admin_F unc15 successf ul	1. Click the "view student seat plan" button located at the left side bar

Admin_F unc16	Adding and updating the student seat plan file	Admin_F unc16 Successf ul	1. Click the "view student seat plan" button located at the left side bar 2. Click the "choose file" button located at upper right side to update a new seat plan
Admin_F unc17	Clearing Schedule of Classes	Admin_F unc17 Successf ul	1. Click the "view student seat plan" button located at the left side bar 2. Click the "clear schedule" button to clear the schedules
Admin_F unc18	Viewing, Adding Editing and Deleting Faculty Members	Admin_F unc18 successf ul	1. Click the "faculty" button located at the left side bar 2. Click the green "plus" button located at the right side column of the chosen instructor 3. Fill in required information 4. Click "save" button 5. Click the green "pencil" button located at the right side of each instructors name to edit the chosen schedule 6. Click the red "trash can" button located at the right side of each instructors name to delete the chosen faculty member.

Admin_Func19	Viewing, Adding Editing and Deleting Laboratories	Admin_Func19 successful	1. Click the "laboratories" button located at the left side bar 2. Click the green "plus" button located at the right side column of the chosen laboratories 3. Fill in required information 4. Click "save" button 5. Click the green "pencil" button located at the right side of each laboratories to edit the chosen schedule 6. Click the red "trash can" button located at the right side of each laboratories to delete the chosen schedule.
Admin_Func20	Editing Admin Account Information	Admin_Func20 successful	1. Click the "settings" button located at the left side bar 2. Click the "pencil" icon to edit admin information 3. Fill in Information 4. Click "save" button.
Admin_Func21	Log out as admin	Admin_Func21 successful	1. Click the "arrow" button located at the upper right to log out

Test case I.D.	Expected results	Actual results	Status
Admin_Func1	1. The website should be up and running 2. All buttons should be working 3. All pages are up and without crashes	As expected	PASSED
Admin_Func2	1. Information can be typed in the login form 2. Login button should be working	As expected	PASSED
Admin_Func3	1. All buttons should be working. 2. The search bar should be working 3. The data should be accurate.	As expected	PASSED
Admin_Func4	1. All buttons should be working. 2. The data should be accurate. 3. Changes should be recorded to reports	As expected	PASSED
Admin_Func5	1. All buttons should be working.	As expected	PASSED

	2. The data should be accurate.		
Admin_Func6	1. All buttons should be working. 2. The data should be accurate. 3. Changes should be recorded to reports	As expected	PASSED
Admin_Func7	1. All buttons should be working. 2. The data should be accurate. 3. Changes should be recorded to reports	As expected	PASSED
Admin_Func8	1. All buttons should be working. 2. The data should be accurate. 3. Changes should be recorded to reports	As expected	PASSED
Admin_Func9	1. All buttons should be working. 2. The data should be accurate.	As expected	PASSED
Admin_Func10	1. All buttons should be working. 2. The data should be accurate.	As expected	PASSED

Admin_Func11	1. All buttons should be working. 2. The data should be accurate. 3. Changes should be recorded to reports	As expected	PASSED
Admin_Func12	1. All buttons should be working. 2. The data should be accurate. 3. Changes should be recorded to reports	As expected	PASSED
Admin_Func13	1. All buttons should be working. 2. The data should be accurate.	As expected	PASSED
Admin_Func14	1. All buttons should be working. 2. The data should be accurate. 3. Changes should be recorded to reports	As expected	PASSED
Admin_Func15	1. All buttons should be working. 2. The data should be accurate.	As expected	PASSED

Admin_Func16	1. All buttons should be working. 2. The data should be accurate. 3. Changes should be recorded to reports	As expected	PASSED
Admin_Func17	1. All buttons should be working.	As expected	PASSED
Admin_Func18	1. All buttons should be working. 2. The data should be accurate. 3. Changes should be recorded to reports	As expected	PASSED
Admin_Func19	1. All buttons should be working. 2. The data should be accurate. 3. Changes should be recorded to reports	As expected	PASSED
Admin_Func20	1. All buttons should be working. 2. The data should be accurate.	As expected	PASSED
Admin_Func21	1. All buttons should be working.	As expected	PASSED

Table 2: Functionality Testing Case of ICS Laboratory Monitoring System for Custodian

DESCRIPTION	ICS Laboratory

	System
CATEGORY/CHARACTERISTIC	Functionality
DATE	January 30, 2022
TESTER	Jener M, Mallari

Test case I.D.	Feature	Precondition	Steps
Cus_Func1	Accessing the website as a custodian	Cus_Func1 successful	1. Go to https://icslabmonitoring.com
Cus_Func2	Log in as Custodian	Cus_Func2 successful	1. "Sign in". 2. Enter the valid username. 3. Enter your password.
Cus_Func3	Viewing the Inventory	Cus_Func3 successful	1. Click the Inventory on the upper left side 2. Click Search Bar 3. Enter Type, Serial No., Description or Brand 4. Click the drop down for statuses. choose status 5. Click the drop down for availability
Cus_Func4	Adding Equipment/Item	Cus_Func4 successful	1. Click the green "plus" button located at the upper right side of the inventory 2. Add information of the item 3. Click the save button
Cus_Func5	Viewing the Item	Cus_Func5 successful	1. Click the "eye" icon located at the right side of the chosen item 2. Click the "print" icon located at the right of each column.

Cus_Func6	Editing the Item Information	Cus_Func6 successful	1. Click the "eye" icon located at the right side of the chosen item. 2. Edit item information 3. Click the "save" button
Cus_Func7	Create Requisition Report	Cus_Func7 successful	1. Click the "eye" icon located at the right side of the chosen item. 2. Click the "create requisition report" icon located at the right side of the reports column 3. Edit item information 4. Click the "save" button
Cus_Func8	Create Damage Report	Cus_Func8 successful	1. Click the "eye" icon located at the right side of the chosen item. 2. Click the "create damage report" icon located at the right side of the reports column 3. Edit item information 4. Click the "save" button
Cus_Func9	Viewing Reports	Cus_Func9 successful	1. Click the "reports" located at the left side bar 2. Click Search Bar 3. Enter Type, Serial No., Description or Brand 4. Click the drop down for statuses. choose status 5. Click the print icon located at the upper right side of the reports column

Cus_Func10	Viewing Schedule of Classes	Cus_Func10 successful	1. Click the "schedule of classes" located at the left side bar
Cus_Func11	Viewing the student seat plan	Cus_Func11 successful	1. Click the "view student seat plan" button located at the left side bar
Cus_Func12	Editing Custodian Account Information	Cus_Func12 successful	1. Click the "settings" button located at the left side bar 2. Click the "pencil" icon to edit admin information 3. Fill in Information 4. Click "save" button.
Cus_Func13	Log out as admin	Cus_Func13 successful	1. Click the "arrow" button located at the upper right to log out

Test case I.D.	Expected results	Actual results	Status
Cus_Func1	1. The website should be up and running 2. All buttons should be working 3. All pages are up and without crashes	As expected	PASSED
Cus_Func2	1. Information can be typed in the login form 2. Login button	As expected	PASSED

	should be working		
Cus_Func3	1. All buttons should be working. 2. The search bar should be working 3. The data should be accurate.	As expected	PASSED
Cus_Func4	1. All buttons should be working. 2. The data should be accurate. 3. Changes should be recorded to reports	As expected	PASSED
Cus_Func5	1. All buttons should be working. 2. The data should be accurate.	As expected	PASSED
Cus_Func6	1. All buttons should be working. 2. The data should be accurate. 3. Changes should be recorded to reports	As expected	PASSED
Cus_Func7	1. All buttons should be working. 2. The data should be accurate. 3. Changes should be recorded to	As expected	PASSED

	reports		
Cus_Func8	1. All buttons should be working. 2. The data should be accurate. 3. Changes should be recorded to reports	As expected	PASSED
Cus_Func9	1. All buttons should be working. 2. The data should be accurate.	As expected	PASSED
Cus_Func10	1. All buttons should be working. 2. The data should be accurate.	As expected	PASSED
Cus_Func11	1. All buttons should be working. 2. The data should be accurate.	As expected	PASSED
Cus_Func12	1. All buttons should be working. 2. The data should be accurate.	As expected	PASSED
Cus_Func13	1. All buttons should be working.	As expected	PASSED

Table 3: Usability Testing Case of ICS Laboratory Monitoring System for Admin

DESCRIPTION	ICS Laboratory System
CATEGORY/CHARACTERISTIC	Usability
DATE	January 30, 2022
TESTER	Engr. Renzi

	Sam Pineda

Test Case ID	Feature/Specification	Remark
Web_Usa1	Is the system easy to deploy?	PASSED
Web_Usa2	Is the system easy to test?	PASSED
Web_Usa3	Is the system easy to maintain?	PASSED
Web_Usa4	Is the web system easy to understand?	PASSED

Table 7: Reliability Testing Case of ICS Laboratory Monitoring System

Test Case ID	Feature	Preconditions	Steps
We b_R el1	Accessing website through Google Chrome (97.0.4692.71) on Windows-based and macOS-based computers	Device is connected to the Internet via wi-fi or data	1. Go to https://icslabmonitoring.com
We b_R el2	Accessing website through Safari (14.1) on Windows-based and macOS-based computers	Device is connected to the Internet via wi-fi or data	1. Go to https://icslabmonitoring.com
We b_R el3	Accessing website through Opera (77.0.4054.90) on Windows-based and	Device is connected to the Internet via wi-fi or data	1. Go to https://icslabmonitoring.com

	macOS-based computers		
We b_R el4	Accessing website through Microsoft Edge (97.0.1072.62) on Windows-based and macOS-based computers	Device is connected to the Internet via wi-fi or data	1. Go to https://icslabmonitoring.com
We b_R el5	Data validation 1	Web_Rel1/Web_Rel2/Web_Rel3/Web_Rel4	1. Go to https://icslabmonitoring.com 2. Go to Log in page 3. Input non-email value to email address field
We b_R el6	Data validation 2	Web_Rel1/Web_Rel2/Web_Rel3/Web_Rel4	1. Go to https://icslabmonitoring.com 2. Go to Log in page 3. Sign in as admin 4. Add Custodian 5. Input non-email value to email address field

Web_Rel7	Data validation 3	Web_Rel1/Web_Rel2/Web_Rel3/Web_Rel4	1. Go to https://icslabmonitoring.com 2. Go to Log in page 3. Sign in as admin 4. Add Custodian 5. Input three (3) letter words for password
Web_Rel8	Influence to other websites	Web_Rel1/Web_Rel2/Web_Rel3/Web_Rel4	Open and navigate https://icslabmonitoring.com
Web_Rel9	Buttons, pages, and menus are responsive to screen size	Web_Rel1/Web_Rel2/Web_Rel3/Web_Rel4	1. Open and navigate https://icslabmonitoring.com 2. Decrease the width of the screen size

Test Case ID	Expected Results	Actual Results	Status
Web_Rel1	1. The website should be up and running 2. All buttons should be working 3. All pages are up and without crashes	As expected	Passed
Web_Rel2	1. The website should be up and running 2. All buttons should be working 3. All pages are up and without crashes	As expected	Passed

Web_Rel3	1. The website should be up and running 2. All buttons should be working 3. All pages are up and without crashes	As expected	Passed
Web_Rel4	1. The website should be up and running 2. All buttons should be working 3. All pages are up and without crashes	As expected	Passed
Web_Rel5	The form should not accept the value and will show an error	As expected	Passed
Web_Rel6	The form should not accept the value and will show an error	As expected	Passed
Web_Rel7	The form should not accept the value and will show an error	As expected	Passed
Web_Rel9	The website should not affect other opened websites to crash or be non-responsive	As expected	Passed
Web_Rel10	The website should maintain the visibility and accessibility of its buttons, menus, and forms.	As expected	Passed

Table 4: Portability Testing Case of ICS Laboratory Monitoring System

Test case ID	Feature/Specification	Remark
Web_Por1	Is the web app adaptable and can be used for multiple types	PASSED

	of devices?	
Web_Por2	Can the web app handle different types of mobile/Desktop device screen sizes?	PASSED

Table 5: Performance Efficiency Testing Case of ICS Laboratory Monitoring System

Test Case ID	Feature	Response Time	Remarks
Web_Per1	Launch application	2.01 seconds	Passed
Web_Per2	User Log in	2.01 seconds	Passed
Web_Per3	Display Side Bar Page View	0.32 seconds	Passed
Web_Per4	Submit buttons	4.08 seconds	Passed
Web_Per5	Creating reports	1.4 seconds	Passed
Web_Per6	Printing reports	2.16 seconds	Passed
Web_Per7	Requisition alert	3.05 seconds	Passed

Table 6: Security Testing Case of ICS Laboratory Monitoring System

Test Case ID	Feature	Threat Level	Remarks
Web_Sec1	Open TCP Port	Medium	Passed
Web_Sec2	Cross Domain Misconfiguration	Medium	Passed
Web_Sec3	Cache Control	Low	Passed
Web_Sec4	X-Content Type Option	Low	Passed

DISCUSSIONS

This section contains summary of findings, conclusions, and suggestions from an assessment study of the participation arrangement and participation program of the Laboratory Monitoring System

Summary of findings

Based on the given results from designing, development, and testing, all features stated in the scope of the study the for ICS Laboratory Monitoring System web-based system are working as expected.

An effective laboratory monitoring system that can save and input item statuses was developed by the researchers. The Administrator has the highest level of privileges and has full access to the system's functions. A third-party program was used to successfully generate a Q.R. Code for each new item added to the inventory (Q.R. scanner). When you scan the Q.R. code, it will show you the information about the item. The damage report and requisition were also successful. After filling out the form, students or instructors can request an item from the Custodian to borrow. The requisition form can be printed and signed if the admin accepts the request. If the item was damaged by the student, a video can be included in the damage report as evidence. The class schedule is also successful, and it is similar to the one that was posted in each laboratory prior to the new normal.

The system is also successful in making a way to send a request to Laboratories where they can moreover react to students. The system is developed to provide automation for the daily attendance of items of laboratories. The purpose of this system is to help the Institute of Computing Studies (ICS).

With the system created with a user-friendly environment, the faculty staff would discover their work simple and proficient.

Conclusions

The defenders concluded that the ICS Laboratory Monitoring System met all the necessities composed within the targets objectives and scope of this study. Furthermore, the results of the test cases and the "Q.R. scanner" App ensured that every feature within the project is working as expected.

Recommendations

The researchers recommend the following:

- The seating plan should be implemented when the face-to-face classes start to make use of the system. By implementing the seating plan the students will be the one who will monitor the laboratories computer.

- ii. The researchers also recommend that the system should be upgraded in the future to cover the whole school inventory.
- iii. The researchers recommend adding a maintenance schedule to upgrade the damage report

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iSEE: IOT-Based Smart Walking Cane for Blind People

Jerome D. Bongcawel
Kaceylyene R. Cotioco
Ma. Daine F. Lorejo
Angelica B. Luce
Emerson S. Yaguel
Lorenzo C. Macam (Technical Adviser)

ABSTRACT

Blind or visually challenged people have difficulty connecting with others and recognizing the world's beauty. Visually challenged people may struggle to identify where they are and how to get from one place to another, making physical exercise challenging. Traditional canes have aided the visually impaired or blind in improving their mobility and recognizing threats; however, with the rapid growth of contemporary technology, the limitations of these aids have become apparent. These devices have a limited range of motion and provide very little information. The desire to employ current technologies to make people's lives easier is becoming increasingly vital as the reach of electronic gadgets grows. Many new areas of research, such as electronic mobility support for the blind, have sprung up as a result of this. The demand for navigational aids and navigational navigation has skyrocketed. The researchers came up with an idea to develop a device that helps blind or visually impaired for navigation. This study is focused on building a device called iSEE, an IoT-based smart-walking cane developed to help blind or visually impaired people safely navigate and avoid obstacles in their surroundings even without any direct contact with an obstacle. It is composed of HC-SR04 ultrasonic sensors that detect obstacles; an LM386 audio amplifier and a micro-SD card module responsible for the audio produced by the device; a buzzer for notification; a vibration motor that is meant for notifying the users with other disabilities like being deaf about the distance and direction of obstacles; a GSM module for the SMS emergency notifications; and a GPS module for the location of the device. Also, a mobile application was developed which shows the real-time tracking of the location of the device and buttons that trigger the buzzer. The overall functionality and usability of the device prototype and mobile application have been tested using a series of test cases. The researchers have executed three trials to ensure that the prototype and mobile application work properly and meet the objectives of the study.

CCS Concepts: • Internet of Things; • Mobile Application Development → Android Application

General Terms: Prototype, Arduino

INTRODUCTION

Visually challenged individuals have trouble recognizing even the tiniest detail with normal eyesight. A visual acuity of 6/60, with both eyes open, is less than or equal to 20 degrees of the horizontal range of the visual field of vision. These people are regarded as blind [1].

Near or far vision impairment affects at least 2.2 billion individuals worldwide. Vision impairment may have been avoided in at least a billion, or roughly half of these cases [2].

In 1 billion of people, there are 88.4 million persons with moderate refractive error; 94

million with cataracts; 7.7 million with glaucoma; 42 million with corneal opacity; 3.9 million with diabetic retinopathy or include people with severe visual impairment or blindness; 2 million with trachoma; and 826 million with diminished myopia due to untreated presbyopia [3].

The estimated number of bilateral blind individuals is 332,150 in the Philippines, 33% of which are caused by cataracts or about 109,609 in 2017, 25% (83,037) by refractive errors (EOR), and 14% (46,501) by glaucoma are estimated. The rest are THE cause of other disorders in the eye, such as glaucoma, retinopathy, and maculopathy. The current number of people with low vision in the two regions, in addition to the present numbers, includes 2,179,733 people whose figures are EOR 43% (937,285), cataract 34% (741,109),

and the remainder, glaucoma and other eye problems [58].

Young children who have severe early visual impairment are more likely to experience motor, language, emotional, social, and cognitive developmental delays, with lifelong impacts. Visual impairment severely affects the quality of life of adults. Adults with visual impairments often have lower employee engagement and productivity. For older adults, blind people may experience social isolation, difficulty walking, an increased risk of falls or fractures, and an increased likelihood of early entry into a nursing home [2].

Although many devices have been developed to help blind and visually impaired people improve movement and orientation, most still rely on existing technologies such as the white cane [4].

Many blind or visually impaired people use white canes. The white cane allows the user to examine nearby hazards or directional signs and helps the observer recognize it as blind or visually impaired and take appropriate action [5]. A person can selectively use it to navigate the area, but the primary function of the cane is to inform the public that the wearer has vision problems.

Canes have assisted the visually impaired or blind in improving their mobility and recognizing risks. Despite their popularity, these technologies cannot provide the blind with all the information and functionalities that people with sight have for safe movement [6], [7]. Regular canes need direct contact with an object or a barrier, which is inconvenient and occasionally endanger the blind or visually impaired person.

With the rapid advancement of current technology, the drawbacks of these aids include limited range of motion and very little information communicated. The guiding cane is lightweight and portable, but its range is restricted to its size, and it cannot be used with dynamic components [8].

With the reach of electronic devices ever-expanding, the need to use these modern technologies to make people's lives easier becomes more and more important. It is also increasingly common to use these technologies to make the lives of people with disabilities easier. This has stimulated many new research

areas, including electronic mobility assistance for the blind [9]. The demand for navigation and navigation aids has exploded [10].

The ability to detect the obstacle from a safe distance would help the visually impaired either step over or avoid the obstacles.

With these implications, the researchers came up with an idea to design and develop a device called "iSEE: IOT-BASED SMART WALKING CANE FOR BLIND PEOPLE" that aims to help the blind and visually impaired to safely navigate, detect and avoid obstacles in the surroundings even without any direct contact.

Background of the study

People who are blind or visually impaired have a more difficult time connecting with others and seeing the beauty of the world and environment. Physical activity can be strenuous for visually impaired people since it might be difficult to distinguish where they are and how to travel from one place to another [11]. People who are blind or visually impaired encounter daily problems such as navigating their environment, spotting obstacles, and recognizing people's faces and facial expressions during a conversation.

According to WHO (World Health Organization), people with 6/60 or a horizontal visual field of vision with both eyes open less than or equal to 20 degrees are considered blind [12], while those with visual impairment market are lost. Part of their vision cannot be corrected with glasses. People with severe visual impairment are more prone to falls [13], especially the elderly [14].

People who are blind or visually impaired have difficulties every day, particularly in navigating their environment. That is why, after World War I, people devised the white cane. In 1991, James Biggs [15], a Bristol photographer who went blind following an accident, decided to paint a stick white to move about his house comfortably.

The purpose of this study is to encourage blinds and visually impaired people to shift to advanced technology such as smart walking cane that provides more benefits than using traditional walking sticks. The device will help the user to detect and avoid obstacles from a safe distance. The researchers hope that the study will provide enough information about

the said technology and contribute to the cause of helping blinds and visually impaired people.

Objectives of the study

The researchers aim to develop a device “iSEE: IOT-BASED SMART WALKING CANE FOR BLIND PEOPLE”, a smart-walking cane device that aims to help the blind and visually impaired to safely navigate and avoid obstacles in their surroundings.

In line with this, this study aims to achieve the following specific objectives:

- To identify the necessary hardware and software required for the development of the device;
- To develop a smart walking cane for blind people with the following features:
 - Obstacle detection using HC-SR04 ultrasonic sensors;
 - Distinct audio produced via earphone depending on the distance and direction of an obstacle;
 - Distinct audio produced via earphone when a hole is detected;
 - Vibrating handle to notify the user with other disabilities such as being deaf if an obstacle is detected;
 - Built-in button that sends emergency SMS to a registered phone number;
- To Design and develop a user interface for the mobile application that enables real-time tracking of the cane's location as well as a button that, when pushed, activates the cane's buzzer, alerting that the guardian is looking for the user;
- To test the device and mobile application using ISO 25010 criteria for test cases and experimental tests for mobile app functionalities.

Scope and limitation of the study

The study covers an IoT-based smart walking cane for blind or visually impaired people. The study aims to design and develop a smart walking cane that will help blind or visually impaired people to navigate and avoid the possible obstacles in their surroundings like parked vehicles, humps on the road, canals, holes, big stones, animals, and even people.

The user needs to turn on the device using the power button provided below the handle to set up the device. The device uses 18650 batteries as a power supply and it will last about 15-20 hours a day. For the mobile application, the user's guardian needs to install and open the app on their mobile phone. To create an account, the guardian must enter the product ID given for security purposes and access the features of the developed user interface to track the blind or visually impaired people every time they use the smart walking cane device. The blind or visually impaired person will have to push the device to navigate the surroundings where it has a small wheel that helps the user push the device smoothly.

The IoT-based smart walking cane for blind and visually impaired people has the features to sense obstacles from a safe distance using HC-SR04 ultrasonic sensors. It also sends emergency notifications using the GSM module by pressing the yellow button placed on the device's handle to notify the guardian about the user's situation. The emergency notification has three levels, one press for "PICK ME UP", a double press for "I NEED HELP," and a long press for "I BADLY NEED AN EMERGENCY ASSISTANCE". The device also comes with a vibration motor, meant for notifying the blinds or visually impaired people with other disabilities such as being deaf. The vibration varies in the direction of the obstacles. For front obstacles, the device vibrates once, twice for left obstacles, thrice for right obstacles, and a two-second vibration for the hole obstacle. The vibrating mechanism would also be used in crowded or loud places to notify the user about the obstacles and the audio produced via earphones. The smart walking cane comes with a strap to secure the user's grip.

The microcontroller would be placed below the handle while HC-SR04 ultrasonic sensors would be placed at the edge part of the stick. The audio that the smart walking cane would produce varies according to the distance and direction of the obstacles. (See appendix F for the prototype and dimension of the device.)

The researchers will use ISO 25010 criteria as a guide for test cases. ISO 25010 criteria are characteristics and sub-characteristics that provide standard vocabulary for describing, measuring, and evaluating system and software

product quality. Furthermore, the MIT app's proposed user interface would have various functions such as tracking the device and notifying the blind or visually impaired that the guardian is looking for the user.

Despite its capabilities in performing the mentioned features, the device cannot detect obstacles height, width, and other obstacles such as wet surfaces like puddles and mud. In addition, due to design constraints, this study does not cover the visually impaired or blind people with other disabilities such as being crippled and mentally unstable people.

Furthermore, the researchers are not liable for any third-party failures, such as a GPS module and sim card that does not have a signal or Wi-Fi that is inaccessible.

Conceptual Framework

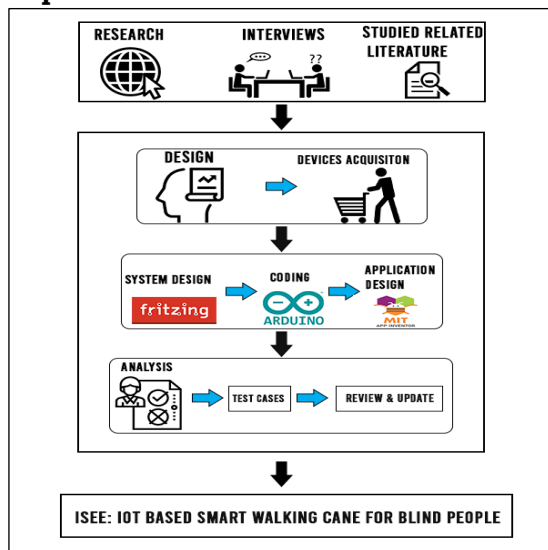


Figure 4: Conceptual Framework

Figure 4 illustrates the conceptual framework of “iSEE: IOT-BASED SMART WALKING CANE FOR BLIND PEOPLE”. The task of transforming concepts, skills, and experience into a compelling performance is accomplished through a conceptual framework. The proposed IOT-BASED SMART WALKING CANE FOR BLIND PEOPLE is represented using an Input, Process, and Output (IPO) diagram.

The researchers take into account the requirements to attain the desired outputs. To construct the application and device, the researchers must first gain knowledge of Arduino electrical circuitry, application

designs, and programming skills. The researchers also conducted a virtual interview with the target beneficiary of the proposed system and studied relevant literature and articles.

The researchers developed the initial design of the device after analyzing the data obtained from observation and interviews. The required devices were obtained to construct the prototype. Using the “Fritzing circuit,” the researchers developed the device's system design and schematic diagram. Considering the system design and specifications, the researchers coded the device using “Arduino IDE,” and for the application design and development, the researchers used “MIT App Inventor.” The researchers conducted the analysis using test cases.

After the assessment phase, the researchers would repeat the process if there are any recommendations to strengthen the methods used in developing the system and further improve the device functionality.

SYSTEM DEVELOPMENT METHODOLOGY

This section presents the development method employed by the researchers in conducting the study and the discussion regarding the Software Development procedures.

The System Development Life Cycle (SDLC), sometimes known as the Application Development Life Cycle in the industry, is a term used to describe the process of planning, building, testing, and deploying an information system [47]. The system development life cycle is a project management model that outlines the steps that must be followed to accomplish a construction process. SDLC is a well-structured sequence of phases for developing or improving a given system. [59]. Under the SDLC methodology, a variety of models has gained prominence in recent decades. One of these models is known as the Prototype Model which would be used to describe the processes employed by the researchers in developing the project. A prototype is developed with minimal specifications in the Prototype model, one of the software development life cycle models. The prototype is then tested and adjusted depending on customer input until a final prototype with all necessary functionality is developed. This final prototype will also serve

as the basis for the final product [60]. (See figure 5 for the Phases of Prototype Model).

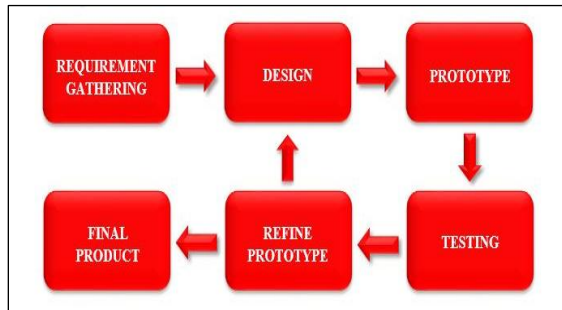


Figure 5: Prototype model

Figure 5 shows the Prototype Model for the development of “iSEE: IOT-Based Smart Walking Cane for Blind People”.

Requirement gathering

In this phase, the researchers interviewed the target beneficiary of the system and surveyed some experts to validate and strengthen the ideas in developing the device. After conducting an interview, the researchers gathered data on how to build the device and the needed features to be included in the proposed system. The prototype is then tested and altered in response to the client's feedback until the final prototype with the needed functionality is created. (See appendix B for the interview result).

Design

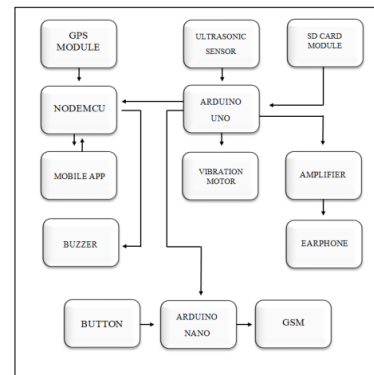
The system construction would take place during this phase. The researcher would ensure that the overall design specified by the users is followed. This section addresses the physical and conceptual nature of the developed method. During this phase, various diagrams such as schematic diagrams and block diagrams would be generated.

Block Diagram. A block diagram is a system diagram in which blocks linked together by arrows represent the main components or functions. They are frequently used in engineering, primarily in hardware design, electronic design, software design, and process flow diagrams [48]. Appendix C explains the systems concept and interconnection of IoT-based smart walking cane to the mobile application. The ultrasonic sensors attached to

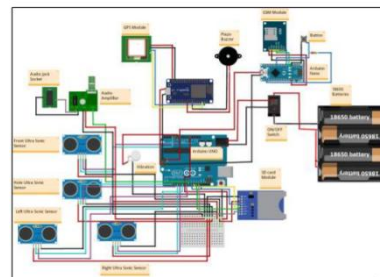
the microcontroller can detect the data, such as distance from the obstacles. In contrast, the microcontroller can analyze the gathered data and make decisions based on the distance of the obstacles. Furthermore, the GPS module would relay data to the NodeMCU and transmit that data to the firebase to the mobile app enable the tracking and displaying of the device's GPS coordinates. (See appendix D for the block diagram).

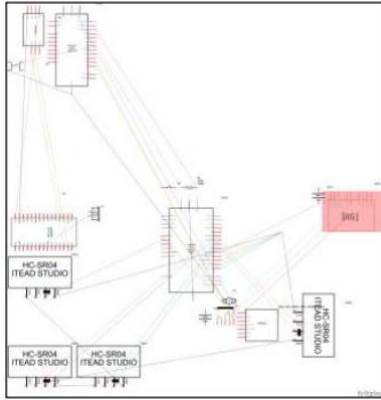
Schematic Diagram. Schematic designs emphasize the primary and auxiliary circuits for control, signaling, monitoring, and protection systems. They are illustrated in sufficient depth to describe the circuitry and its manner of functioning to the user. They allow circuits to be ‘followed through’ when tracing faults [49]. The wiring, connections, and placement of the IoT-based smart walking cane. (See appendix E for the schematic diagram).

Appendix D
BLOCK DIAGRAM

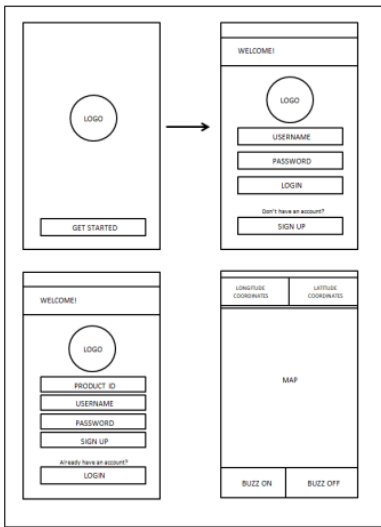


Appendix E
SCHEMATIC DIAGRAM





Appendix G
STORYBOARD



Prototype

During this process, the proposed system would be constructed. The researchers assessed the overall design as well as the data collected during the data collection process. The researchers used this data to ensure that the device met all of the requirements outlined in the study's objectives.

The researchers utilized "Arduino IDE" as the programming platform to build and upload programs to Arduino compatible boards, "Fritzing" for the suggested system's design and schematic wiring diagram, as well as "MIT App Inventor" for the mobile application.

Hardware and Software Requirements

The following table below shows the minimum specification of the required hardware and software used to develop the system.

Table 1: Hardware Specification

Components	Specification
Processor and Frequency	Celeron
RAM	4GB
Operating System	Windows 7

Table 2: Software Specification

Software	Description
Arduino IDE	Used to write codes and upload programs to Arduino compatible boards.
Fritzing	Used to create the schematic diagram or the electrical wiring circuit of a specific device.
MIT App Inventor	Used to develop and create GUI of a mobile application for Android phones.
Adobe Photoshop	A photo editing software. Used to create the logo for the mobile app.

Testing

The functionality of the device and developed user interface for the mobile application would be tested during this phase. The device would be deployed in an area where obstacles are present to test if the device is capable of detecting obstacles, producing distinct sounds and vibration, informing the user about the direction of the obstacles and if the location of the device can be tracked using GPS tracking application. Furthermore, the button on the cane would also be tested during this phase whether the device sends an emergency SMS notification to the registered mobile number to notify the user's guardian.

Refine prototype

Redesigning and redeveloping of the proposed system would be made during this phase. The panelists' recommendations and suggestions are strictly followed to improve the functionality of the device further. For instance, problems encountered in wiring connectivity during testing of the device and defective mobile

application would be repaired during this phase.

Final product

After the series of testing and reviews made to the device functionality and mobile application, the final product takes place during this phase. In compliance with the objectives that the researchers set out to achieve, the researchers were able to design and develop the final product in line with the panelists' recommendations. (See appendix F for the device prototype.)

RESULTS AND OUTCOMES

This section presents the results and discussion of the testing and evaluation of the system made by the proponents. The researchers used test cases as the testing tool to check the system's stability.

The researchers were able to identify the necessary hardware and software requirements. Using the aggregate information gathered by the researchers they were able to achieve the study's system prototype requirements and objectives. The iSEE device can now detect obstacles such as holes, as well as produce audio depending on the direction and distance of the obstacles via earphones. If an obstacle is detected, it would trigger the vibrating mechanism of the device as an additional means of notifying the blind or visually impaired person with other disabilities such as being deaf. It also has a built-in button that sends emergency SMS notifications to the user's guardian. The device also includes a mobile application that the guardian may use to track and inform the user.



Figure 6: The iSEE mobile application user interface

The figure above shows the mobile application user interface of the iSEE device. The first screen displays the homepage with the get started button; clicking this button will proceed to the second screen, which has the login form; however, the guardian must first create an account before signing in. The third screen displays the sign-up form, from which the guardian can create an account. In creating an account, the guardian must create a username and password and is required to enter the given product ID before accessing the location tracker feature of the mobile application. The product ID will provide extra security for the user of the device and since without a product ID, the user cannot create an account, and without an account, the user cannot access the user's location. The fourth screen displays the location tracker as well as the button that activates the device's buzzer to notify the user.



Figure 7: Obstacle detection



Figure 8: Photo proof from Arduino's serial monitor

Figures 7 and 8 show the obstacle detection feature of the device using HC-SR04 ultrasonic sensors. A photo proof from the Arduino's serial monitor was provided to show the exact distance of obstacles from the sensors. (See video reference.)



Figure 9: Distinct audio via earphone

Figure 9 shows that the device produces distinct audio via earphones depending on the direction and distance of the obstacles. (See video reference.)



Figure 10: Vibrating mechanism



Figure 11: Vibration test in rough road and moving vehicle

Figure 10 shows the vibrating mechanism of the iSEE device using a cup of water placed above the box where the vibration motor is attached, while figure 11 shows the testing conducted to verify if the user of the device can distinguish the difference in vibration between the device and the surroundings such as rough roads and moving vehicles. When the device detects an obstacle, it will emit a distinct sound; nevertheless, users with other disabilities, such as deafness, will benefit from the vibrating mechanism. The device will

vibrate in accordance with the direction of the obstacles, with one vibration for the front, two vibrations for the left, three vibrations for the right, and two-second vibration for the hole. (See video reference.)

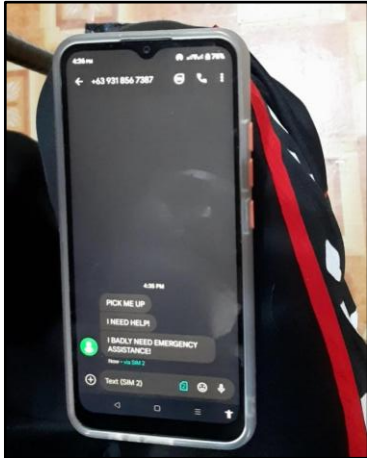


Figure 12: Emergency SMS notification

Figure 12 shows the levels of emergency notifications sent via SMS. The iSEE device includes a built-in button that the user may use for emergency purposes. When the button is hit once, it sends an SMS that says "PICK ME UP," when it is double pressed, it sends "I NEED ASSISTANCE," and when it is long pressed, it sends "I BADLY NEED AN EMERGENCY ASSISTANCE!". (See video reference.)

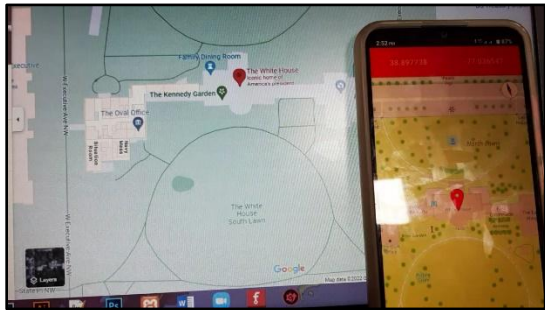


Figure 13: Google Map verification

Figure 13 shows the verification of the accuracy of the map displayed on the mobile application using Google Maps. The researchers tried to manipulate the data from

the database and input GPS coordinates (longitude and latitude) of a specific place from the Google Map to verify if the location shown on the mobile app is accurate. (See video reference.)



Figure 14: Latency test of receiving SMS emergency notifications

Figure 14 shows the latency testing of receiving SMS emergency notifications using Signal Strength, a third-party mobile application used for testing Wi-Fi and cellular data signals. The researchers have measured the average time in which the registered mobile number would receive the message. Based on the result shown using Signal Strength, the researchers have found that with an optimal signal strength of -106 dBm, the average time to receive an SMS notification is 24.3 seconds while 24.6 seconds with a non-optimal signal strength of -113 dBm. (See video reference.)

Remember that each hardware feature has been tested thrice to guarantee that the IoT components are functioning properly. Based on the test cases results, it was found out that the obstacle detection feature along with the audio and distinct vibrations produced by the device works properly in three directions (front, right and left) as well as in detecting hole obstacles. Furthermore, the researchers have found out that the delays in sending emergency notifications are affected by the strength of the cellular network’s signal. (See Appendix K for the test cases results for the functionality of iSEE Prototype.)

Table 3: Functionality Test Cases Result of iSEE Prototype

Hardware	Yes	No

Does the device detect obstacles at a distance of 0-10 cm in three directions (right, left, front)?	☐	
Does the device detect obstacles at a distance of 10-20 cm in three directions (right, left, front)?	☐	
Does the device detect obstacles at a distance of 20-30 cm in three directions (right, left, front)?	☐	
Does the device detect obstacles at a distance of 30-40 cm in three directions (right, left, front)?	☐	
Does the device detect obstacles at a distance of 40-50 cm in three directions (right, left, front)?	☐	
Can sensors detect car obstacles in three directions (front, left, right)?	☐	
Can sensors detect moving obstacles in three directions (front, left, right)?	☐	
Are the sensors properly placed to avoid water splashes on the ground?	☐	
Can the device detect falling objects in three directions?	☐	
Can the hole sensor detect potholes, cracks, manhole, small indents hole, and edges?	☐	
Does the device produce audio through earphones when it detects obstacles?	☐	
Does the device's audio indicate the distance between obstacles?	☐	
Does the device produce vibration at a distance of 0-10 cm in three directions (front, left, right) when an obstacle is detected?	☐	
Does the device produce vibration at a distance of 10-20 cm in three directions (front, left, right) when an obstacle is detected?	☐	
Does the device produce vibration at a distance of 20-30 cm in three directions (front, left, right) when an obstacle is detected?	☐	
Does the device produce vibration at a distance of 30-40 cm in three directions (front, left, right) when an obstacle is detected?	☐	
Does the device produce vibration at a distance of 40-50 cm in three directions (front, left, right) when an obstacle is detected?	☐	
Does the vibration strength change when	☐	

the battery is not fully charged?		
Can the user distinguish the difference in vibration between the device and surroundings such as rough roads and vehicle vibration?	☐	
Does the user still feel the vibration when riding a transportation vehicle?	☐	
Can the vibration strain or make the user's hand numb in prolonged uses?	☐	
Does the user can easily press the button dedicated to sending SMS emergency notifications?	☐	
Can the button still function even when pressed aggressively multiple times?	☐	
Does the built-in button send emergency notification to the registered mobile number?	☐	
Does the strength of the cellular network's signal affect the receiving of SMS emergency notifications?	☐	
Can the sim properly receive load?	☐	
Does the wheel still work smoothly at normal speed and high speed?	☐	
Does the wheel still work on dirt roads/muddy areas?	☐	
Can the user still clearly hear the audio even in loud places?	☐	
Can the sound of the buzzer still be heard in loud places?	☐	
Can the sound of the buzzer still be heard when the user rides a vehicle?	☐	
Can the user change the battery on its own in case of an emergency?	☐	

Table 4: Usability Test Cases Result of iSEE Prototype

System Feature	Yes	No
Do the device features appropriate for the needs of the user?	☐	
Is the device easy to understand?	☐	
Is the mobile application user interface easy to understand?	☐	
Is the mobile application user interface pleasing to the eyes?	☐	

Three trials are made to ensure that the features of the developed mobile application

functions well and are able to serve its purpose. The researchers have found out that the speed of the Wi-Fi connectivity affects how immediately the mobile app displays the location of the device. However, when the Wi-Fi connectivity is stable, the GPS coordinates and real-time location of the device shows on screen and the buttons dedicated for notifying the user of the device prototype works properly. The buzzer turns on when the “BUZZ ON” labeled button is pressed and turns off when the “BUZZ OFF” button is pressed.

After a series of testing, the researchers concluded that the developed mobile application works properly and verified its effectiveness, capabilities and functionality. (See Appendix M for the test cases results for the Mobile Application User Interface of iSEE Prototype.)

Table 5: Mobile Application User Interface Test Cases of iSEE Prototype

User Interface (UI) Test Cases	Yes	No
Does the app display the real-time location and GPS coordinates of the device?	☐	
Does the strength of the GPS signal affect the displaying of GPS coordinates in the mobile application?	☐	
Is the GPS coordinates shown on the mobile application accurate using Google Maps?	☐	
Does the app still work properly even though the hotspot is congested (many connected)?	☐	
While installing the app and the connection is lost, will the installation still be completed?	☐	
While downloading the app and the connection is lost, will the download still be completed?		☐
While loading the map and the connection is lost, will the map still be loaded?		☐
Is the map available for dragging in other locations?	☐	
Does the button on the app trigger the buzzer from the device when it is pressed?	☐	
Is the registered number able to receive the SMS text?	☐	

Does the app last long without error?	☐	
Does the login and sign-up button work?	☐	
Can the user create another account using the same product ID?		☐
Will the account still be logged in if the user suddenly exits the app?		☐

DISCUSSIONS

The researchers used the prototyping model phases to create the prototype iSEE and mobile application integrated output product. Specific goals were developed based on the functionalities and design elements. The researchers ran test cases to measure and test the state of the mobile application and the prototype in order to confirm the intended outcome. The panelist recommended adding a login and sign-up option as well as strengthening the security of the mobile application, which was accomplished by creating a new application on a different platform. Furthermore, the researchers devised a method for evaluating the prototype and mobile application in different locations. One of the researchers used the prototype to test its functionality, such as sensing and detecting obstacles, producing vibration and audio, and transmitting data location to the mobile application. Another researcher used the mobile application to see if it functions properly by sending and receiving responses from the connected prototype.

Conclusion

This chapter consists of the summary of findings, conclusions and recommendations based on the results of the study entitled “iSEE: IOT-BASED SMART WALKING CANE FOR BLIND PEOPLE”.The proposed system adheres to its specific goals. Researchers created a device that helps blind or visually impaired people safely navigate, detect, and avoid obstacles in the surroundings even without direct contact.. The prototype was built with ultrasonic sensors, microcontrollers, vibration and sound motors and is connected to the developed mobile application that allows the parents or guardians to track the location of the blind or visually impaired person whenever they use the smart walking cane. The parents or guardians are also allowed to send and receive notifications to the blind by using the mobile application.

The set goals and objectives are finally achieved by utilizing the prototyping method. Different experimental trials were performed to check the integrity and functionality of the prototype and mobile application. The researchers formulated test cases to measure and secure the functionality of the prototype and mobile application to verify the expected result. All phases were repeatedly checked and tried until an acceptable, complete and successful prototype and mobile application was achieved.

The researchers used test cases to test the hardware and software functionalities. Based on the results of the test cases performed in the prototype and mobile application, the researchers have found out that both hardware and software are working properly. Furthermore, there are a total of thirty-four test cases conducted for the prototype and sixteen for the mobile application. Three trials were performed to ensure the integrity of each test case.

The developers were able to create the functionality of login and sign up features of the mobile application for security purposes. They were also able to display the real-time location of the user using the developed mobile application. In conclusion, the researchers were able to develop a working IoT-based smart walking cane along with a mobile application that is intended to help the blind and visually impaired people.

Recommendations

The researchers considered the following recommendations for future improvement of the developed iSEE prototype.

- Improve the device's design by reducing its size into a smaller, lighter and portable version.
- Enhance the power source by replacing the battery with a rechargeable and reusable power source.
- Improve the mobile application where the admin can add another device. Add a water sensor to detect puddles or other water obstacles.

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iYear: A Digital Yearbook Creator Web Application for Mabalacat City College

James arvie Maderas
Adrian Miranda
Edrielle Masbang
Patrick Villanueva
Nick Tyrill Alfaro
Ronald T. Domingo, MSIT (Technical Adviser)

ABSTRACT

The benefit of technology is that it allows people to accomplish things that make their lives simpler. The researchers developed "iYear," a digital web-based yearbook creator. This study was done by researchers for Mabalacat City College to be an alternative to the hardbound yearbook. "iYear: A Digital Yearbook Creator Web Application for Mabalacat City College" that can be accessed online using a desktop or mobile browser. This is a yearbook creator that can easily input data about alumni, events, and news, and it can be viewed or downloaded as a pdf on any device that can access the web application. It can also be printed as a hardcopy. The method used is an extreme programming model, which concentrates on preliminary growth and design before progressively developing until the final software is completely built.

INTRODUCTION

In recent years, the fast evolution of the internet and wireless communication technology has resulted in the development of various interactive multimedia networks, such as using devices that can be used for studying [1].

A yearbook is a book containing photos and words that is published annually by an institution to commemorate and highlight the events of a given school in the previous year. It features the information and likes of the individual student and gives a general account of the student's life. It also contains information about the achievements and events of the previous year in a particular place or school organization. Yearbooks are an important part of an individual's history. They are intended to be kept and cataloged by the school and its students. According to Melissa Caudill [2], yearbooks have two major audiences. The first is the present students who receive their yearbook every year. The second audience is the same group of students who are trying to recall their school days 25 years later.

Traditionally, yearbooks are produced by students at the high school and collegiate levels, and therefore, the purpose is to preserve images, stories, and facts from every year.

As they glance back to a degree in time, to a selected experience, an occasion or perhaps a

memorable incident, a few of those moments are "once in a very lifetime" occurrences, and plenty of the people they meet along the way may never cross paths with them again. Well, the iYear is passionate and committed to capturing and preserving those memories. The researcher understands how essential the yearbook is to alumni since seeing kids who have graduated from college helps them feel good. [3]

This study is a platform wherein school yearbooks will be available using mobile, tablet, and personal computer technology. The application will serve as an online gallery of yearbooks for easy and convenient access by Mabalacat City College students.

IT students, the primary target audience for college yearbooks, are the leading purchasers of these devices. According to the U.S. Department of Education, National Center for Education Statistics [4], in 2015, 94% of children aged 3 to 18 had a computer at home, and 61% of children aged 3 to 18 had access to the Internet at home. The percentage of children using computers and the Internet at home in 2015 was higher among older children, those with more educated parents, and those with higher-income families. And I believe that almost all learners have devices that can browse.

The researchers created the "iYear," which is a web-based yearbook where they can submit

information about alumni students, teachers, events, news, or speeches from workers with positions, according to the developer. Only the administration, staff, and alumni students identified per institution have access to this yearbook. Of course, admin may upload images to the web-based yearbook, which is exclusively available at the school of Mabalacat City College. Here are all of the institution's programs, or what they commonly refer to as courses. Each university has its own backdrop design, and each institution chooses their preferred design.

The researchers decided to do this because, according to those they spoke with, the Mabalacat City College school was founded in 2007 and opened in 2008. Since then, no single yearbook has been published for the students at Mabalacat City College, so researchers decided to create this digital yearbook as an alternative yearbook for Mabalacat City College, so that alumni will have a yearbook starting this year. According to the developer, who may publish numerous photographs at a time on the admin site, it is very simple to use for posting photos, news, or anything else connected to the yearbook.

Background of the study

The researcher's locale is the Mabalacat City College school. And they all know how important the yearbook is for a student. Here they will remember the time when, through the hardships of life and studies, they were able to graduate with the help of our Lord and parents. The researchers talked about making a digital yearbook called "Mabalacat City College Yearbook" because, according to Sir Niel Ridgao of the IGP, since the establishment of the Mabalacat City College until now, the school has no record of publishing a yearbook.

The researchers developed a digital yearbook system named "iYear." This is a web-based yearbook where the admin can enter information about alumni students, events, news, or speeches from employees with positions. Only the administration, staff, and alumni students of Mabalacat City College can access this yearbook according to those listed per institution. And of course, they can put photos in the web-based yearbook, although it is only at the school of Mabalacat City College this digital yearbook. Here are all the institute

programs, or what they often call courses. Each institution has its design for the background, each institution chooses for their desired design. And it can also print the yearbook of each institution and it can be printed via pdf.

The researchers chose to propose this study to help the college administration and staff with an effective alumni yearbook maker that might be able to solve the problems for all students who want to check their yearbooks. The iYear is the most simple and user-friendly form that student alumni can access via their browsers on their phones, tablets, and PCs.

This is an excellent alternative to traditional hardcover yearbooks, which can cost a lot of money to create hardcopy yearbooks. Students can access iYear through their browsers on their phones, tablets, and PCs, making it the simplest and most accessible form.

Objectives of the study

The main objective of the study is to develop an alumni yearbook maker for Mabalacat City College that provides easy free accessibility and availability.

iYear is a digital yearbook where admin can add alumni, students, information for every institute.

In line with this, the study aimed the following specific objectives:

- To gather reliable information in identifying initial requirements for the system development.
- To design the system using VTOC, Use case, Context Diagram, Entity Relationship Diagram.
- To develop and design Web-based system digital yearbook application with the following features:
 - Four access levels:
 - Admin;
 - Sub-Admin;
 - Staff;
 - 3.1.2 Students;
 - Downloadable yearbook.
 - Printable PDF yearbook.
- To evaluate the web-based application using the following ISO/IEC 9126 standards:
 - Usability
 - Functionality
 - Reliability
 - Portability

- To publish the Web – based server through a hosting service platform.

Scope and limitation

The title of this study is "iYear: A Digital Yearbook Creator Web Application for Mabalacat City College," whose net objective is to have easy access to a yearbook for the alumni of Mabalacat City College School. To accomplish this, the researchers began by gathering information from scholarly articles on the internet to define the problem(s) and identify the initial system development requirements. due to the inability of the school workers to create and produce a yearbook, the researchers planned to do so. Furthermore, the researchers conducted online meetings to brainstorm and design diagrams based on the features of the proposed system. The researchers came up with the features that will be incorporated into the web-based server. These features are visually represented using a diagram called the Entity Relationship Diagram. The features and functionalities of the web-based server are tested using the test cases.

The researchers have developed a Web-based application for the digital yearbook that is easy to access and easy to use. It will help Mabalacat City College to have its own digital yearbook that is very easy to use and will speed up the making of the yearbook.

The researchers will develop and design the iYear web-based server using the following software programs: MongoDB is a tool that can manage document-oriented information and store or retrieve information. Express JS is a backend application framework that is used to create online applications as well as APIs. And there's ReactJS, which generates user interfaces and can be used to construct single-page apps or mobile apps. And Node.js is a server-side programming environment for executing JavaScript code. They are collectively referred to as the MERN stack. they also utilize the Photoshop design program to develop or design templates. The researchers also use Adobe Acrobat.

First, alumni must visit the website mccyearbook.ddns.net to access and login to the application. The alumni must have an account. The alumni will automatically have an account when they are a candidate to graduate.

It will be given to Alumni by the school via email. when they log in, they will see the home page. Then scroll down. They will see the Mabalacat City Mayor, board of trustees, and news and updates. and they can also see it here. There are four buttons next to the home button. The first is the batch year button. They can see here the yearbooks of each institute and each section. The events button in this section displays the event(s) that took place at the school. in the gallery, they can see the extra images of the alumni except for the yearbook images. In the account button under it, there are also buttons to request a yearbook, download, profile, account manage, help, and logout.

One of the objectives of the researchers is the request for a yearbook located on the student site. They can see here that there is a "request a yearbook" button for when the yearbook is already available and has been enabled by the admin so that the student can request a yearbook. After requesting the student (s) to notify the admin, the admin will reserve the yearbook for the student (s). Take note that the yearbook can be requested based on the student's batch year; for example, if the student's batch year is 2021-2022, the yearbook can be requested to be for the batch 2021-2022 only.

The "Download Yearbook" button on the student site where the yearbook can be downloaded as a softcopy. Once the admin has made the copy of the yearbook and enabled it to be downloadable, the student can download it. If it is not enabled in the admin, the student cannot download the yearbook.

One of the objectives of the proponent for managing the web application is the admin. The administrators of iYear can also sign in through the website(mccyearbook.ddns.net) Admin is the highest user role; it adds, changes, and deletes data records. The admin (s) will manage the web application and maintain it.

The overview can be seen on the web page of the admin after signing in. In the over view they can see the number of records entered by the admin, the number of graduates, those who requested the yearbook for printing, and how many batch years there are. In addition, recent graduates can be found here.

The administration can see the board of trustees here. If the admin has entered here, they can see the lists of board of trustees including the chairman, vice chairman, chairperson, faculty representative, ALCU representative, MCC alumni representative, and student representative. It can also edit and change the name, position, and image. In the gallery, here they can see random images posted by the admin. they can also put images related to news and events or happenings at the school by simply dragging the image to the center of the box. They can enter data based on those who received honors and awards in a batch using honor and awards. The latest news and events can simply add news about Mabalacat City College by clicking the "new" button on the upper right. Same with news on events. They can enter events that happened at school and just press the "add new button" on the upper right. The commence button is where the mayor of the municipality's speech is delivered. The admin also receives concern or issue messages from users of the web application. An admin can change his or her email and password. The account management is available here. the admin creates the user accounts. When the alumni clicked they will see the numbers of each user, and when they click it, they will see the names of the users who are who they are. They can also add a user by clicking on the position they want to take. After they click the add icon button, they must enter the email and password and register it. The batch template can be found on the admin site where they can customize and add a template design to the cover page of the yearbook created. They just click the year design button and they will see that they can set the mission and vision, goals, core values, as well as customize the yearbook back page. They can also customize the cover page templates, name tags of each alumni, and be able to post quotes from each Alumni. The pdf control can be found on the admin site, and the yearbook button can be found there with the pdf control. After clicking the pdf control, they will see the list of all created pdfs. The purpose of this pdf control is to print a yearbook to be printed by the admin. There is a file icon on the right side. By clicking on it and it will go to the list of already created pdfs that

have different contents. If the user wants to see it, they can do so by selecting the eye icon. By click on it and it will go to the new tab where there is the pdf that the user wanted to see. There are also features that can enable the download link when this pdf is finished, and on the student site it is already activated and can be downloaded as a soft copy on their devices. It can also be updated. By clicking the update icon on the right side and it can be updated.

They will also find here a button under the yearbook, along with the pdf control, which is the request. Here the request can be seen if anyone has requested a yearbook. Here can be seen the number of those who have requested. Only student alumni can request the yearbook. This institute is the main target of researchers because here they can see the literal yearbook. It can be seen on the admin site where it is one of the Admin manages. Once they click the "institute" button, they will see the lists of existing institute programs if the admin has already entered the data.

Inside this institute button they will see adjacent buttons, the first of which is the plus icon. It can create another institute and just enter its requirements to create it. One of the requirements is the institute name, institute logo, background, and institute acronym. The second button is the view button, where when they click on the view, the institute program buttons will change to view records, and the user can see what's within by just clicking on the section they want to see. The third button is the edit button. When they click the buttons, the edit institute program will change. it can add or change data according to what the admin wants to happen. The fourth button is the delete button. The label placed on each institute of the deleted record will also be different when they click the delete button icon. They can also remove the data that needs to be removed. There is also a search button that can be used to search for specific items, such as the name of an alumni.

And test the system by verify the System functions if are they working properly based on their functionalities. The researchers checked the Web application's GUI, Buttons, and Security to ensure that it functions properly. During the test, several items didn't work, researchers rectified each mistake one by one

until there were none left. The most essential aspect of the test is that they can see the mistakes.

The limitation of this iYear is made for the Mabalacat city college school only. Because, according to their local, it is only the Mabalacat City College. Researchers wanted to facilitate the making of the yearbook and improve the yearbook of Mabalacat City College.

SYSTEM DEVELOPMENT METHODOLOGY

This section discussed the methodology of this study and how the application was developed using the developmental tools and techniques used by the researchers, from data collection to testing and evaluation, and even how the application was implemented to meet the testers' and evaluators' expectations.

The researchers of this study chose to use the system development life cycle method in designing and developing the web-based server of iYear. The extreme Programming is an agile software development framework that aims to produce higher quality software, and higher quality of life for the development team. [25]

The general method used in this study is qualitative, relying on the data and information provided by our respondents or interviewers. It improves the study's conclusions by gathering and comprehending data concepts from similar research. Furthermore, it enables the researchers to have an in-depth understanding of the study in order to successfully improve and develop the methods to successfully complete it.

Extreme Programming (XP)

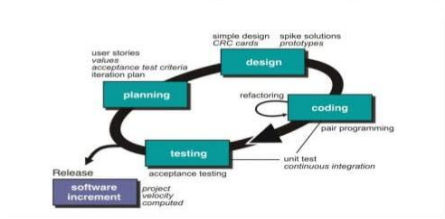


Figure 7: Extreme programming Methodology
(Source:

https://www.researchgate.net/figure/eXtreme-Programming-XP-Development-Model-6_fig1_339093922)

The researchers chose the Extreme Programming Methodology technique, since it explains the actual procedures required in developing the study's system application from planning to deployment. This notion is applicable to a wide variety of software applications that are relevant to the study to organize and work with the concepts. There are five phases of extreme programming methodology that include planning, designing, coding, testing, releasing.

Planning

The first phase will start with planning. Researchers gathered to discuss what is needed to build our system and what needs to be added to it. Based on the developed system, they devised a plan for creating a yearbook. the researchers also searched for information on processing applications and compiling the yearbook at Mabalacat City College School so that they would know how they are processed and who compiles the yearbook. They also spoke to the institute to request information such as instructors, deans, news, and events. The researchers also discussed software that can help build the system.

Designing

The second stage is the design stage. The researchers decided to use Yearbooks from different schools to obtain information about the formats and projects that they could apply to the system. Also use Photoshop to create and design templates. And they developer was looking for applications that he thought could be used and that would be easier to develop the system.

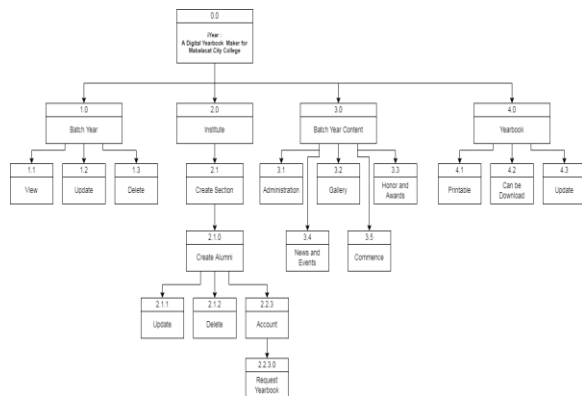
To show the backend features of the iYear web site, the researchers of this study used a VTOC (Visual Table of Contents). (See Appendix H for the Visual Table of Contents Diagram). Visual Table of Contents is a display in a report or document that reveals in advance the content of the document, how the information inside has been structured and the page in which you can find each section [26].

The researchers also used a Use Case Diagram to represent the different user's goals and how one interacts with the system. (See Appendices I, J, K, and L for the Use Case diagrams). The Use Case used includes the system of iYear, 4 Users, and use cases.

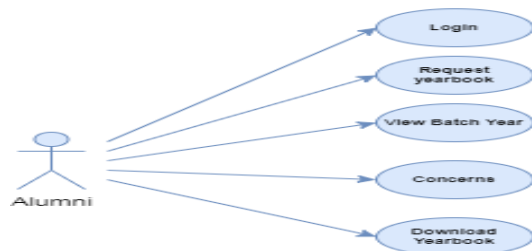
The researchers also used a Context Diagram to define the boundary between the system and actors and to show the entities that interact with the system. (See Appendix G for the Context Diagram diagram).

The researchers also created an Entity Relationship Diagram to show the relationships of entity sets stored in the iYear database and to illustrate its logical structure. (See Appendix E for the Entity Relationship diagram)

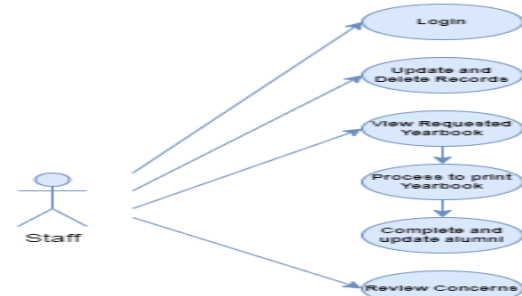
Appendix H VTOC



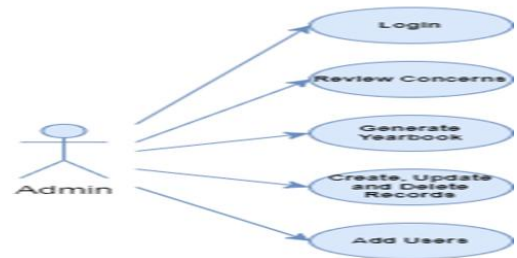
Appendix I Use Case Diagram for iYear Alumni



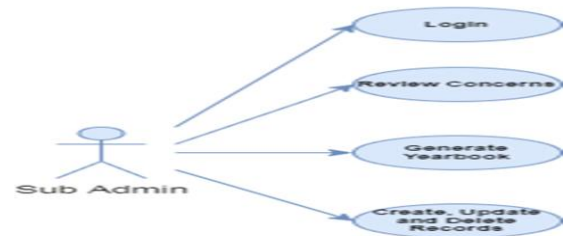
Appendix J Use Case Diagram for iYear Staff



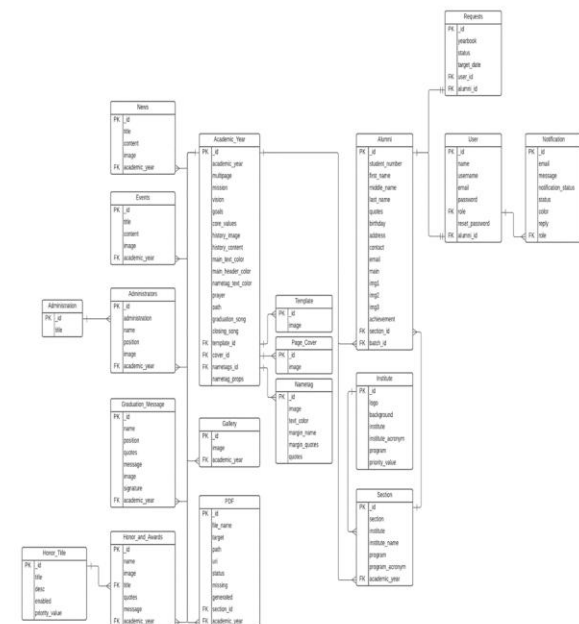
Appendix K Use Case Diagram for iYear Administrator



Appendix L Use Case Diagram for iYear Sub Administrator



Appendix E Entity Relationship Diagram



Coding

The third step is coding. The researcher will put the strategies developed during the planning phase into action, as well as the decisions made during the designing phase. To expedite the study, the researchers divided the tasks, and they used what they learned in earlier classes that might have been applied to

past studies in their research. The programmer also looked at the software programs that will be used, such as MongoDB, Express, React, and Node.js, collectively known as the MERN stack. MongoDB is a document database, according to the programmer. Node.js web framework Express (.js). React (.js) is a JavaScript framework for the client side. Node.js is the most popular JavaScript web server. The following are the applications of this program in the creation of our system. In addition, the designers utilized Photoshop to build templates for the yearbook system.

Testing

The researchers conducted test cases in terms of functionality, reliability, portability, and usability of the web-based application before the deployment. In terms of functionality, the researchers test all buttons, input field validations, and security. If there's a problem with the functionality, it will iterate again back to the planning phase until the functionality is all done and working as expected, (please see table 3, appendix B for the results). in terms of reliability, by making sure that the system is user friendly, (please see table 4 appendix C for the results). In terms of portability assuring the compatibility of every devices to worked on the system, (please see table 5 appendix D for the results). In usability, if the users are satisfied based on their experience with the system result, (please see table 2 appendix A for the results).

Appendix B

Functionality Test case

Table 3: Functionality Testing Case of iYear Web-based Server

Test case ID	Feature	Precondition	Steps
Web_Func1	Accessing the website as a regular visitor	Web_Func1 successful	1.Go to mccyearbook.ddns.net

Web_Func2	Log in as user	Web_Func2 successful	1.Go to mccyearbook.ddns.net 2.Tap the "Sign in". 3.Enter the valid username. 4.Enter the password.
Web_Func3	Can input many student info in a time as admin	Web_Func3 successful	1.Go to mccyearbook.ddns.net 2.sign in as admin 3.click institute button 4.click view records 5.Add multiple data.
Web_Func4	Requesting for yearbook printing as student	Web_Func4 successful	1.Go to mccyearbook.ddns.net. 2.Log in as student. 3.Click the request yearbook.
Web_Func5	Printing yearbook in website	Web_Func5 successful	1.Go to mccyearbook.ddns.net 2.Log in as admin 3.Click batch template 4.Click the ellipsis and click view yearbook 5.Press ctrl+p for printing
Web_Func6	Creating PDF	Web_Func6 successful	1.Go to mccyearbook.ddns.net 2.Sign in as admin 3.Click the button PDF control 4.Click the file icon and wait 5.And click generate yearbook

Web_Func7	Adding user role	Web_Func7 successful	1.Go to mccyearbook.ddns.net 2.Log in as admin 3.Click the button manage account 4.Choose account what they wanted to manage.

Test case ID	Expected results	Actual results	Status
Web_Func1	1. The website should be up and running 2. All buttons should be working 3. All pages are up and without crashes	As expected	PASSED
Web_Func2	1. Information can be typed in the login form 2. All buttons should be working	As expected	PASSED
Web_Func3	1. All buttons should be working. 2. The information should be sent back to the admin interface. 3.The data should be accurate.	As expected	PASSED

Web_Func4-	1.button should be working. 2.Notification from alumni when there was a change in the request.		PASSED
Web_Func5	1. The text and images should be aligned properly.	As expected	PASSED
Web_Func6	1.All buttons should be working. 2.Response should be sent back to the admin interface when the yearbook is finish.	As expected	PASSED
Web_Func7	1.All buttons should be working. 2.Only the admin role can access the page. 3. The information should be sent back to the admin interface. 4.The sending of email should be working.	As expected	PASSED

Appendix C

Reliability Test case

Table 4: Reliability Testing Case of iYear Web-based Server.

Test case ID	Feature	Preconditions	Steps

Web_Rel1	Accessing website through Google Chrome (96.0.4664.110) on Windows-based	Device is connected to the internet via wi-fi or data	1.Go to mccyearbook.dns.net
Web_Rel2	Accessing website through Firefox (95.0.2) on Windows-based	Device is connected to the internet via wi-fi or data	1.Go to mccyearbook.dns.net
Web_Rel3	Accessing website through Opera (55.2.2719.50740) on Windows-based	Device is connected to the internet via wi-fi or data	1.Go to mccyearbook.dns.net
Web_Rel4	Accessing website through Safari (15.2) on macOS-based	Device is connected to the internet via wi-fi or data	1.Go to mccyearbook.dns.net
Web_Rel5	Accessing website through Microsoft Edge (91.0.864.37) on Windows-based	Device is connected to the internet via wi-fi or data	1.Go to mccyearbook.dns.net

Test case ID	Expected Results	Actual Results	Status
Web_Rel1	1. The website should be up and running 2. All buttons should be working	As expected	Passed

	3. All pages are up and without crashes		
Web_Rel2	1. The website should be up and running 2. All buttons should be working 3. All pages are up and without crashes	As expected	Passed
Web_Rel3	1. The website should be up and running 2. All buttons should be working 3. All pages are up and without crashes	As expected	Passed
Wev_Rel4	1. The website should be up and running 2. All buttons should be working 3. All pages are up and without crashes	As expected	Passed

Web_Rel5	1. The website should be up and running 2. All buttons should be working 3. All pages are up and without crashes	As expected	Passed

Appendix D Portability

Table 5: Portability Testing cases of iYear

Test case ID	Feature/Specification	Remark
App_Por1	Is the web app can be used for multiple types of devices such as mobile, tablets, desktop?	PASSED
App_Por2	Can the web app handle different types of mobile/Desktop device screen sizes?	PASSED
App_Por3	Can the web app handle different types of screen DPIs (dots per inch)?	PASSED

Appendix A Usability Test case

Table 2: Usability Testing Case of iYear

DESCRIPTION	iYear
CATEGORY/CHARACTERISTIC	Usability
DATE	January 28, 2022
TESTER	Sr. IT Prog. Jay-Ar Maderas

Test Case ID	Feature/Specification	Remark
App_Usa1	Is the system easy to deploy?	PASSED
App_Usa2	Is the system easy to test all the button functionalities?	PASSED

App_Usa3	Is the system easy to maintain (from bugs to scaling)?	PASSED
App_Usa4	Is the web app easy to input data as an admin?	PASSED
App_Usa5	Is the web app easy to understand and use as a user?	PASSED
App_Usa6	Is every image and text in the web app design visible?	PASSED
App_Usa7	Aren't the colors of web app designs painful to the eyes?	PASSED

Releasing

At this stage, as the whole system is fully developed and passed all the test cases, the researchers deployed the whole system. Finally, upon the acceptance of board of panelist, capstone adviser and technical adviser in completion of iYear web-based system, the researcher developed web-based system would be freely accessible at the website domain address of <https://mccyearbook.ddns.net/>.

RESULT AND OUTCOMES

This section discusses and explains how the main objective of the study is met which is to provide a digital yearbook web-based application for Mabalacat City College. Also included in this chapter is the discussion of the requirements gathering, design and development, and testing results.

Data and Requirements Gathering

The researchers held brainstorming meetings online and gained scholarly ideas via internet researches. As a result, the proponents found out and completed the requirements needed to achieve the features of the whole integrated system of web-based application.

Table 6: Hardware and Software requirements

HARDWARE REQUIREMENTS	SOFTWARE REQUIREMENTS	FUNCTION
Android Phone/ Tablet	Android OS 4.4 (minimum) 1GB RAM (minimum) 2GB RAM (suggested) 8GB (minimum) 16GB (suggested)	Mobile operating system Memory Internal Storage
Desktop/Laptop	Google Chrome Microsoft Edge Safari Opera Firefox	Browser

Design and Development Phase

The proponents virtually represented every feature and flow of the system that it aimed to provide by creating diagrams namely Visual Table of Contents, Storyboard, Use Case Diagram, Context Diagram, and Entity Relationship Diagram. With these diagrams, the researchers were able to have a better perception of designing the web-based application.

In designing the web-based application, the researchers used Adobe Photoshop, Adobe Acrobat DC, MongoDB, Express, React, Nodejs.

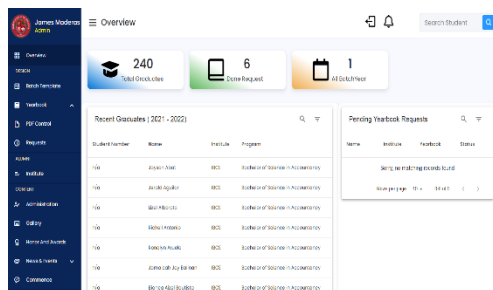


Figure 8: Admin screen

Figure 8 shows the admin page. The admin is the highest role and can add, edit, and delete a data record. The figure above shows an overview of all the information entered by the administrator, including the overall number of graduates, the number of

requests for authorization to print the yearbook, and the total number of batch years. Using the bulk template button, they can add and generate templates for each institute. It may also add, select, and alter users' accounts as an admin.

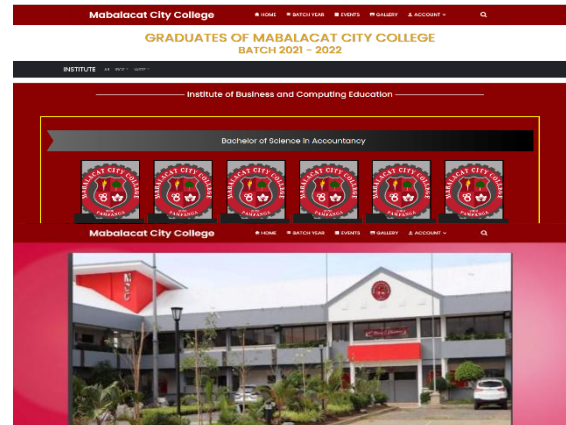


Figure 9: Student screen

Figure 9 shows the student page, the first image is the website's home page; the data will only show information from the most recent batch year; while no user logs in, the navbar will only show three buttons (Home, Events, and Login); when a user's role is alumni, three additional buttons will be added (Batch Year, Gallery, and Account). If they are looking for an alumnus by batch year or event material, the search bar has a checkbox capability. The nav links for batch years will take them to a page where they can see all the batch year alumni that have graduated (this only shows what batch year they belong in). The workout gallery material, as well as the alumni second and third bonus photographs, will be shown in the gallery. The second image is the Batch Year Page, which has a list of all the graduating graduates from that batch year, as well as all the institutes and programs they attended. By selecting a certain institute or program, the data will be filtered according to the selected criteria. Finally, when they click on an alumnus, they will be sent to another website where alumni may check their profile.

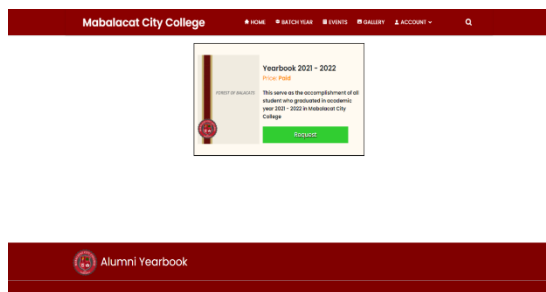


Figure 10: Requesting Yearbook

This illustration depicts the process of requesting a printed yearbook. If the alumni haven't received their yearbook, they can use this to request one. Simply tapping the Request button will add them to the list of yearbooks that have been requested. The alumni will be notified by the administration when their yearbook is completed and ready to be published. When it's finished, it'll notify alumni through email or their account that the yearbook is ready to be claimed.

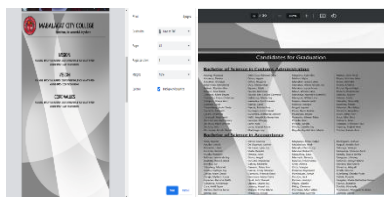


Figure 11: Printing Yearbook in web

Before printing the yearbook, the figure above depicts how the overall yearbook appears before the printing process.

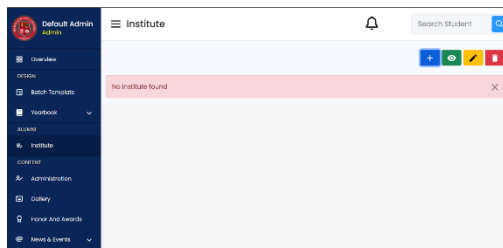


Figure 12: Creating an institute

The figure shown above is the institute button where the admin can create all the existing institutes. This interface can be found on the admin page, where only admins can add, modify, and delete items. Here in the blue button, the admin may establish an institution

solely according to the existing institutes. When the admin has made an institute, they will see the "view records" button. Simply click on it and he/she will see the parts of an institute. They can also go here. To construct a yearbook, enter data into each area to show the information of alumni. And, the green button is for viewing records, the yellow one is for editing the records per institute or section, and lastly, the red button is for deleting records. They can simply choose the record if want to delete it. And, the related data will be kept, but it will not be accessible anywhere until he/she create the same institute.

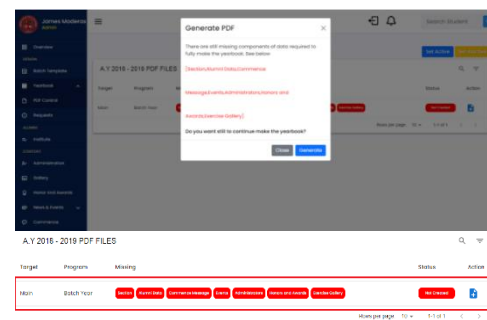


Figure 13: Creating PDF

If there is any missing content before the admin produce the PDF, a pop-up notification will display telling that there is missing content, as seen in the image above. It is, however, possible to do so and then change it afterwards. If admin click on the missing material, it will be sent to a page where it may fill in the blanks.

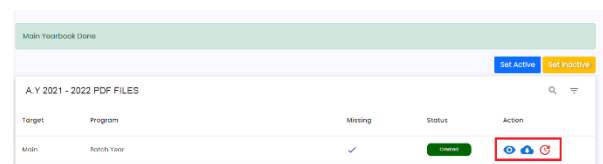


Figure 14: PDF Created

When the PDF is finished being created, a new button with new capabilities will appear, as shown in the figure above. The first button will allow them to see the newly created pdf file, while the second will allows it to enable the yearbook's download link. It is up to the administrator to activate or disable it so that the yearbook may be accessed and downloaded by the appropriate alumni. The third button's

purpose is to update the yearbook content when there are changes to the data.

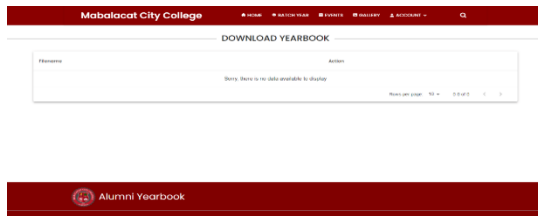


Figure 15: Download yearbook

The administrator is the one who chooses whether or not the yearbook file may be downloaded. The file will be visible on the alumni page account and may be downloaded by clicking the download button if the admin allows it. The download link will not show if the administrator has not approved the download. The researchers of this study used the Extreme programming methodology in designing and developing iYear integrated system. This methodology includes a testing phase using test cases. A test case is a range of steps performed on a system to determine if it really meets system requirements and functions adequately. Its purpose is to determine whether different components of a system are working as expected and to confirm that the system satisfies all related standards, guidelines, and user requirements. The testing done on the web application is based on the international standard of ISO/IEC 9126 for Software Engineering.

To achieve the web – based application of iYear, the researcher used few images of web application to show the interface. The admin has the highest role and can do add, edit and delete a data record, here is where they may add and generate templates for each institute using the bulk template button. Admin may also add, select, and alter users' accounts as an admin. when a user's role is Alumni, three additional buttons will be added (Batch Year, Gallery and Account). If they are looking for an Alumni by batchyear or events material, the searchbar has a checkbox capability. The navlinks for batch years will take them to a page where they can see all the batch year alumni that have graduated (only shows what batch year they belong). If the alumni haven't received their yearbook, they can use this to

request one. Simply tapping the Request button will add them to the list of yearbooks that have been requested. The overall yearbook appears before the printing process. If there is any missing content before the admin produce the PDF, a pop-up notification will display telling that there is missing content, as seen in the image above. It is, however, feasible to do so and then change it afterwards. When PDF is Done Created, A new button with new capabilities will appear. The first button will allow to see the created pdf file, while the second will allow admin to enable the yearbook's download link. The file will be visible on the alumni page account and may be downloaded by clicking the download button if the admin allows it.

The researchers used test cases to test the software functionalities. Based on the results of the test case responses, the software works properly. Because of the alternative to the traditional yearbook and the design of our web-based application, they came up with our study. First, on the admin site, they'll see an overview here, where they can check how many records or data points the admin has entered. Admin may specify a template for each institute in the batch template, and the input will be shown in the interface when it is completed automatically. Here they'll find the actual yearbook as well as photos of former pupils. In addition, the administrator can appoint another administrator. There is also a PDF control button for publishing yearbooks in PDF format. The admin can also add honors and awards based on who is on the list of people with honors and awards. The administrator can also add new events and announcements, depending on the school. Admins might also get a notification about a concern or a problem on their admin site. As previously said, the admin can create, modify, and remove users, and there is a button that allows users such as admins, submains, staff, and students to manage their accounts.

DISCUSSIONS

This section consists of the summary of findings, conclusions, and recommendations based on the results of the study of iYear: A web-based system yearbook for the school of Mabalacat City College.

Summary of Findings

To achieve the web – based application of iYear, the researcher used few images of web application to show the interface. The admin has the highest role and can do add, edit and delete a data record, here is where they may add and generate templates for each institute using the bulk template button. Admin may also add, select, and alter users' accounts as an admin. When a user's role is Alumni, three additional buttons will be added (Batch Year, Gallery and Account). If they are looking for an Alumni by batchyear or events material, the searchbar has a checkbox capability. The navlinks for batch years will take them to a page where they can see all the batch year alumni that have graduated (only shows what batch year they belong). If the alumni haven't received their yearbook, they can use this to request one. Simply tapping the Request button will add them to the list of yearbooks that have been requested. The overall yearbook appears before the printing process. If there is any missing content before the admin produce the PDF, a pop-up notification will display telling that there is missing content, as seen in the image above. It is, however, feasible to do so and then change it afterwards. When PDF is Done Created, A new button with new capabilities will appear. The first button will allow to see the created pdf file, while the second will allow admin to enable the yearbook's download link. The file will be visible on the alumni page account and may be downloaded by clicking the download button if the admin allows it.

Conclusions

The researchers used test cases to test the software functionalities. Based on the results of the test case responses, the software works properly. Because of the alternative to the traditional yearbook and the design of our web-based application, they came up with our study. First, on the admin site, they'll see an overview here, where they can check how many records or data points the admin has entered. Admin may specify a template for each institute in the batch template, and the input will be shown in the interface when it is completed automatically. Here they'll find the actual yearbook as well as photos of former pupils. In addition, the administrator can appoint

another administrator. There is also a PDF control button for publishing yearbooks in PDF format. The admin can also add honors and awards based on who is on the list of people with honors and awards. The administrator can also add new events and announcements, depending on the school. Admins might also get a notification about a concern or a problem on their admin site. As previously said, the admin can create, modify, and remove users, and there is a button that allows users such as admins, submains, staff, and students to manage their accounts.

The developers were able to develop the functionality for login security issues, that is, providing a username and password to prevent the web application from being used by multiple devices. The developers were able to develop the functionality of preventing duplicate data and validating forms.

The developers were able to develop the functionality of improved security for injecting codes that can capture user data using forms. Researchers were able to construct when alumni access restricted pages, they will be automatically redirected to the home page or a popup will indicate that this page is not accessible. When the developers were able to design, when the alumni are fixed to their batch year, when they are trying to access others, they cannot view them.

Recommendation:

The researchers recommend the following:

- Adding feature of uploading PSD file on template design.
- Considering adding option to edit or add institute.
- Including option to edit or add honor and awards.
- Preventing duplication of alumni data.
- Adding option to edit or add administration.
- Adding an option to edit or add position (commencement).
- Improve the design of the template.
- Improving the system having an auto generate feature to produce a yearbook ready for printing preferably in PDF format.

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Kiddie-dule: Mobile Module and Speech Training for Toddlers with Speech Recognition

Jasmine A. Alvarez
John Erazar Curato
Ryan M. Garcia
Danicah S. Mosende
Gabrielle Mei C. Motol
Jayvee Verzosa
Ronaldyn T. Domingo, MSIT (Technical Adviser)

ABSTRACT

Mobile phones play a big role in people's everyday lives nowadays, from unlimited development of applications that aid people's need, up to the applications that give entertainment. Due to the time of the pandemic, different applications were developed to bridge the gap that it made. There are applications for communications, transportation, and different services that are developed. One of the gaps that the pandemic made is children cannot go to school because of the risk the virus has. That is why the researcher's goal is to develop an application that will help children learn at the comfort of their home, Kiddie-dule. Kiddie-dule is an educational application with reading materials, videos about phonetics, pronunciation, and letters, assessment for kids with choices, audio of word pronunciations, and achievements display. What makes it more interesting is Kiddie-dule uses speech recognition in enhancing speaking skills. The application is developed by using Android Studio, Google Speech API, and ExoPlayer as the media player. In order to achieve the desired prototype, the researchers used evolutionary prototyping wherein they utilize the application after testing and getting feedback from the user which makes them identify and solve encountered problems until the final prototype is ready. To make sure that the application reaches its full development, the researchers used Meega+ as an evaluation tool. Meega+ covers usability with sub-criteria of aesthetics, learnability, operability, and user experience. The researchers use meega+ questionnaires to get feedback from the users. And after several testing, the researchers conclude that the application passes the meega+ criteria (usability and user experience testing). The researchers believe that there are still many improvements in the application that will make it more interesting and effective to the target user. Adding more functions such as teacher/students accounts for personalization and including more videos and materials is recommended to maximize the application's ability.

INTRODUCTION

Nowadays, mobile phones are more important than everything that people have. Teenagers and even kids' lifestyle revolves around their mobile phones which has both positive and negative side. However, let us focus on the good side of it. With the unending upgrades and releases of mobile technology, not only that it serve as people's communication but also includes our everyday life and activities. The availability and access to high-speed internet and remarkable communicative interfaces to these devices make it more of a high level of innovation in mobile computing. All of these are more possible with the development of mobile applications or mobile apps.

Many mobile applications are developed to aid people's activities and get the hang of them. "Our lives will be facilitated by a myriad of adaptive applications running on different devices, with different sensors, all of them collecting tidbits about everything we do, and feeding big digital brains that can adapt applications to our needs simply because they get to know us", said Márcio Cyrillo, Executive Director at CI&T. Before, to access the internet, read and check emails, users needed to access the computer, but now, people can do all those things at their own pace, just because they have phones that they carry everywhere they go. Even transferring money, booking a place to have a vacation, and paying bills, people can just do it sitting and letting the technologies

work on their phones. Moreover, all of these are possible with the skills of app developers.

In this time of the pandemic, mobile applications play a big role in aiding the needs of the people to survive in this so-called “New Normal” that they are living in because of the COVID-19 virus. The users access mobile applications for online studying, communicating, shopping, and transportation. While parents are busy finding jobs to sustain their family needs and barely have time to assist younger kids, the sisters and brothers are busy doing their modules and assignments, what about the younger ones? They also need to learn and study. Nowadays, parents cannot just focus on teaching their children, especially kids who are about to start schooling, because they have jobs to attend to or find work to sustain their needs during this pandemic.

The COVID19 pandemic makes it impossible to go to school and study. That is why the researchers are proposing this mobile application to help kids learn and improve their speaking skills in the comfort of their home and in the easiest and most fun way. In addition, the kids can use this application as preparation when going to school is possible.

Background of the study

The uncontrollable spread of COVID19, which is now a pandemic virus, leads all the establishments that gather many people to shut down including schools, which leads students to have an online learning system, which is an alternative for the traditional face-to-face learning method. For an estimated eight million students around the globe—who should have been in the first grade—the wait for their first day of in-person learning has been over a year and counting, as they live in places where schools have been closed throughout the pandemic.

"The first day of school is a landmark moment in a child's life—setting them off on a life-changing path of personal learning and growth. Most of them can remember countless minor details—what clothes they were wearing, their teacher's name, who sat next to them. But for millions of children, that important day has been indefinitely postponed," said UNICEF Executive Director Henrietta Fore. "As classes resume in many parts of the world, millions of first graders have been waiting to see the inside

of a classroom for over a year. Millions more may not see one at all this school term. For the most vulnerable, their risk of never stepping into a classroom in their lifetime is skyrocketing." [11]

"Your first day of school is a day of hope and possibility—a day for getting off to a good start. However, not all children are getting off to a good start. Some children are not even starting at all," said Fore. [11]

As stated, one of the best moments of a child and parent is their children's first day of school. However, it is not possible now because of the pandemic. Therefore, the researchers plan to give at least that moment a chance by creating a mobile application, Kiddie-dule that can help children and parents at this time in bridging this gap of their life.

The first grade sets up the building blocks for all future learning, with introductions to reading, writing, and math. In addition, a period helps children gain independence, adapt to new routines, and develop meaningful relationships with teachers and students. In-person learning also enables teachers to identify and address learning delays, mental health issues, and abuse that could negatively affect children's well-being.

The proponents came up with the idea of creating a mobile learning system entitled “Kiddie-dule: Mobile Module and Speech Training for Toddlers with Speech Recognition”. This will help children from 4 – 6 years old (toddlers) to learn basic knowledge and give them speech training to help them speak words fluently and clearer with the help of speech recognition technology in our application.

Objectives of the study

The general objective of this study is to develop a mobile learning application, entitled “Kiddie-dule: Mobile Module Speech Training for Toddlers through Speech Recognition” that will help children ages 4 – 6 years old in enhancing their basic knowledge and speech skills for android and smartphones.

In line with this, this study aims to:

- To gather information through the internet and chosen professionals (teachers) and parents that the application may contain to provide credibility of the purpose of the application;

- Design a mobile application using the following software and hardware;
 - Android Studio
 - Android Device
 - Computer
 - Google Speech
 - EXO Player API
- Create a mobile learning application with the following features for kids;
 - Reading Modules
 - Videos about Phonetics, Pronunciation, and Letters
 - Speech Recognition
 - Assessment for kids with choices
 - Audio of Word Pronunciations
 - Achievements Display
- Evaluate the game based on the following criteria of Meega+.
 - Usability
 - Aesthetics- the application design is attractive for the target age group.
 - Learnability- learning how to operate the application is easy.
 - Operability- the application should be easy to use.
 - User Experience

Scope and limitation of the study

The study covers the design, development of the mobile learning application, entitled “Kiddie-dule: Mobile Speech Training for Toddlers through Speech Recognition” for android and smartphones.

As the user opens the application, the user will have to click the “LET’S LEARN” button to go to the main screen. The main screen will contain the choices of what the user wants to do. The user can; go to the Modules with a list of topics (Alphabets, Animals, Colors, Days, Months, Number, Shapes, and Vegetables); Watch videos with the same topics as modules; Take Quiz, and take the Speech Training.

Kiddie-dule is a combination of module learning and assessment. The application has a learning material, a video, and a reading module that is to take based on the kid’s choice. In the Take Module, the kid will choose if he/she wants to take the module or take the quiz as a challenge in his/her knowledge. If the kid decides to take a module, he/she can choose among the five (5) topics given.

The quiz will serve as an assessment of the application. The quiz can be (1) an identification of sounds of what is in the picture or vice versa. (2) A puzzle in which the user needs to choose from the choices to complete the image. (3) Color identification.

The application also includes speech recognition that will serve as the user’s speech training. The application will first tell the word twice (2) and after that, the user will repeat and needs to have the same pronunciation or at least close enough to the application’s pronunciation. The user will have five (5) seconds to speak and after that, the application will tell if the kid is right or wrong. If the kid got the wrong mark, the application will prompt him to repeat the word until he gets it correct.

The application will use interfaces that will match the preference of the children and will make them use the application easily and understandable and will add fun for the children in using this application. If the user wants to choose another lesson to take, he/she can do so.

The application is only applicable to Android Operating System and not supported by IOS. The application uses an internet connection. The page loading time of the application depends on the internet speed of the user for fetching data and images.

Kiddie-dule is a mobile application specifically for children ages 4 to 6 years old that are in preschool or kindergarten level to grade 1 and preparing to study. The application is compatible with android 5.0 Lollipop up to the latest only.

A parent or guardian must guide the child when the application is used. They will be the ones to tour the child in using the application. They will also help in correcting the child and explaining the right answer. Once the child got familiar with the application, they will be able to use the application alone and just have to ask a guardian if needed. In this generation where the use of mobile devices is widely used even at the said age of children, they can use the application alone. The user-friendly interface of the application will surely help them.

SYSTEM DEVELOPMENT METHODOLOGY

This section shows the methodology used in the development of the application and the tools and techniques the proponents applied in this study.

The researchers will develop a prototype, tested, and reworked until the researchers achieve and accepted. It also created base to produce the final system or software. It is best used when all the details is already gathered. It is an iterative, trial and error method, which takes place between developer and client.

Specifically, the proponents used Evolutionary Prototyping, where the prototype developed is incrementally refined based on user's feedback until it is finally complete. It will help them to save time as well as effort. That is because developing a prototype from scratch for every interaction of the process can sometimes be very frustrating.

This model is helpful for a project, which uses a new technology that is new and complex project where functionality is tested. It is helpful when the requirement is not stable or not understood clearly at the initial stage.

In Kiddie-dule, the proponents used Evolutionary Prototyping [13], where the developer will give a sample of the ongoing application available to a picked and available future user and the user will give feedback on the effectiveness of the application. After the developer receives the feedback, the developer will do what the user suggested to make the application even more effective.

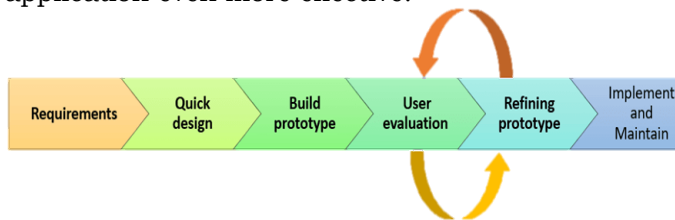


Figure 3 Prototyping Model

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

Requirements Gathering and Analysis

A prototyping model starts with requirement analysis. In this phase, the proponents have done research about a study and articles related to Kiddie-dule and the tools and software needed in developing the application.

The proponents prepare the software and device to use in developing the application.

The proponents also conducted an online interview to teachers who are teaching in preschool or kindergarten stage to Grade 2 children. (See Appendix E) The interview questions are:

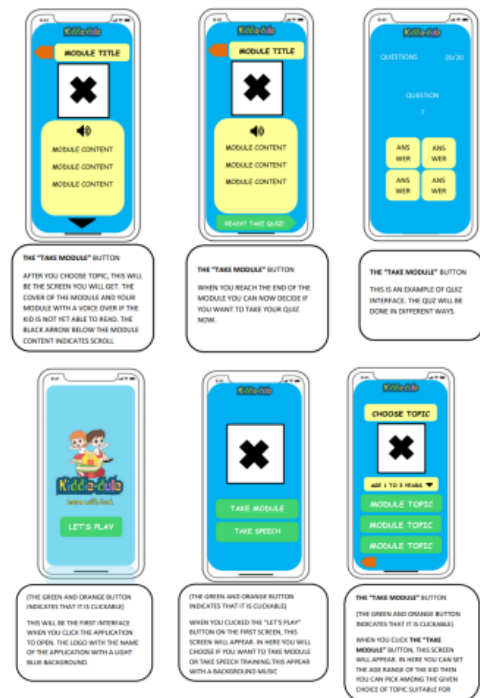
What age group is suitable for the application?
Is the application can really help the kids to learn?

Recommendations and suggestions in creating the learning materials.

After the interview, the proponents provide a form that will serve as the validation of the teachers that will make all the responses reliable.

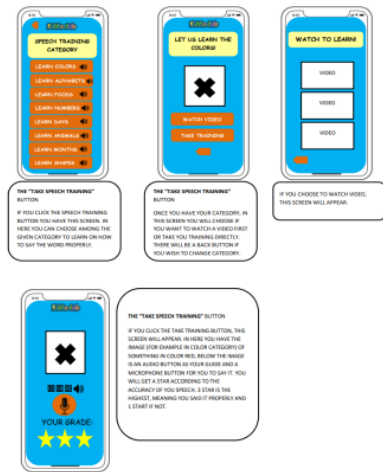
APPENDICES

Appendix A: Storyboard



Quick design

The second phase is a preliminary design or a quick design. In this stage, the proponents used storyboard to give a preview and the layout as well to visualize the application and serve as a guide in developing the interfaces of the application. (See Appendix A for Storyboard)



Build a Prototype

In this phase, an actual prototype refers on the information gathered from quick design. The proponents can now create the application base on the quick design phase. In this phase, the proponents identified the software and hardware to use in developing Kiddie-dule. The researchers started producing images, reading materials and videos to put in the application. The buttons, the user interfaces are now available and some contents base on the application's requirements, such as the learning material, image, videos, and music. The interfaces are developed in this phase.

Appendix B: Previous Interface



Initial user evaluation

In this stage, the Kiddie-dule application presented to the kid as the user for an initial evaluation. In addition, testing the application

using the Meega+ evaluation tool (see appendix G) will be implemented to the proponents' younger siblings and other kids whose age is in the target age of the application, which is toddler age to 6 years old. The users distributed the meega+ questionnaires using Google form. The researchers use the Likert Scale Pointing System and Range evaluation tool to gather feedback from the selected respondents. The total response and the equivalents of the average score are used to get the average result.

Table 4: Likert Scale Evaluation Range

Likert Scale	Points	From	To
Strongly Disagree	-2	-1	-1.2
Disagree	-1	-1.3	-0.4
Neutral	0	-0.5	0.4
Agree	1	0.5	1.2
Strongly Agree	2	1.3	2

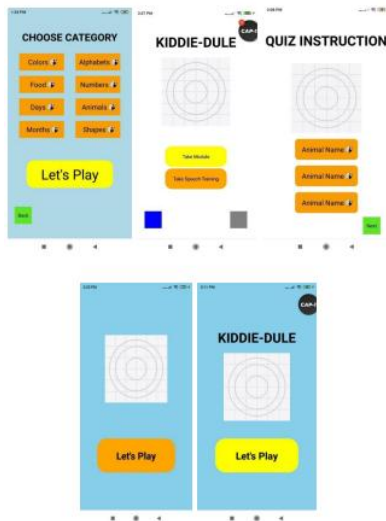
The initial design's interface (see Appendix C) is buttons, menus, and sample image only. The initial design is where the positions of the buttons and menus are and some background images for the application. The buttons classified in color according to their functions. In addition, in this initial design, some of the functions are not yet working as required.

Refining prototype

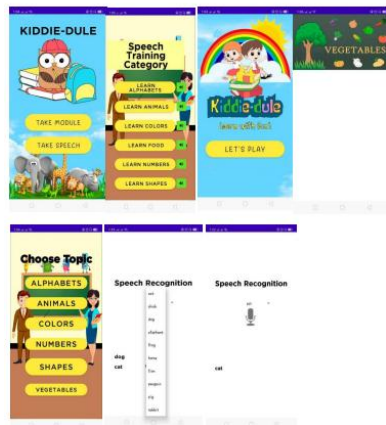
In this phase, the proponents received feedback that the Kiddie-dule application needs to be more appealing to the kids through the colors, design and image. To make this phase, the proponents update the application to meet the user's suggestions.

The researchers designed buttons and images that suits the application's target age. Combinations of colors, kid's images, and buttons were finally refined. The reading modules and videos in each category given were also included in the application. The speech recognition is also working as required. The quiz parts were also included in the application, with pictures and choices of answer. (See Appendix D)

Appendix C: Initial Design



Appendix D: Refined Prototype



Implement Product and Maintain

Once the final application is done, it will be tested accordingly and ready to be installed from a third-party download platform. The application will undergo several tests to make sure that there will be no more unseen errors and will have more updates to make the application more useful to the kids. After the testing and evaluations, the researchers uploaded the application to a third-party download platform called "Itch io" for availability and ready-to-download the application.

Itch.io is an open marketplace website for sole digital developers. A platform that is free to sell the content they created.

RESULTS AND OUTCOMES

This section discusses the results in developing the Kiddie-dule: Mobile Module and Speech Training for Toddlers with Speech Recognition in response to the objectives in which the researchers use tables and screenshots of the application for better presentation and the analysis of test and evaluation.

Credibility Requirements

To develop the Kiddie-dule application, the researchers conduct an interview and inquiries to chosen professionals (teachers) and parents using Google form (see Appendix D). The question the researchers asked the professionals to ensure the credibility of the application is as follows:

What age group or range is suitable to use the application?

Will the application help to the user in preparing to go to school?

Suggestions and recommendations for the learning materials to use in the application.

So that the researchers can prove the credibility of the answers of the professionals, they asked for copies of supporting documents and credentials by providing a Google form to fill out. (See Appendix E)

Hardware and Software Requirements

The researchers identified and used suitable hardware (see Table 2) and software (see Table 3) in developing the Kiddie-dule Application. The hardware that the researcher used is android 8.1 to view the application and computer. The software used in developing the application is Android Studio and EXO Player API to play videos on the application.

Table 3: Hardware Requirements

Components	Description
Android Device	Android 8.1, 3gb RAM
Computer	Intel Core Duo 2, 3.5gb RAM

Table 4: Software Requirements

Software	Description
Android Studio	Android Studio 2020, 3.1.24 Windows

Google Speech API	A program is used for the application's speech recognition ability.
ExoPlayer API	A program used as the application's media player.

4.3 Graphical User Interface

The Welcome Screen

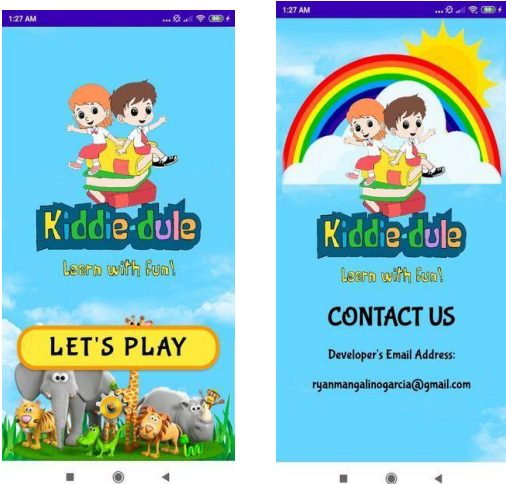


Figure 4: Welcome Screen

This will be the first screen when the user launches the application after the installation. It has the logo and the name of the application (KIDDIE-DULE, LEARN WITH FUN), and a button “LETS PLAY” that will lead the user to the main screen. In addition, there is a settings button that will lead the user to the contact information of the developer.

The Main Screen

The main screen contains the choices on what activity the user wants to do. The user can take the modules with a list of topics the user wants to learn. The user can also watch videos, take a quiz also with a list of topics and lastly, the user can take the speech training with a given topic.

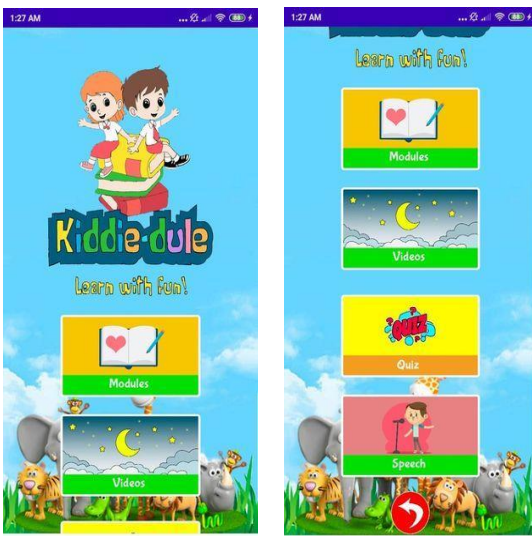


Figure 5: Main Screen

The Module Screen

The module screen is where the user can choose on what topic to take, the topics are Alphabets, Animals, Colors, Days, Months, Numbers, Shapes, and Vegetables. Each topic has a module with a short quiz about the module.

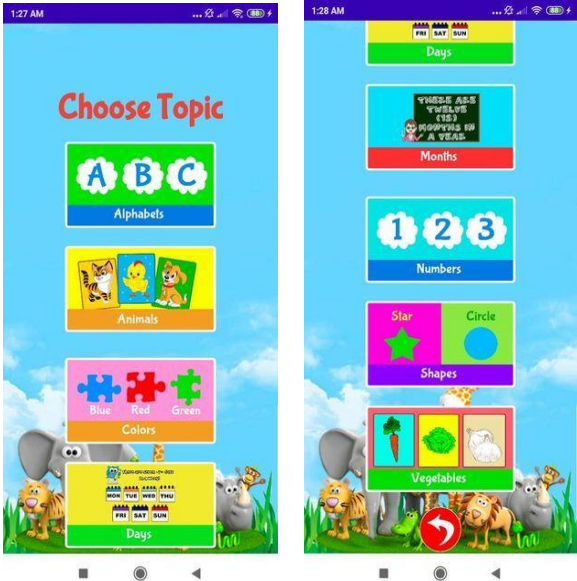


Figure 6: Module Screen

The Module Content

In here is one of the module's screens that is a scrollable interface. Each module will have a reading material and short quiz that will help

the user to test what he/she learned on the module.

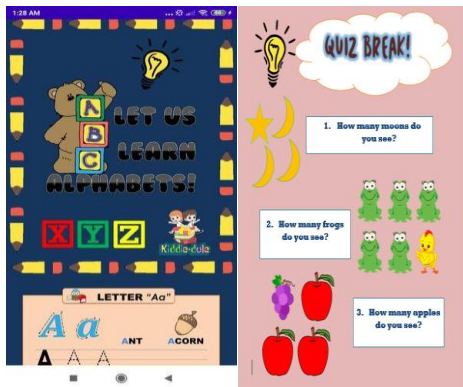


Figure 7: Module Content Screen

The Video Screens

On this interface, are the list of topics of videos that the user wants to watch, “Learn Alphabets”, “Learn Animals”, “Learn Color”, “Learn Numbers”, and “Learn Shapes”, “Learn Vegetables”. When the user plays a video, it will be on a landscape format that is more convenient for the user to watch on a large screen.

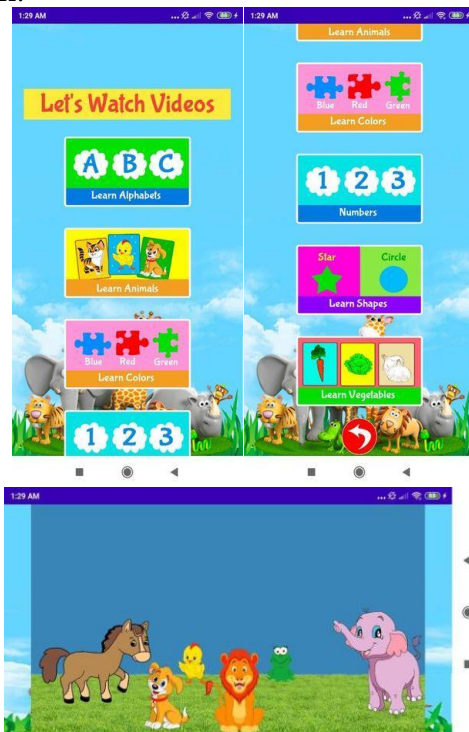


Figure 8: Video Interface

The Quiz Interface

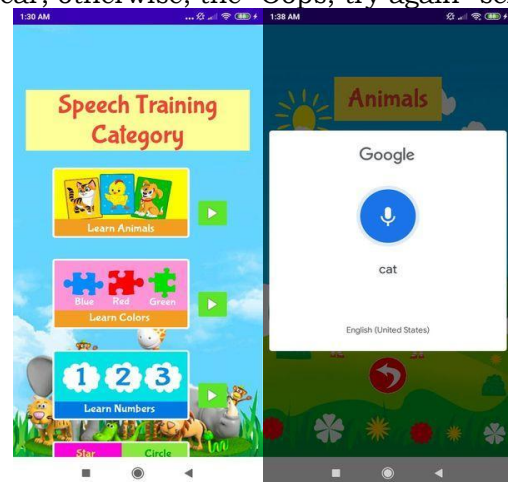


Figure 9: Quiz Screen

In this interface, has quiz part of the application. There is a picture shown in the screen and the user will choose on the given choices. If the user got the correct answer, a voice over saying “Very good!” otherwise, a voice over saying “oops, try again” will play. At the end of the quiz a congratulatory screen will appear.

The Speech Training Interface

In this interface, is the speech training part of the application. The user has a list of categories. When the user has already chosen a category, there is a drop-down list of words that the user will practice. After the user chose a word, the user will have to click the microphone to start to speak. If the user says the word properly, a “Very good!” screen will appear, otherwise, the “Oops, try again” screen.



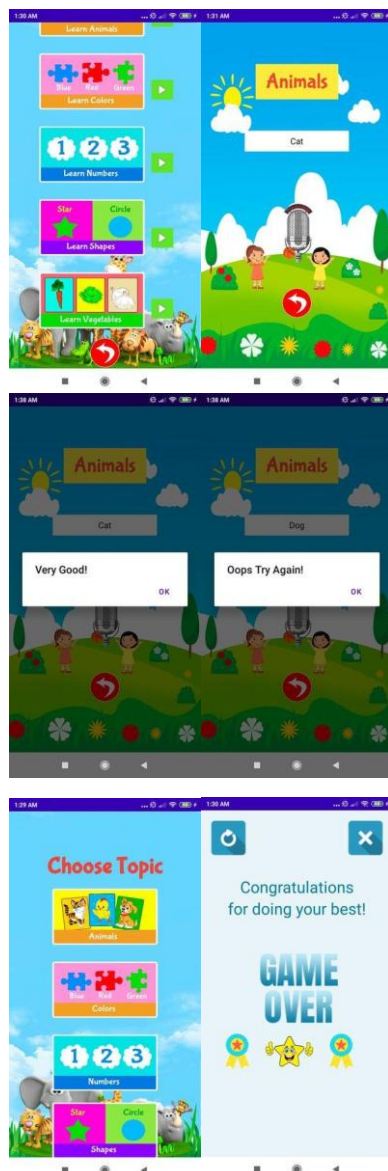


Figure 10: Speech Training Screen

MEEGA+ Questionnaire Result

Meega+ has two (2) main criteria, Usability and **User Experience.**

The researchers provide and distribute questionnaire under Usability Testing (see appendix G) to four (4) selected evaluators. Usability is the measurement of how well the application performs as for the requirement. Usability has sub-criteria: Aesthetics, Learnability and Operability.

Aesthetics

In the first statement, the application's interface is suitable for target users (4 to 6 yrs. Old), three (3) out of four (4) respondents is Strongly Agree and one (1) is Agree. In the statement, the buttons have the required size suitable to the users, three (3) says Strongly Agree and one (1) says Agree. In the statement, the icons are natural and consistent with the application, three (3) respondents say Strongly Agree and one (1) say Agree. In the statement, the buttons which has the same function has the same color, three (3) say Strongly Agree and one (1) say Agree. In the statement, the text is simple and clear to be visible to the users, three (3) said Strongly Agree and one (1) said Agree. In the statement, the font size is big enough to be readable and not too big or too small, two (2) said Strongly Agree and two (2) said Agree. Lastly, in the statement, the application is overall attractive in terms of graphics, interface, and sounds, three (3) said Strongly Agree and one (1) said Agree.

Learnability

In the first statement under learnability sub-criteria, the application is easy to use for children 4 to 6 yrs. Old, two (2) said Strongly Agree and two (2) says Agree. In the statement, the application's navigation is easy to understand, two (2) said Strongly Agree and two (2) says Agree. In the statement, the speech recognition feature is accurate, two (2) said Strongly Agree and two (2) says Agree. In the statement, the application provides undoing method or going back when the user touches the wrong button, three (3) said Strongly Agree and one (1) said Agree. Lastly, in the statement, the learning materials, videos and quizzes are credible, two (2) said Strongly Agree and two (2) says Agree.

Operability

In the first statement under operability, the page load time is within acceptable range; one (1) answered Agree and three (3) answered Strongly Agree. In the statement the application works with internet, three (3) says Strongly Agree and one (1) says Agree. In the statement, the installation is smooth, two (2) answered Strongly Agree and two (2) answered Agree. In the statement, the uninstallation is smooth, three (3) said Strongly Agree and one (1) said Agree. In the statements, the

application runs on android 5 up to the latest and the buttons are easy to touch, both got the response two (2) Strongly Agree and two (2) Agree.

User Experience is another main criterion of Meega+. It determines the success rate of the application based on the user's experience. The researchers conduct the user experience test (see Appendix J) with the following sub-criteria.

Perceive Learning

In the statement, the application contributed to the user's learning, three (3) out of four (4) respondents said Strongly Agree and one (1) said to agree. In the statement, the application is a good teaching guide for the user, three (3) said Strongly Agree and one (1) said Agree. Lastly, in the statement, the application can enhance the speaking skills of the user, two (2) said Strongly Agree and two (2) says Agree.

Confidence

In both statements, the application is easy to use and understand with the help of a guardian until mastered and the user interface makes the user confident to use the application, both got three (3) Strongly Agree and one (1) Agree.

Fun

In the first statement, the user learns with fun using the application, two (2) said Strongly Agree and two (2) said Agree. In the statement, there are some errors while using the application, one (1) said Strongly Agree, one (1) said Agree and two (2) says Disagree.

Table 5: Compatibility Testing

Device	Version/ Specification	Feedback
Redmi 4a	Android 7.1 2 GB	Installed but with lag
Oppo A5s	Android 8, 3 GB	Installed, good
Redmi 5	Android 8.1, 3GB	Installed, good
Infinix Hot s3	Android 8.0, 3 GB	Installed Good

The researchers also conducted compatibility testing using different devices. The researchers installed the application in Redmi 4A first, android 7 with 2 GB of RAM. The installation is smooth. But when the user uses the application, there are some lags and is hard to scroll the interface. The second device used for

app testing is the Redmi 5, which has specs Android 8.1 (Oreo) with 3GBRAM; it also runs smooth on this device. The third device used for app testing is the Oppo A5s which has specs Android 8 with 3GB ram, the application runs smoothly on this device. The last device is Infinix Hot s3 with 3 GB RAM, the application also runs here with no lags.

Kiddie-dule Implementation

Kiddie-dule

Kiddie-dule is an application for children age 4-6 years old that will help them learn with fun in the comfort of their home. Kiddie-dule has several categories with learning materials and videos to choose from. Kiddie-dule will help children in preparing to start schooling after this pandemic.

[More information](#) ▾

Install instructions

App Compatibility: Android 5 to latest

Download

[Download](#) Kiddie-dule.apk 35 MB

Leave a comment

[Log in with itch.io](#) to leave a comment.

Figure 11: Kiddie-dule in Itch.io

The researchers reach the final prototype after testing and evaluations and uploaded the application to a third-party download platform called "itch.io". It is a free marketplace on a website that allows developers to promote and sell their creations, receive comments and follow creators to get updated on the latest applications uploaded.

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LABAN BAYANI: Mobile-Based 3D Multiplayer Fighting/Beat-Em Up Game

Michael Jay S. Cunanan
Justin E. Dizon
John Thomas E. Fernandez
John Paulo Galang
John Deker C. Pangilinan
Jaypee B. Patdu, MIT (Technical Adviser)

ABSTRACT

The gaming industry has been flourishing as one of the sources of entertainment for a lot of people and one of the most common products from the gaming industry are mobile games. The popularity of mobile games paved the way to the rise of historical games – and it has been studied that these can be “potential valuable teaching tools” in history subjects or courses. It is in this sense that the researchers of this capstone project decided to design and develop LABAN BAYANI, a mobile Android-based 3D historical, fighting, beat ‘em up, adventure, and multiplayer game that aims to let its players learn and play at the same time using the software Unity and Photon Pun 2. It features five (5) national heroes of the Philippines, namely, Lapu-Lapu, Andres Bonifacio, Antonio Luna, Gregorio del Pilar, and Jose Rizal. For the development of the game, the researchers used the Agile Scrum methodology while MEEGA+ test cases were used to test and evaluate the game. Based on the test cases results, the researchers have successfully completed the project anchored to the objectives of this study.

Keywords: bayani, mobile game, 3D, beat ‘em up, multiplayer, Android, Philippine history.

CCS Concepts: • Mobile Game; • Mobile Game Development → Android Application

General Terms: Android Package Kit, Unity and Photon Pun.

INTRODUCTION

In people's daily lives, technology is inevitable. In today's changing environment, living without technology is futile. The basic goal of technology, which brings together instruments to encourage development, usage, and information sharing, is to make chores simpler and to solve many of humanity's issues. When technology advances and makes people's lives even more convenient, they must emphasize how important it is to them [1].

The gaming business is, without a doubt, one of today's most essential and cutting-edge areas of technology. Its significance in terms of culture, entertainment, and social networking cannot be overstated. Gamers are no longer confined to Hollywood or the film business, as gaming is now one of the most immersive and awe-inspiring kinds of entertainment available to over two billion people all over the world[2].

One of the most common types of video games on a smartphone is a "mobile game." Historically, the phrase has been used to describe any game that can be played on any portable device, including mobile phones, tablets, personal digital assistants (PDAs), handheld gaming consoles, portable media players, and graphing calculators, as well as games that are network-free[3]. The game business has seen enormous changes as a result of the surge in gaming consumers over the previous year. The industry is now raking in additional billions of dollars as a result of this move. As a result, operators in this space, such as game developers and marketers, have a lot of room to grow. Mobile games account for about 21% of all Android app downloads and 25% of iOS app downloads. This figure is projected to rise in 2021, with several investors and developers releasing excellent titles. The researchers in this capstone project set sights on developing an Android app and be a part of that 21%[4].

A beat 'em up (also known as a brawler) is a video game genre in which the player engages in hand-to-hand battle with an unusually large number of enemies. Traditional beat 'em ups take place in two-dimensional (2D) stages that scroll, but some later games have more

accessible three-dimensional (3D) worlds with even more enemies[5]. The game is played by walking through a level one section at a time, beating a group of enemies before moving on to the next section; each level usually ends with a boss battle[6]. Kung-Fu Master, based on Hong Kong martial arts films, was the first beat 'em up, released in 1984. Nekketsu Kha Kunio-kun, released in 1986, popularized contemporary urban environments while also introducing underworld revenge themes. The Western translated iteration, Renegade, added even more underworld revenge themes[7].

In 2007, MacCallum-Stewart and Parsler defined “historical games” as a game that “has to begin at a clear point in real world history, and that history has to have a manifest effect on the nature of the game experience” [8]. Using the software Unity[9], this capstone project seeks to design and create a mobile-based 3D fighting/beat 'em up game with the title Laban Bayani which will feature few of the most important heroes in the Philippines, namely, Lapu-Lapu, Jose Rizal, Andres Bonifacio, Antonio Luna, and Gregorio Del Pilar. Laban Bayani is comprised of five parts/levels – every part/level is dedicated to one national hero. The researchers in this capstone project set sights on designing and creating a mobile game where players can enjoy and learn at the same time. The weapons used and battles mentioned in this developing game are all factual and the researchers see to it that the game is as historically representative as possible.

As mentioned already, the researchers in this capstone project decided to feature a few of the most important heroes in the Philippines, namely, Lapu-Lapu, Jose Rizal, Andres Bonifacio, Antonio Luna, and Gregorio Del Pilar. The researchers deemed them to be five of the most significant historical figures in the Philippines. First is Lapu-Lapu, who is widely celebrated as the “first Filipino hero” for being able to vanquish the troops of Ferdinand Magellan in their failed attempt to colonize Mactan[10]. Being the first Filipino hero, it is just right to include him in the first level. A 20-meter brass statue was erected on Mactan Island in honor of Lapu-Lapu’s historical significance. In addition to that, the town of Opon in Cebu was renamed Lapu-Lapu

City[11]. Lapu-Lapu is expected to have his face plastered on the upcoming 5,000-peso bill. Another featured hero in the game is popularly known as the national hero of the Philippines: Jose Rizal. He was a prolific poet, essayist, and novelist, best known for his two novels, *Noli Me Tangere* and *El Filibusterismo*. During the Spanish colonization of the country, these social commentaries formed the core of literature that influenced both nonviolent reformers and armed revolutionaries[12]. José Rizal was a political figure who established La Liga Filipina, a civic group that later gave rise to the Katipunan, headed by Andrés Bonifacio, a secret society that would launch the Philippine Revolution against Spain, ultimately laying the foundations for Emilio Aguinaldo's First Philippine Republic[13]. As a commemoration to him, Rizal Monument is now located near the Luneta in Bagumbayan, which is now known as Rizal Park, a national park in Manila, where he was killed[14]. Philippines also honors Rizal and his contributions to the country by renaming districts after him, passing Republic Act 1425 or the Rizal Law to require all high schools and colleges to offer courses about his life, works, and teachings, erecting monuments, putting his face on peso bills, and many more.

The Andrés Bonifacio Monument, also known as the Bonifacio Monument or the Monumento, is a memorial monument in Caloocan, Philippines, created by National Artist Guillermo Tolentino to honor Bonifacio. The Philippine Legislature passed Act No. 2946, declaring November 30 each year a national holiday to celebrate Bonifacio's birth, twenty-four years after his death[15].

General Antonio Luna is the former general of the Philippine Republic Army and he is also commemorated in this country in several ways. The popular Sunken Garden in the University of the Philippines, Diliman is named Antonio Luna Parade Grounds[16]. Various municipalities, streets, barrios, provinces, and national roads are also named after him. A movie entitled “Heneral Luna” was also based on him and his death during the war between Filipinos and Americans[17].

Lastly, the last historical figure to be featured in this game is Gregorio del Pilar, who was one of the youngest generals in the Revolutionary

Army during the Philippine-American War. During the war, he was remembered for his successful attack on the Spanish barracks in Paombong, his victory in the first step of the Battle of Quingua, and his last stand at the Battle of Tirad Pass[18]. He earned the nickname "Boy General" due to his youth. He was also regarded as a ladies' man and was dubbed the "Byron of Bulacan" by National Artist for Literature Nick Joaquin[19]. As memorials of the Boy General, the Philippine Military Academy in Baguio is named after him, as is Fort Del Pilar. In addition to that, in 1955, the town of Concepcion, Ilocos Sur, was renamed Gregorio del Pilar in his honor, after the Battle of Tirad Pass. BRP Gregorio del Pilar, the Philippine Navy's newest submarine, was named after him in 2011. The frigate is a patrol ship.

Laban Bayani: Mobile-Based 3D Multiplayer Fighting/Beat 'Em Up Game can vaguely represent the past contributions and impact of the mentioned heroes in what the Philippines is today. Players can have a glimpse as to why Lapu-Lapu is widely celebrated as the "first Filipino hero", how Rizal's political writings and execution "sparked" the revolution, how Bonifacio advocated complete independence from Spain through the Katipunan[21], how Luna's leadership, bravery, and passion for patriotism burned through before his assassination by his co-Filipinos[22], and how Goyo stood tall despite his young age – until his death at the age of 24.

Background of the study

The researchers in this capstone project seeks to design and develop a mobile-based 3D fighting/beat 'em up game entitled Laban Bayani to highlight five of the most significant figures in the history of the Philippines, namely, Lapu-Lapu, Jose Rizal, Andres Bonifacio, Antonio Luna, and Gregorio del Pilar. Through the utilization of mobile gaming and development, the researchers can be able to teach its players some of the most important events in Philippine history, especially during the Spanish and American colonization period. In the present times, now that the Philippines is at a political unease because of the dispute regarding the West Philippine Sea (WPS) against the Chinese, it seems like the country is being colonized again, gradually. Even

though the WPS is inside the Philippines' Exclusive Economic Zone (EEZ), there are still almost 300 Chinese militia vessels scattered in the area[23]. The issue of being timely and being fought over since the administration of former president Benigno Aquino urged the researchers to design and develop a historical mobile game that features five of the many Filipinos who battled and have gone to war to protect the sovereignty and get back the independence of the Philippines from the Spaniards and the Americans. This game aims to educate its players that years ago, there was a Lapu-Lapu, a Rizal, a Bonifacio, a Luna, and a Del Pilar who fearlessly offered their blood, sweat, and tears to save the country from colonizers. In return, the players would see and know that history should not repeat itself – that the Filipinos should not be colonized again from any intruders, regardless of the intruders' relationship/association in the country.1.3

Objectives of the study

In this capstone project, the researchers' general objective is to design and produce "Laban Bayani: Mobile-Based 3D Fighting/Beat 'Em Up Game" – a game where players can learn few facts regarding the significant events in Philippine history and enjoy playing at the same time.

- To develop a 3D cooperative platform game that will feature a few of the national heroes of the Philippines.
- To create a game that will at least encourage the people of the Philippines to fight for what is right and what is for them.
- To make a game that has some other cool way to teach anyone while playing.
- To generate an application using the following tools such as Unity, Blender 3D, Microsoft Visual C++, Photon Pun 2, and Adobe Photoshop CS6.
- To design a short-animated story 2D for every level or hero using the following tools such as Adobe Premier Pro, Adobe After Effect and Adobe Photoshop CS6.
- To use the Stratified Convenience Sampling to gather respondents and make them test/evaluate the game
- To use MEEGA+ as the tool for the evaluation

- To design and develop a game with the following features:
 - 1.3D
 - Mobile/Android-based
 - 4 fighting levels with Quizzes
 - Lapu-Lapu (LEVEL 1)
 - Andres Bonifacio (LEVEL 2)
 - Antonio Luna (LEVEL 3)
 - Gregorio del Pilar (LEVEL 4)
 - interactive question and answer level
 - Jose Rizal (LEVEL 5)
 - Controls
 - Joystick for upward, downward, and sideward movements
 - Attack button
 - Special attack button
 - Main Menu
 - Play Button
 - Story Mode Button
 - Multiplayer Button
 - Back Button
 - Options Button
 - Volume
 - Graphics
 - Back Button
 - Quit Button
 - Boss fights in fighting levels
 - Special attacks
 - Agila mode
 - Rage mode
- To create a mobile game using the following:
 - Unity 3D
 - Photon PUN 2
 - Blender 3D
 - Adobe Photoshop
 - Adobe Premier Pro
 - Adobe After Effect

Scope and limitation of study

This section includes the scope of the study and also the limitations that are not showcased in the developed game.

Laban Bayani: Mobile-based 3D Multiplayer Fighting/Beat 'Em Up Game will be accessible on smartphones with the Android Operating System ranging from versions Lollipop to Android 10 and it is playable in offline mode. It

can be downloaded by people of ages 7 and above.

For the multiplayer mode, Wi-Fi will be the connectivity to be used to connect with other players. While for the single-player mode, there would be a question-and-answer portion and video animation for the backstory before the 4 levels start.

In multiplayer mode, two (2) players are allowed to join and play the game together. Unlike in the single-player mode, the question-and-answer functionality is not available in this mode and the weapons that the players can use are the default ones.

With the study's historical aspect, Laban Bayani will feature five (5) national heroes and will highlight one (1) significant battle these heroes have participated in. Lapu-Lapu's level focuses on Battle of Mactan, Rizal's level focuses more on significant life events (See Appendix C), Bonifacio's level focuses on Battle in Montalban, Luna's level sets on Battle in Manila, and lastly, Goyo's level features Battle in Quinga.

For the testing and evaluation of the game, the researchers reached out to 20 respondents aged 7 and up, then used MEEGA+ as the tool used for evaluation. It is initially a 5-point Likert scale but the researchers reduced it to a 2-point scale, namely, Agree and Disagree.

For the character's movement, the player will be using a game joystick for upward, downward, and sideward movements. The attack button will trigger the attack skill of the character while the special attack button is for the character's special attack such as the Rage or Agila mode with a cooldown period of 60 seconds after use.

The fighting levels are Levels 1, 2, 3, and 4. The characters in the mentioned levels will initially have individual weapons. Weapons can be upgraded once the user finishes answering the quizzes correctly. These levels will include special attacks, enemies, boss fights, and 100 HP life bar. The weapons include rattan bangkaw and kampilan for Lapu-Lapu, bolo and revolver for Andres Bonifacio, and Mauser rifles for Antonio Luna and Gregorio del Pilar. The special attacks are Agila Mode for Goyo, and Rage Mode for Luna. In these 4 fighting levels with an interactive question and answer functionality, the total correct points

accumulated for each correct answer will be converted into a reward that can be utilized in the Boss Levels (i.e., back to full health, damage increase, special attacks, buffs (Rage and Agila). Below is the Waves and Enemy Spawns for Story Mode:

-Stage 1, 1st wave will spawn 2 enemies, 2nd wave will spawn 3 enemies, and 3rd wave will spawn 4 enemies.

-Stage 2, 1st wave will spawn 3 enemies, 2nd wave will spawn 4 enemies, and 3rd wave will spawn 5 enemies.

-Stage 3, 1st wave will spawn 4 enemies, 2nd wave will spawn 5 enemies, and 3rd wave will spawn 6 enemies.

-Boss Fight

For Multiplayer Mode:

-Stage 1, wave will spawn 3 enemies, 2nd wave will spawn 4 enemies, and 3rd wave will spawn 5 enemies.

-Stage 2, 1st wave will spawn 4 enemies, 2nd wave will spawn 5 enemies, and 3rd wave will spawn 6 enemies.

-Stage 3, 1st wave will spawn 5 enemies, 2nd wave will spawn 6 enemies, and 3rd wave will spawn 7 enemies.

In the Rizal Level or Level 5, with every fighting level finished, a puzzle piece of Rizal's picture will be rewarded to the player. Completing the puzzle pieces unlocks multiplayer mode. There will also be a question and answer portion and a video animation before the level starts. This is an interactive question and answer level.

Conceptual Framework

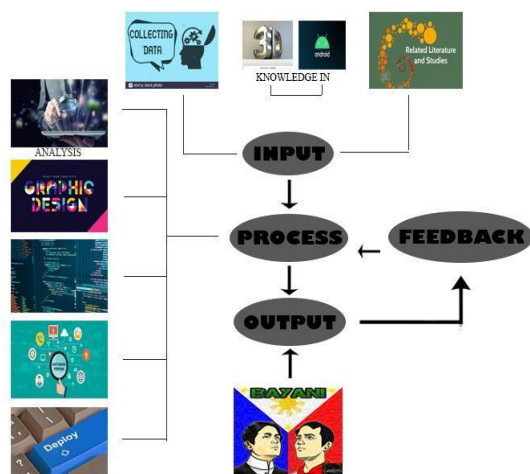


Figure 5. Conceptual Framework

During this phase, the researchers held several meetings online to brainstorm ideas about the game.

Data gathering was done through the internet, where the researchers got influences from related games.

This phase was also where the researchers talked about the mechanics, storyline, characters, settings, assets, software to be used, and other important details of the game in progress. Lastly, the researchers grouped themselves into two: one group for programmers/designers, and another one for researchers.

SYSTEM DEVELOPMENT METHODOLOGY

The researchers in this capstone project employed an Agile Scrum methodology, a project management method that works on a step-by-step basis. This method allowed the members to have more effective collaborations and focus on one task to finish in a specific period.

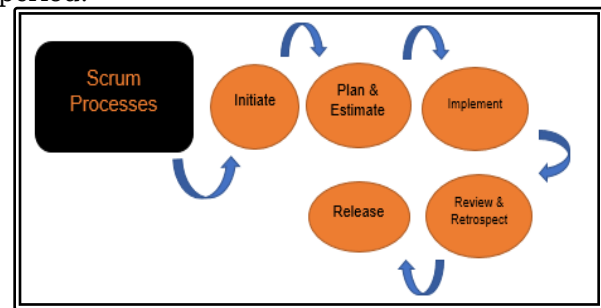


Figure 6. Agile Scrum Methodology

The Agile Scrum Method/Model has 19 processes which are grouped in five phases, namely, Initiate, Plan and Estimate, Implement, Review and Retrospect, and Release [52]. For the Product Backlog, Sprint Backlog, and Scrum Roles, see Appendices F, G, and H, respectively

Phase 1: Initiate

In this phase, the processes include creating the project vision, identifying scrum master and stakeholders, forming the team (in this case, the researchers and the two groups which are programmers/designers' group and researchers' group), developing goals, creating priorities of tasks (backlogs), and conducting release planning.

During the initiation phase, the researchers already had a plan in mind to make a game. The team consists of five members, where two are in charge of programming/designing, and the other three are in charge of researching and the document. The backlog in this project consists of goals to be accomplished such as writing the required chapters per defense, defending the title, working on the game itself, passing the requirements, meeting with the adviser, etc. Each task accomplished is marked as “done”. The release planned on this capstone project depends on the deadline set by the Capstone I and II instructors.

Phase 2: Plan and Estimate

This phase is where processes of planning and estimating tasks occurred. In this phase, the researchers held meetings, planned and estimated time duration for the accomplishment of tasks based on the presentation schedule (e.g., March 10, 2021 – title presentation; May 13, 2021 pre-oral presentation; October 8, 2021, prototype presentation; January 21, 2022, final presentation). The researchers also formulated a timetable that served as a guide to complete their tasks (see Appendix M).

In line with gathering of information, the researchers proposed the project to the product owners during the defenses aforementioned. The goal was to define the application requirements, to understand the problems and opportunities, and analyze the game to be developed.

The researchers also discussed and listed down all the project scope in a product backlog (see Appendix F) and divided it into submodules to identify the task needed to finish each sprint (see Appendix G).

Phase 3: Implement

This phase is concerned with completing the tasks and activities necessary to complete a project's product. During phase 3, the team met to discuss the tasks that are accomplished and the tasks that are still pending. Both the programmers/designer's group and the researchers' group report their progress to each other and align the details of their progress so that there is congruence between the product and the document. Proofreading and testing/debugging are also done during this phase to refine the project. Before the pre-oral

defense, it is expected that the researchers finish 2-3 levels of the game. The prototyping phase will also occur here.

Procedures

In this capstone project, the researchers started on brainstorming and data gathering for the design and the workflow process for the mobile game. After the rigorous generation of ideas, and upon the approval in the title defense and consultation with the capstone adviser, the researchers started the process of the game-making and designing. The researchers utilized the following software for this capstone project: Blender [53], a free, open-source 3D creation suite for animation; Adobe Photoshop [54], an image editing and designing software for the assets; Adobe Premier Pro and Adobe After Effects for the 2D video animations; and, as mentioned before in this paper, Unity 3D and Photon Pun 2[55], for making the game.

Phase 4: Review and Retrospect

This phase is concerned with assessing the deliverables and progress that has been completed, as well as identifying how to enhance project work processes and procedures. Same with the last phase, proofreading the document and testing/debugging the prototype is being done in phase 4. The reviews are from the evaluator's rating, suggestions, and feedback that were conducted using Google Form. Regular meetings with the group are still being held to finalize the project.

TOOLS

The researchers of this capstone project have utilized MEEGA + as a method for the evaluation of the quality of the game “Laban Bayani”. MEEGA + is a method for the evaluation of the quality of games for computing education developed by Giani Petri and Christiane Gresse von Wangenheim. It is divided into 2 categories: Player Experience and Usability. Player experience has 8 subcategories which are: Focused Attention, Fun, Challenge, Social Interaction, Confidence, Satisfaction, Relevance, and User Error Protection, while Usability has 4, namely, Learnability, Operability, Aesthetics, and Accessibility (see Figure 7).⁴

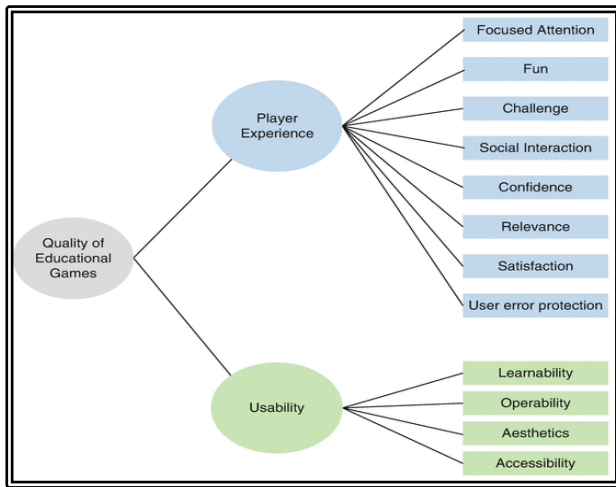


Figure 7: MEEGA + Test Cases Categories and Subcategories

To look for 20 players/users who can evaluate, the researchers contacted accessible individuals aged 7 above by sending them private messages through Messenger where a link for a Google Form with the test cases is included. The Google Form followed the division of categories (Player Experience and Usability) and their subcategories in making the form. Per subcategory, 3 test cases statements were put to be answered by the respondents. In the last part of the form, a section for Suggestions/Feedback was made available so that the respondents can put in additional thoughts and recommendations about the game. The evaluators were also asked to rate the game on a scale of 1 star to 5 stars – 1 being the lowest rating and 5 being the highest rating.

Phase 5: Release

This process focuses on implementing the customer's Accepted Deliverables as well as defining, recording, and internalizing the project's lessons learned. After thorough review, evaluation, testing, and debugging, the project is granted clearance from the scrum master and product owners to finally be uploaded in the Google Play Store.

RESULTS AND OUTCOMES

This section presents the results and discussion to determine if the researchers were able to meet the objectives of the capstone project. It also provides the discussion of gathering requirements, design and development, and the results of the testing.

Data and Requirements Gathering

The researchers were able to gather data by having group meetings online to brainstorm and by reviewing related literature. Past capstone projects found on the internet also aided the group in the data gathering process. As a result, the researchers found and completed the requirements needed to meet the objectives of the project.

Table 1. Software Requirements

Hardware Requirements	Software Requirements	Function
Android Phone	Android OS 5.0 (Lollipop) (Recommended)	Mobile operating system
-	2 GB RAM (Recommended)	Memory
-	8 GB (Recommended)	Internal Storage

Design and Development Phase

For the design and development of this capstone project, the researchers used different resources and software.

Visual Studio Community 2019 was used for coding while Unity 3D version 2019.4.22f1 was used to compile the game. To test the android game, Nox Emulator was also utilized. Photo Pun 2 was used in attempting to finish the multiplayer mode of the game.

For modeling, UV wrapping, and animation, Blender 3D version 2.92.0 was used. For the video animations before each level, Adobe After Effects 2020 was the software utilized. Along with this are Adobe Photoshop 2020 and Adobe Premier Pro 2020 for drawing the characters and editing the video animations, respectively

Mobile Game Screenshots



Screenshot 1: Laban Bayani's Main Screen

The screenshot above is the main screen that the players see in Laban Bayani when the game has been successfully installed on their Android Devices. The players will see the buttons wherein buttons for proceeding with the game (PLAY BUTTON), modifying the settings of the game (SETTINGS BUTTON), or quitting the game (QUIT BUTTON).



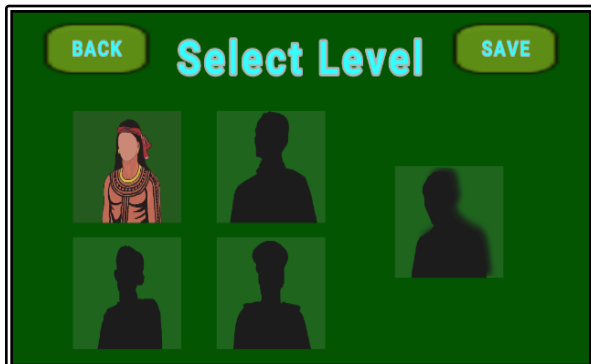
Screenshot 2: Screen after selecting the PLAY

BUTTON

Screenshot 2 shows the options available after clicking the PLAY BUTTON. It consists of STORY MODE, MULTIPLAYER, and BACK BUTTON if the user wants to return to the main screen.

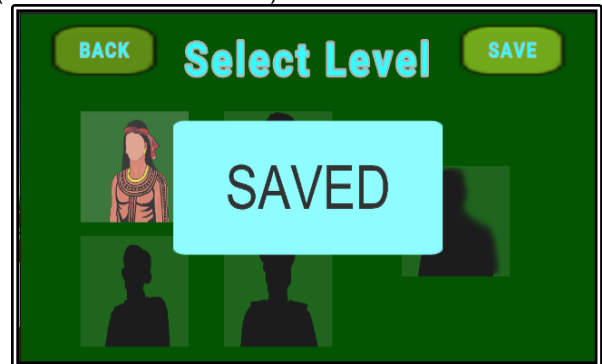


Screenshot 3: Screen after selecting STORY MODE
BUTTON



Screenshot 4: Level Selection

The 3rd and 4th screenshots showcase what happens after selecting the STORY MODE BUTTON. A level selection screen will show up, consisting of the 5 heroes featured in the game (Screenshot 3). The shadows represent the unlocked levels. There is also a save button in the upper right corner so that the user can save his/her progress when playing (Screenshots 4 and 5).



Screenshot 5: SAVED interface

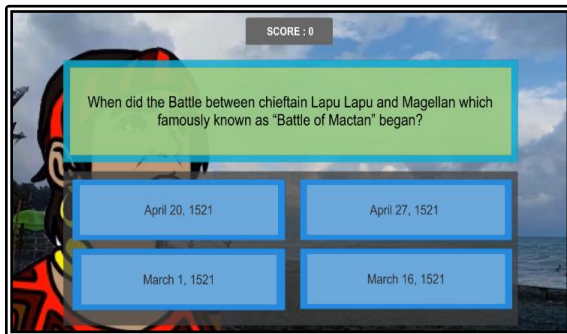
Selecting Level 1 (Lapu-Lapu) will then proceed to a short video animation before it starts. The same goes with the other levels (see Screenshot 6). A short video animation will play first before the levels actually start. Players who wish to skip the video animation can do so with the SKIP BUTTON at the bottom right part of their screens (Screenshot 6). If the players want to go back to the Level Selection interface, the players can tap the BACK BUTTON.



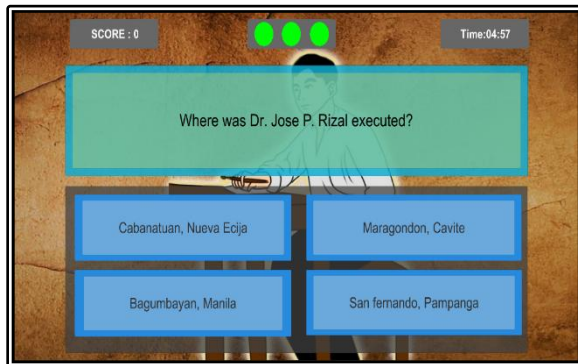
Screenshot 6: Video Animations of the 5 levels



Screenshot 7: Pre-QnA for Weapon/Rewards Bonus / History of Rizal Pre-QnA Screen



Screenshot 8: Sample Question in the QnA for Weapon/Rewards Bonus

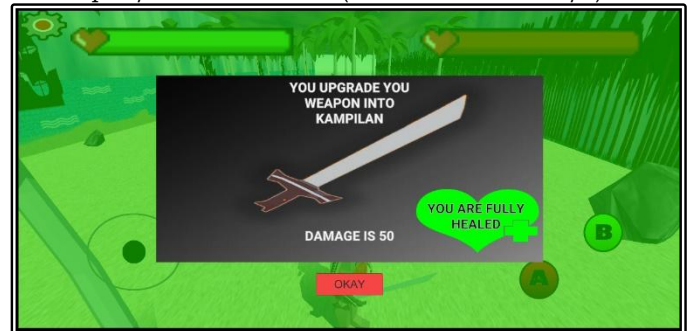


Screenshot 9: Jose Rizal QnA

In the case of the Jose Rizal level – the only non-fighting, interactive question and answer level in the game – all ten (10) questions will be asked and there would be a timer of 5 minutes to answer all the questions (see Screenshot 9). The three (3) green dots in the upper middle part of the screen are the 3 lives of the player. One (1) wrong answer in the quiz is equivalent to a loss of one (1) life. When only one (1) life is remaining, the one (1) dot remaining will turn red.



Screenshot 10: Sample Result of QnA for Weapon/Rewards Bonus (0-3 correct answer/s)



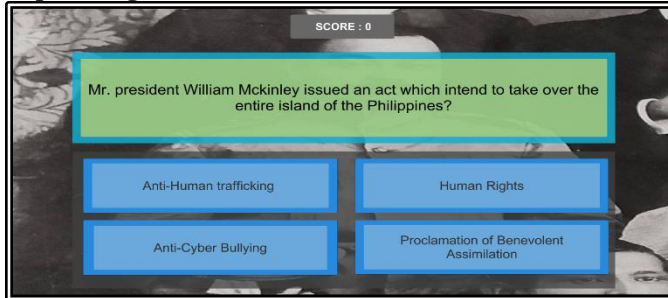
Screenshot 11: Sample Result of QnA for Weapon/Rewards Bonus (4-5 correct answers) Before the levels actually start, a pre-test consisting of five (5) questions will be played by the palyer. The sample result for the players who answered 0-3 questions correctly is in Screenshot 10 while the sample result for the players who answered 4-5 questions correctly is in Screenshot 11. After the results are shown, the level begins. Before the Boss Fight of the 4 fighting levels, bonus questions will appear on the screen for rewards like full HP and weapon upgrade, as shown in Screenshot 12



Screenshot 12: Pre-Bonus Questions for Boss Fight Screen for levels 1-4

When the START BUTTON is pressed in Screenshot 12, five (5) more questions will be asked. A sample question are shown in

Screenshot 13. In Screenshots 14 and 15, the results of the Bonus Questions will flash on the player's screen. The rewards are either full HP, buffs, special skill, or upgraded weapons, depending on their scores.



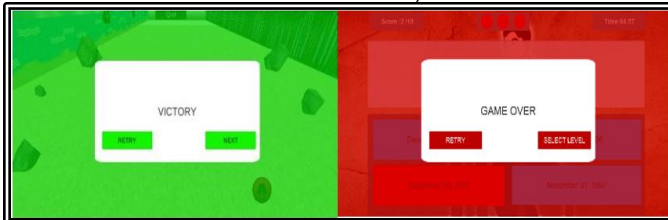
Screenshot 13: Sample Bonus Question for Boss Fight for levels 1-4



Screenshot 14: Full HP Reward for Boss Fight Levels 1-4 (0-3 correct answers)



Screenshot 15: Rewards for Boss Fight Levels 1-4 (4-5 correct answers)



Screenshot 16: Victory Interface

Screenshot 16: Game Over Interface

Screenshot 16 shows the Victory Screen when the player manages to defeat the boss and complete the level while Screenshot 17 is the Game Over Screen if the player fails to beat the level. RETRY BUTTON will reset the level while the NEXT BUTTON will proceed to the next level. In the Game Over Screen, Select Level would bring the player back to the Level Selection Screen/Interface. A puzzle piece of Rizal's picture will be shown in the next screen to signify the player's success in completing the level.



Screenshot 21: Luna with Sword

Below are more screenshots from Laban Bayani's Story Mode:



Screenshot 18: Andres with Bolo



Screenshot 19: Andres with Revolver/Gun



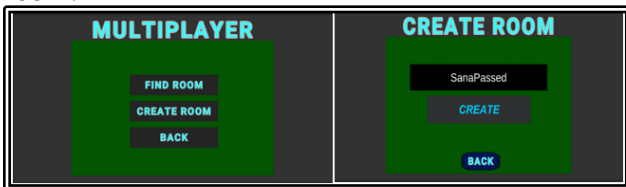
Screenshot 20: Goyo with Eagle Buff



Screenshot 22: Luna with Mauser Rifle

Screenshot 23: Luna in Rage Mode

For the Multiplayer Mode, the player will see a screen with 3 buttons: FIND ROOM BUTTON, CREATE ROOM BUTTON, and BACK BUTTON (see screenshot 24). FIND ROOM BUTTON is for players who wish to join an existing room and CREATE ROOM BUTTON is for players who wish to create a room that can be joined by other players. Screenshot 25 shows a sample of what the screen will show when the player pressed CREATE ROOM BUTTON. The players can type in their desired name for the room.



Screenshot 24:
Multiplayer Mode
Screen

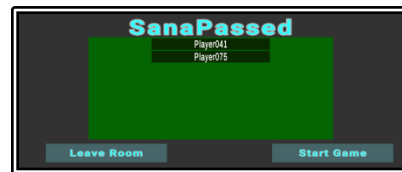
Screenshot 25: Create
Room Interface

Screenshot 26 exhibits what the player sees when FIND ROOM BUTTON is pressed. Once the players find a room, the players will be able to join and see the room creator already in the

room (see Screenshot 27). There will be a LEAVE ROOM BUTTON and a START GAME BUTTON so the player has the option to leave a room and find/create another, or start the game for the multiplayer mode to commence. Note that only the room creator can start the game.

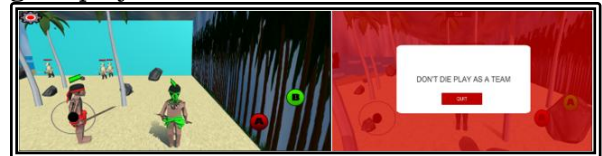


Screenshot 26: Find Room Interface



Screenshot 27: Room with Player 1 and Player 2

Below are screenshots of the multiplayer mode gameplay:



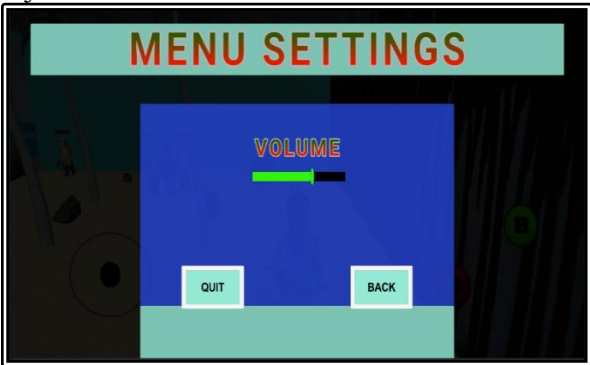
Screenshot 28: Player
1 and Player 2

Screenshot 29:
Player 1 dies



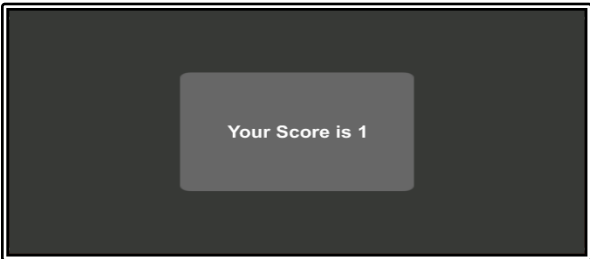
Screenshot 30: Player 2 remaining
Screenshot 28 will show Players 1 and 2 as Lapu-Lapu in red and green. If there is an instance when Player 1 dies (see Screenshot 29), Player 2 can still play and can proceed to the next level with Player 1 if Player 2 manages

to defeat the enemies and the Boss (see Screenshot 30). Multiplayer mode also has 4 fighting levels like the Story mode – no QnA and Rizal level since Rizal Level was used to unlock it. Lastly, players’ names in the multiplayer are randomized and cannot be customized by the players.



Screenshot 31: Menu Settings

In every level, whether single player mode or multiplayer mode, the settings button is available on the upper-leftmost corner of the player’s screen so that the volume can be adjusted whenever the player wishes to (see Screenshot 30). A screen will also appear showing the player’s score after the QnA portions (see Screenshot 31).



Screenshot 31: Sample Score on Q&A portion

Test Cases Results

Using MEEGA+ test cases for the testing and evaluation, the researchers were able to gather the results for the test cases. To statistically interpret the data gathered, the researchers converted Agree to 1 and Disagree to 2 – making the MEEGA+ 5-point Likert scale into a 2-point Likert scale. Then, the mean and the mode were calculated. The mean is the average of the data while the mode refers to the value that appears most often in a data set. The mean and the mode were calculated to determine if the majority of the answers of the

testers passes or fails the game in the evaluation.

The range of Agree (1) is from 1 to 1.49, while Disagree (2) ranges from 1.50 to 2 (see Table 2). Table 2: 2-point Likert Scale Evaluation Range

Scale	Range
1	1-1.49
2	1.50-2

Player Experience

This section is dedicated for the results of evaluation for Player Experience. The tabulation which includes the calculated means, modes, ratings, and scales are presented. As already mentioned, every subcategory of Player Experience had 3 questions each. With the results of each subcategory, the mobile game was able to pass all the test cases (see Appendix I).

For Focused Attention, the first statement garnered a mean of 1 and a mode of 1, indicating that all of the users were able to focus their attention to the game the entire time, while the second statement had a mean of 2 and a mode of 2. These results show that all of the players did not have problems in regards to any distractions – supporting the result from the first statement. For the last statement, the mean and the mode were 1.25 and 1, respectively. This can be interpreted with the player’s overall focus on the game – yet again, supporting the first and second statement for Focused Attention. In summary, Laban Bayani passed the test cases for **Focused Attention.**

For the second subcategory which is Fun, the first statement had a mean and a mode of 1 – indicating that the testers were able to be entertained by the game due to its video animations, sound effects, or other elements. With the next statement, the results were also a mean and a mode of 1 – showcasing that all of the players had fun in playing the game. Lastly, the third statement garnered a mean of 1.75 and a mode of 2. These results show that, majority of the players disagree that the game made them feel bored – supporting the two previous statements wherein the testers were entertained and were able to have fun. All in all, Laban Bayani passed the test cases for the Player Experience subcategory, Fun.

Challenge is the third subcategory of Player Experience. For the first statement, a mean of 1.05 and a mode of 1 was calculated. This shows that most of the players found the game easy. The second statement had a mean of 1.05 and a mode of 1. This presents that most of the evaluators saw that though the game was easy, it also had a reasonable amount of challenge in it when being played. Lastly, the third statement had a mean of 1.35 and a mode of 1, which indicates that the users also had difficulties in completing some of the levels/tasks in the game. These results support the second statement which is “This game is appropriately challenging for me” – wherein there is a mixture of easiness and difficulty in the game, making it appropriately challenging. Therefore, Laban Bayani managed to pass the test cases dedicated to Challenge, the third subcategory of Player Experience.

As mentioned before, this game has a multiplayer mode that can be enjoyed by its players. The fourth subcategory of Player Experience, which is Social Interaction, focuses on the multiplayer mode of the game. For the results, 1.2 and 1 were the mean and the mode of statement 1, respectively. This shows that the game made it possible for its players to interact with each other through its multiplayer mode. The second statement had a mean of 1.15 and a mode of 1 – emphasizing that the game did promote cooperation among its players since 2 players can play as Player 1 and Player 2. The last statement’s mean was 1.35 and its mode was 1. This illustrates the enjoyment of the users in the multiplayer mode of the game. In general, the three statements were mostly agreed upon by the testers. Hence, Laban Bayani passed the Social Interaction subcategory of Player Experience.

Confidence is the next subcategory of Player Experience and it is about how confident the players are in finishing the game, especially the story mode, on their own. The first statement had a mean of 1.05 and a mode of 1. The next statement had a mean of 1.05 and a mode of 1 as well, and the last statement had a mean of 1.35 and a mode of 1. The three of these statements, combined together, shows that, majority of the users felt confident to play the game by themselves and not seek help from others in finishing it. For an overview of the

results, the game, Laban Bayani, passed the test cases involving Confidence, the fifth subcategory of Player Experience.

Satisfaction is the sixth subcategory of Player Experience. The statements on this subcategory focuses on the ability of the game to satisfy its users with its content and features. In consecutive order, the means were 1.05, 1, and 1, while the modes were all 1. This conveys Laban Bayani’s ability to pass the test cases which can be interpreted that the users were satisfied with the overall contents of the game.

Second to the last subcategory of Player Experience is Relevance. As shown in the table (see Appendix I), the three statements garnered the same mean of 1.05 and also the same mode of 1. When integrated, these statements prove that Laban Bayani passed the test cases for Relevance – making it a game that is related to the present time, related or similar to other popular games, and relevant to the preferences of the players in gaming.

Last subcategory for Player Experience is User Error Protection. The first statement had a mean of 1.1 and a mode of 1. Meaning, almost all of the players agree with that statement. Second statement’s mean and mode are both 1. This shows that all of the evaluators were able to prevent making mistakes because of the clarity and conciseness of the instructions provided by the game developers. Lastly, the third statement had a mean of 1.5 and a mode of 2 which implies that no personal errors from the users were committed that could affect their gameplay. When integrated, Laban Bayani’s instructions were clear and concise enough that the users did not have problems with making mistakes in the game. Laban Bayani passed the last subcategory of Player Experience.

Usability

Like Player Experience, Usability’s subcategories had 3 questions each. The means, modes, ratings, and ratings are tabulated (see Appendix J)

The first subcategory is Learnability. In consecutive order, the statements’ means were 1, 1.05, and 1.55, while the modes were 1, 1, and 2. In statement 1, all of the evaluators agreed that new information was learned, especially about Philippine History, through the

game. In statement 2, almost all of the evaluators agreed that their peers can learn new information from the game too. Lastly, the evaluators felt no need to research about some things before they could play the game, especially when answering the question and answer portion, since the video animations before the levels start provide the information needed to answer the questions correctly. In short, Laban Bayani passed all the test cases in Learnability.

For the second subcategory of Usability, which is Operability, the researchers garnered the same mean and mode of 1 for the first two statements while the third statement had a mean and mode of 2. This was a landslide result and indicates that in terms of the operability of the game in the players' devices, it ran smoothly, functioned properly, and did not make the device of the users hot or laggy. With this, Laban Bayani was able to pass the test cases for Operability – the second subcategory of Usability.

Next is Aesthetics – which also had landslide results. This subcategory focused on the game's design (graphics, fonts, texts, assets). All of the statements had both a mean and a mode of 1, which means all of the evaluators agreed to all three statements. As a result, Laban Bayani passed all of the test cases in Aesthetics.

Last is for Accessibility, the last subcategory of Usability. The first and second statements had a mean of 1 and also a mode of 1. When integrated, these two statements prove that all of the evaluators had ease of access with the game since it was easy to download and install, and that it was compatible with the devices of the users. In regards to statement 3, the mean was 1.55 and the mode was 2. These results indicate that when looking for the game in the Amazon App Store, the testers found it easily. To summarize, Laban Bayani also passed the test cases for the fourth subcategory of Usability, which is Accessibility.

Suggestions/Feedback

To get an in-depth information about the Player Experience and Usability of the game, the researchers decided to get the evaluators' suggestions and/or feedback by making the evaluators rate the game from a scale of 1 star to 5 stars and write/type in their thoughts and

recommendations for the improvement of the game. The average rating of the game was 4.7 stars (see Appendix K) and the comments of the respondents are shown in Appendix L. Note that the evaluators who answered N/A or none in the suggestions/feedbacks were excluded in the table. These data show that overall, the game gained mostly positive reviews and recommendations are usually graphics improvement.

DISCUSSIONS

This section consists of the summary of findings, conclusions, and recommendations based on the results of the study” Kiddie-dule: MODULE AND SPEECH TRAINING FOR TODDLERS WITH SPEECH RECOGNITION”.

The researchers successfully developed an application that meets the requirement needed that will help children ages 4 – 6 years old in enhancing their basic knowledge and speech skills for android and smartphones in a fun way of learning.

The researchers came up with the idea of developing Kiddie-Dule: Mobile Module and Speech Training for toddlers with Speech Recognition during the pandemic to help the children ages 4-6 years old in preparing or at least bridging the gap made by the pandemic for them to go to school. One of the researcher's youngest siblings inspires the application. The families are worried that because of the pandemic, the youngster will not be able to attend school. Therefore, they came up with ideas on how they can teach him at home the fun way, and the researchers proposed this application.

The researchers gathered information with the help of professionals (teachers) and parents that provides credibility to the purpose of the application. The researchers use Android Studio and android devices to create an application with Reading Modules, Videos about Phonetics, Pronunciation, and Letters, Speech Recognition, Assessment for kids with choices, Audio of Word Pronunciations, Achievements Display that meets the Meega+ criteria.

The Usability Testing Result (see Appendix I), shows that the respondents are Strongly Agree that the application passes the sub-criteria of Aesthetics, with an average scale of 2. The

application is overall attractive to the user because of the interfaces, images, and colors used in the application.

Under learnability, the respondents agreed with the average scale of 1, that the application is easy to learn and understand by the target users. The respondents also agreed that the speech recognition of the mobile application is accurate and the learning materials and videos are credible with the help of professionals.

In the operability sub-criteria, the respondents agreed, with an average scale of 1.19, that the application responds on an acceptable range of time. The response time of the application also depends on the speed of the internet.

The User Experience Testing Result (see appendix J), shows that the respondents agreed with the average scale of 1, that under perceive learning, the application play its role. Respondents agreed that the application is a good teaching guide and enhance the speaking skills of the user.

Under confidence sub-criteria, the respondents are strongly agreed with the average scale of 1.75, that the application's interface and with the help of the guardian, they are confident enough to use the application.

Lastly, under fun sub-criteria, the respondents are agreed with the average scale of 0.65, the user learns with fun using the application. There are some encountered errors while using the application but it is only because of the version and specifications of the device used which is Android 7, 2 GB of RAM. There are some lags encountered while using the application.

Conclusions

The researchers have successfully developed a Kiddie-dule application that meets the Meega+ criteria in terms of usability and user experience evaluation. The final evaluation in Usability Testing, makes the researchers conclude that the application is aesthetically developed, easy to learn and operate. With the respondent's feedback, the researchers are able to reach a good final average scale.

In the final evaluation in User Experience Testing, the researchers conclude that the application works as the researcher's goal in helping children enhance their speaking skills and learn basic knowledge before going to school with fun in the comfort of their home.

Recommendations

The following are recommendations to improve the Kiddie-dule: Mobile Module and Speech Training for Toddlers with Speech Recognition in future development:

- The researchers believe that including a function that allows the teachers to upload modules for the target user will make the application more credible and contain more learning materials.
- Allows a teacher/user to create accounts for more personalization.
- Adding more learning videos, learning materials.
- Adding more topics to tackle and learn.
- Allows higher-level users to use the application and contain higher-level users not just for toddlers.

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Makibalu King Mabalacat: Virtual Reality Museum for Mabalacat City

Baby-Jane C. Estrella
Jonnel C. Garcia
John Paul D. Salazar
Kayla Mae G. Soriano
Paulo B. Tolentino
Dessalyn J. De Castro (Technical Adviser)

ABSTRACT

The virtual museums enrich the museum user experience allowing them to interact and explore different Images, Artifacts, History, and Information. Makibalu King Mabalacat Museum aims to provide information about Mabalacat City. The future visitors can have a virtual tour from the comfort of their own homes and utilize it as a substitute for going to the museum in person. Emerging technologies such as mobile phones and different applications nowadays. The research gap aims to find and develop an application, especially when people are not safe freely walking around and exploring these beautiful places. Makibalu King Mabalacat. The research study analyzed the information and requirements needed in creating 3D models, PNG images, Animations, and videos. Information gathered from its history. Using the related studies about virtual museums, the researchers consider and use them as a procedure or idea for the museum. As a result of completing the design, the researchers developed a Virtual Reality Museum for Mabalacat City as an alternative physical visit and to provide knowledge for the users. This Virtual museum is not only for self-gain but to make the information content accessible to the broader public, especially people in the community, students, future researchers, and art lovers. The implication of our findings is making a virtual tour for people who loves to explore history and knowledge about the information and beautiful places in Mabalacat City. The Makibalu king Mabalacat can walk freely to explore beautiful places and use it as an alternative way to visit a location that satisfies users' curiosity, explore the history of the city and artifacts, and learn about the information of Mabalacat City in a virtual tour.

INTRODUCTION

Tourism is essential for the success of many economies around the world. Tourism in host destinations has some advantages. It generates thousands of jobs, improves a country's infrastructure, and fosters cultural exchange between foreigners and natives. Many tourists go to learn about the culture and traditions of the host country. Meeting people from different cultures will demonstrate to tourists that the world is not the same for everyone. Apart from traveling to foreign countries to learn about diverse cultures, one approach to broaden people's understanding of the world's cultures and beauties is to visit museums that hold various representations of foreign civilizations, arts, and customs.

A museum is a place where individuals can learn about values, history, and uniqueness. People are continuing to use mobile devices as technology advances. As a result, visiting museums is not necessary. Works on display can be subject to damage by visitors. However,

visitors might damage the works on display. Some museums have resorted to using mobile devices to revolutionize the way people explore the world.

Mobile phones are no longer for voice communication. It evolved into a platform for voice, music, text, video, and image communication which mobile users can share and demand these communications. Mobile devices are used, among other things, for easy access [1].

From a societal standpoint, mobile technology began as an unusual gadget used by a small number of people who needed to interact with others in real-time emergencies, such as police officers and military personnel. Mobile technology has also used mobile technology for medical services, education, political events, new product marketing, location services, games, music, and video. Mobile phones are regarded by many as "the most intimate piece of technology that anyone will ever own." (Krum, 2010, p. 7) [1].

Individuals use mobile phones in a variety of ways practically every day. Virtual Reality is a popular technology that has been employed in applications and sectors throughout the years, ranging from marketing and entertainment to space missions and the expansion of physical viewings. The phrase "virtual reality" was coined in the mid 1980s by Jaron Lanier, founder of VPL Research, who began developing the necessary equipment, such as goggles and gloves, to experience what he dubbed "virtual reality" [2].

A virtual reality museum is a collection of digitally recorded images, audio files, written documents, and other historical or cultural content. Virtual museums are collections that make full use of the World Wide Web's easy access, flexible arrangement, hyperlinking, interaction, and multimedia features. According to the

International Council of Museums, the Brochure Museum, Content Museum, and Learning Museum are three virtual museums developed as extensions of real-world museums on the Internet. Users learn about the painting's wood panel texture and how the passage of time has impacted the way it looks using interactive design, sound, and animated visuals. The experience is available in five languages and may be booked directly at the Louvre for four months. It is also available for download on the VR app store Viveport, IOS, and Android [3].

Other countries are passionate about the arts and have been constructing Virtual Museums to highlight their beauty over the past few years. Virtual Museums are extensions of actual museums that give opportunities for art enthusiasts to continue to experience various types of art. Virtual Museums are available in these states; in Poland, UK museums explore Virtual and Augmented Reality exhibitions based on 3D models of artifacts presented. The 3D Murale project in Europe is an Ancient Lost Worlds aimed at developing a system capable of recording archaeology excavation phases using Virtual Reality techniques. The National Museum of Finland in Helsinki produced a new virtual reality display. Visitors can go back to 1863 to visit The Opening of the Diet of Ekman's painting by Alexander II. The Louvre in Paris has released 'Mona Lisa: Beyond the

Glass' as part of its Leonardo da Vinci blockbuster show, a virtual tour that examines Renaissance painting.

The COVID-19 pandemic resulted in significant loss of human life throughout the world, and it gives an unexpected threat to public health, food systems, and the workplace. The pandemic's economic and social effects are devastating; tens of millions of people are on the verge of falling into deep poverty, and the number of malnourished is rising, which is estimated to be around 690 million. COVID-19, a unique human coronavirus illness, has become the world's fifth recorded pandemic since the 1918 influenza pandemic, which began in March 2020.

People have restricted access to the outside due to current events that affect the community because of COVID-19. The epidemic has resulted in significant losses in several sectors of the country, including business, medicine, and education, not to mention the tourist, entertainment, and art industries. When it comes to visiting museums and experiencing new areas, art enthusiasts and tourists are affected.

The researchers aim to conduct a Virtual Museum using Mobile Applications and Virtual Machines for the Clark Museum. This application provides realistic images and objects and serves as an alternative medium for exhibitions when displaying a collection of art, sculptures, paintings, and works. The categories researchers project has: for students of Mabalacat City College taking history subjects, people in the community and for the tourist/visitors outside the municipality which allows the visitors to explore through virtual. The researchers developed the proposed virtual application using a VR box on smartphones or android devices to provide a virtual reality experience.

Background of the study

The Virtual Reality Museum in Mabalacat City is a virtual interaction with museums using the virtual Reality of some arts, sculpture, items, paintings, old images, historical places, works, and Mabalacat City's history. It is a method of advertising the tourism attractions of Mabalacat City through the use of an application named "MAKIBALU KING MABALACAT."

Until the world experienced this epidemic, the tourist sector was one of the world's most important markets. Traveling is the most enjoyable method to meet new people and see different locations. COVID-19 has a significant impact on the tourist sector's outcomes. The spread of the Corona Virus Disease affected the Philippines in March 2020. The reactions of travelers during the pandemic trends outlined by adopting text mining techniques and deciding to cancel or delay trips. The virus is rapidly spreading and developing in the human population, prompting the Philippines to declare an Enhanced Community Quarantine in the same year.

Because of the epidemic, most essential and non-essential establishments have been closed. There are laws and provisions mandated by the government prohibiting citizens from going outside. Non-essential establishments include but are not limited to entertainment, parks, resorts, art galleries, and museums, which do not serve services or offer items that the authorities deemed not to be essentials. As mentioned earlier, the establishments' temporary closure has dramatically affected the economy. The imposition of a travel restriction has stopped individuals from traveling to other locations. However, these non-essential enterprises have continued to operate this year, although some individuals, particularly youngsters and older citizens with limited access, are still forbidden from visiting. Because it is unsafe and recommended, fewer opportunities are to stay. Many regulations and safety protocols are still in place and followed, and it is not yet safe to visit places due to possible virus transmissions. A site that accepts many visitors has a higher risk of contracting the disease because the virus can be transmitted easily from one host to another. In these situations, Virtual Museums are safe for those people who love exploring, for those people that would want to visit a museum or place, particularly in Mabalacat.

Virtual Reality is rapidly improving in terms of realism and usability. Simultaneously, building virtual reality experiences to highlight Mabalacat City's history and promote its uniqueness is becoming more accessible and accessible. Museums provide digital tours, presentations, and exhibitions that provide

more knowledge, flexibility, and immersion into art while entertaining users and satisfying their curiosity. Virtual Reality Museums are now available and safe, and people will cease visiting actual museums as a result of this application by preventing the spread of Coronavirus Disease.

Objectives of the study

The general objective of this study is to develop "MAKIBALU KING MABALACAT": A Virtual Reality Museum for Mabalacat City.

In line with this, this study aims to achieve the following objectives specifically:

- To design and develop an android-based application with the following features:
 - Virtual Reality
 - Text
 - Images
 - Audio
 - Video
 - Animation
- To design and develop an android-based application using:
 - Unity3D/2019v
 - Blender
- To design and develop an android-based application integrating the following concepts:
 - Tourist attractions in Mabalacat using 2D/3D images;
 - Virtual Reality Screen Modes and Character Navigation:
 - D-Pad thumb-operated in-game controllers
 - VR Mode tilt to make movements
- To test the android-based application using MEEGA+ as an evaluation tool with the following criteria:
 - Aesthetic
 - Learnability
 - Operability
 - Perceived Learning
 - Satisfaction
 - Confidence
 - Fun

Scope and limitation of the study

The virtual Reality Museum for Mabalacat City, named "MAKIBALU KING MABALACAT." is designed and developed. The researchers used a questionnaire with statements based on MEEGA+ evaluation criteria to conduct a

survey and gather feedback from the evaluators. The development of the study aims to put up a Virtual Reality Museum application that can provide knowledge about a brief history of Mabalacat City and showcase the beauty of Mabalacat City by creating a virtual representation of different categories of historical attractions, Modern attractions, and the barangay representation.

"MAKIBALU KING MABALACAT" can serve as an alternative medium that will allow users to explore the city's beauty using android devices or smartphones. The application's VR compatibility can limit the application to be played by the users on devices that do not support Virtual Reality. The MAKIBALU KING MABALACAT will cover the features and functionalities such as Designing and developing android based applications with the following concept; 3D models, Virtual Reality, and Interactive multimedia. With the following features; Two VR and Character Navigation using Unity3D/2019 and Blender. The results of the application's evaluation through the MEEGA+ questionnaire have been the basis of the researchers in interpreting the testing outcome. MEEGA+ supports the application evaluation for the computing studies; this measures the application quality in terms of usability and user experience. The researchers used the MEEGA+ by evaluating to achieve valid results, composed of the following sub-criteria that the researcher used: Aesthetic, Learnability, Operability, Perceived Learning, Satisfaction, Confidence, and Fun. The researchers formulate three questions per criteria (see appendix H). The questions are related to the study's objective included in the measurement to achieve the specific goals of the application. This method helps the researcher improve and be effective in computing studies.

The prototype provides virtual tours with different categories such as Historical attractions, Modern attractions, and the Barangay of the city. When accessing the application, VR Mode and D-Pad Mode will display in the main menu. After choosing VR Mode or D-Pad Mode, the second screen will display the instructions in the app.

In D-Pad Mode, once entering the app, the user can take a look around the virtual museum,

and the user will see 2D and 3D images, artifacts, animations, and the logo of Mabalacat City. The user will also see the back button in the upper left and the setting in the upper right. There is a selection of background music and categories in the settings menu, and the user can also turn background music on and off. When choosing one of the categories, the user will select the 27 barangay in Mabalacat City in the barangay. Each barangay has a logo, origin, and description. Users can see five (5) old homes in Mabalacat City in the old houses. Every old house has a description and button for the narration, which the user can choose voice one (1) or voice two (2). Seven (7) famous tourist attractions in Mabalacat City are also featured. Each tourist destination has a scene where the user can see and see four different images and locations, and each category also has a theater door.

In VR Mode, the first screen will show the instructions of the application, on the second screen, the categories will direct the play button, and the user can choose what to view first; once choosing the preferred barangay, there will be options to choose from, either voice one or voice two. Once the user has already selected the specified voice option, the screen will then display the twenty-seven (27) barangays of Mabalacat City will show up. There is only an x button in the upper left in this category, and the user can use this button to return to the category option. Selecting to visit the old house category, the user can interact with the objects by integrating written description and voice narration. The seven (7) famous tourist spots in Mabalacat City are among the featured things of the application. There is also a tourist spot; once entering it, the user will see the seven famous tourist spots in Mabalacat City; every tourist spot has a scene, and when the user goes near the tourist spot, the user will go to its stage/scene. The user will see four different pictures, locations, and descriptions. Lastly, the others, once entering others. The user will see the 2D images, the logo of Mabalacat City, and 3D artifacts, and there is also a door for theater in each category.

The study will feature the following category:

Old Houses

- The Dela Cruz Tower House

Husband and wife Vicente de la Cruz and Felipa Lim built the Dela Cruz Tower House for daughter Constancia in 1932. The daughter had suffered from tuberculosis which prompted the building of the tower house since having such an illness requires inhaling fresh air.

- The Morales Mansion

The mansion is an 82-year-old concrete and wood tower with a design that harkens back to the days of Sta Ines "Bahay na Bato" by Don Quentin Morales and Dona Paula Guzman, members of the local "pincipalla," who owned the property. A 1972 film entitled "Mga Tigre ng Sierra Cruz" was filmed starring Vilma Santos, Dan Rivero, and Christo Solis in the said mansion. After some renovations, the Morales Mansion is now under the Dominican Sisters of San Fernando.

- The Mariano De La Cruz House

The 1900s house Mariano Dela Cruz's residence was built by Mariano de la Cruz, a former Municipal president of Mabalacat City. A cast cement figure of a lady carrying a basket of fruits, positioned in the center of a flower garden, is its most noteworthy feature and is currently being resided by the family heirs Ernesto and Irada de la Cruz.

- The Garcia-Perez House

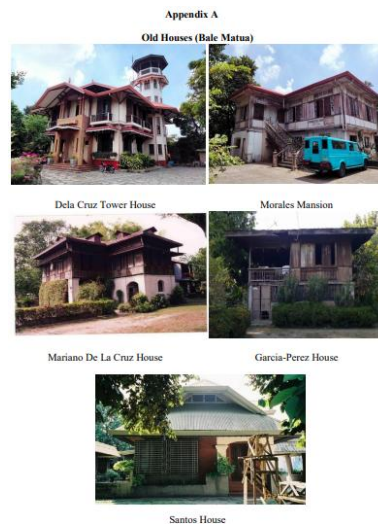
The residential house's pillars are from the Narra tree and Apitong wood. With intricate Antillian-style cutwork on the transoms, massive double doors, and broad flooring 1850-1860s ancient house built by Eulalio Tolentino, a premiere "haciendero" and a former Gobernadorcillo of Mabalacat, for his wife Lorena Lugtu, it served as a school in 20th century and a Japanese soldier's outpost during the World War II.

- The Santos House

Mr. and Mrs. Marcos Santos was the owner of this house. Town people have believed that Vice Admiral Ohnishi formed the first kamikaze unit in the said house, making it the official birthplace of World War II's famous Japanese Kamikaze organization.

The researchers have selected the mentioned houses due to the uniqueness of historical background passed down to several generations. Memories and old stories have remained with the houses until now. The desire to view the interior of the mansions and houses has remained constant over the years.

To represent the old homes in Mabalacat City constructed many years ago, symbolize the old Mabalacat City and remind people of the old way of life, see appendix A. Old Houses (Bale Matua)



- Kamikaze Pilot Statue

Vice Admiral Takijirnishii organized the first special assault force in 1944, using Zero planes to carry out aerial suicide operations, each bomb weighing 250 kg. Lieutenant Yukio Seki's Shikishima Squadron took out from Mabalacat Airfield and carried out Japan's first official aerial suicide assault. Since Japan violently colonized the Philippines during WWII, some people believe the

Philippines should not be honoring the Japanese kamikaze pilots. Officials from Mabalacat have defended the statue, claiming that its purpose is to promote peace via the study of combat.

Tres Marias

The "Tres Marias" were three massive pine trees that stood side by side at Clark's Mabalacat Gate. As the townspeople say, the location is haunted by evil spirits, making it prone to accidents. Tres Marias alludes to local mythology about three sisters who pledged to each other that they would always be together and that anybody who threatened to separate the tres Marias would suffer. Rumors state that the cars that drive through the course are being haunted and chased by the three (3) sisters. To this day, townspeople have

practiced blowing car horns thrice as a sign of paying respect to the three (3) sisters.

A Photo of Negritos

Lareana Tolentino served as Mabalacat's first "cabeza de barangay," or barangay captain. The lowlanders who frequented the area to hunt wild animals and fowls eventually drove the Negritos back to adjacent highlands and hills. The city's name was after the indigenous Negrito term Mabalacat means "forest of balacats" or "many balacat trees." And officially founded in 1792.

Balakat Tree

The City of Mabalacat gets its name from an old indigenous word that means "full of Balakat trees." Bearing the scientific name *Ziziphus "talanai,"* plenty of Balakat trees can be seen around the city.

The researchers' purpose in including the history, trivia, and facts about the city is to promote the rich heritage of the humble beginnings of Mabalacat City, reminding its people of the beauty of the city's roots, see appendix B. Artifacts

Appendix B
History, Trivia's and Facts



Kamekaze Pilot Statue



Tress Marias



Photo of Negritos



Balakat Tree

- Tapayan

Jars made of clay, a large earthen pot with a faucet that can contain 11 gallons of water

- Kamot Jar (Gusi Small)

Used as a salt or bagoong container due to its small size. Also known as "Kamot" because of the scratched lines on the shoulder

- Guguling (Gusi Maragul)

Large-size clay jar compared to Kamot Jar and known as "guguling."

- Dapukanan Aslam

Vinegar jar. But it is also used for storing other liquids.

- Masetas

A flower container with a more sophisticated finish than a standard "pasu." The word "mazeta" is a Spanish word that means "flower pot." Small size, used as a salt or bagoong container. Also known as "kamot" by Tagalogs due to the scratched lines on the shoulder.

The researchers have selected the mentioned artifacts to showcase how the city has developed by improving the people's way of living through the years. The town's growth is evident by the richness of the clay-made artifacts that the early Mabalagueños have utilized, see appendix C.

Appendix C

Artifacts



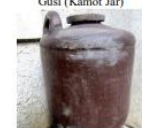
Tapayan



Gusi (Kamot Jar)



Gusi (Maragul)



Dapukan Aslam



Masetas

Tourist Spots

- Dinosaurs Island

Animatronic theme park and museum offer visitors a unique interactive learning experience of the dinosaurs with life-sized creatures in Clark Freeport Zone, Pampanga.

- Haduan Falls

Haduan Falls is a hidden paradise in Mabalacat Mabalacat Haduan Falls is located in Sitio Haduan, Mabalacat City.

- Clark Parade Ground

Also known as the Clark Development Corporation Parade Grounds (CDC PG) is a sporting open ground at the Clark Freeport Zone in Mabalacat, Pampanga, Philippines.

- Aqua Planet

Aqua Planet is a water park at the Clark Freeport Zone in Pampanga, Philippines. It is the largest water park in the Philippines.

- Nasyon ng Filipino

The Nasyon ng Filipino Clark is a cultural theme park featuring Filipino culture at the Clark Freeport Zone in Mabalacat, Pampanga.

- Clark Museum

A local history museum that exhibits diverse regional artifacts & an interactive documentary film houses some of the unique histories of Mabalacat City.

- Air Force City Park

A one-of-a-kind leisure facility both adults and children can enjoy. Prepare to journey back in time and experience being a vital part of the military forces in combat as the Philippines Air Force's history through a range of aircraft and guns on exhibit.

The researchers have chosen famous tourist spots as one of the contents in the virtual museum.



These establishments make Mabalacat City known to other cities through its exhibit and cultural value and one of the reasons tourists always visit Mabalacat city, see appendix D. Barangays in Mabalacat City

Lungsod ng Mabalacat

Mabalacat is a 1st Class Municipality. The city is in the 1st District of Pampanga, Region III, an Urban Municipality (Central Luzon).

- Atlu Bola

Barangay San Isidro, originally known as Barangay Atlu Bola, was named after patron saint, San Isidro Labrador. The barangay's elders agreed to adopt its festival date, celebrated every year on the 15th of May. According to the elders, sugarcane, to make sugar, are crushed by three (3) stone balls.

- Bical

After a type of thin climbing bamboos known as "Bical" (*Schizostachyum diffusum*) grew abundantly in the region, the place was named Bical in 1843. Luis Narciso and Mateo De Leon founded the company. Bical is known as Apung Duquit, then abbreviated to Duquit, and is under the patronage of San Roque. It's one of the three original "sitios," along with Dalan a Bayu (new road) and Sumangid Dalan (another side of the road).

- Bundagul

Barangay Bundagul is approximately 4 kilometers away from the town and is in the east part of the city. The place's name came from Maria Dagul, the first female settler. The place's last name is "masulput," also known as "sulput" or "Amor Seco plant.

- Dau

Barangay Dau traces its origins back to 1843 when Teodoro Lising founded a small and sleepy community in the rolling plains some distance from the Zambales Mountain Range. In 1935, Dau was elevated by a Commonwealth Act, from a small village to a full-fledged Barrio.

- Dolores

The popular name is Dolores, although it is known as Engineer Bus- bus commuter or riders. This barrio was called Dolores in honor of the Patron Saint Dolores, who has miraculous powers. The Old Dolores, the original place where the present people of New Dolores once lived, was a rolling plain bounded by high hills. It was once a meeting place of Pampangos and Negritos who traded cloth, wild fruits, rattan, gogo bark, deer meat, and logs.

- Duquit

Barangay Duquit is previously known as DUKIT. According to the elders, DUQUIT is a species of tall, lean trees that made good as houses, posts, and sculpture is their form of livelihood; it was then headed by a chieftain today known as Barangay Captain.

- Lakandula

Lakandula is what mainly was a former area of land called Bernardo Subdivision.

- Mabiga

Old folks claimed that the topography of Barangay Mabiga is high flat land. And most of the time, the sky was cloudy, which means in Pampango dialect "MA-BIGA," since the place was called MABIGA.

- Macapagal Village

In 1957, Barangay Macapagal Village, Mabalacat, Pampanga was known Baluga Village (negrito village). Most of the residents are "ITAS." But in 1961, the "ITAS" was evacuated by the Americans inside the Clark Air Base and left the residences which are not ITAS.

- Mamatitang

Barangay Mamatitang acquired its name from the wealthy family settlers named "Titang," and the word "mama," which refers to the wealthy Titang. The Catholic religion is dominant in the barangay. The Chapel of San Roque, in honor of the Patron Saint, was built. The celebration of the feast of San Roque every August 15 and 16 of the year. Other religions are Baptist, Seventh Day Adventist, Protestant, and others.

- Mangalit

Mangalit is a barangay of the Philippine Municipality of Mabalacat in Pampanga province in Central Luzon. This barangay is a part of the Luzon group of islands. The municipality's population is about 203,307, and its 27 barangays belong to the urban areas in the Philippines. Mangalit had 617 residents by the end of 2007.

- Marcos Village

The Aetas resided in the MARGOT and Sapang Bato mountains in the past. Planting at night, rice and sweet potatoes were their way of life. Aetas residents also get to try venison, snake meat, and grass pigs while hunting and also have a personal law stating that "a life, for a life." The majority of the population worked at the Clark Air Base, which the Americans abandoned.

Marcos community is known to be a pleasant and vibrant village.

- Mawaque

The name Barangay Mawaque is from the work —makawaya. It was once a secluded place with bungalows, "sawali," and bamboo houses.

The patron saint of Barangay Mawaque is Sta. Teresita. Based on the stories of the elders, Sta.

Teresita was seen from afar and subsequently became the barangay's patron.

- Paralayunan

According to the elders in barrio, PARALAYUNAN was once known as GUYUNG-GUYUNG. The Patrons of SAN ANTONIO DE PADUA and SAN ISIDRO DE LABRADOR wanted Guyung-Guyung (purpose-meaning living). People have modified the name of the site in BARANGAY PARALAYUNAN after the two Saints resided in Guyung-gyung.

- Poblacion

Barangay Poblacion was also one of the affected areas during the volcanic eruption of Pinatubo. Still, because of the diligence and perseverance of living here, Barangay Poblacion has adjusted and regained its livelihood. People's lives in Poblacion went to industrialization for the American soldiers' base. This event serves as an opportunity for the people living in Poblacion to settle in a job.

- San Francisco

Barangay San Francisco is in the northern part of the Municipality of Mabalacat. It is bounded north of Barangay Poblacion; on the south of Barangay Sto. Rosario; on the west by Clarkfield; and on the east by Barangay Sta. Maria.

- San Joaquin

It is bounded on the North by Barangay Dolores, on the South by Barangay Poblacion, on the East by Barangay Mamatitang, and on the West by Clark Special Economic Zone, all of Mabalacat.

- Sta. Ines

Barangay Sta. Ines is one of the first barrios of Mabalacat and became a barangay in the year 1890. The first living people in the barrios and other barrios were Aetas. One of the first families who settled in the barrio was Dela Cruz Family. The family has a Patron Saint St. Agnes (Sta. Ines).

- Sta. Maria

Barangay Sta. Maria got its name from the Patron Saint Maria Magdalena.

The statue of the saint is being taken care of by a prominent person Alejandrino Angeles. Initially, the Barangay proper had only two (2)

households, Sitio Libutad had 19, and Sitio cuatro had 4.

- Sto. Rosario

A specific religious person named Mr. Pedro Dizon donated a Patron Saint named Santo Rosario. The people of Mawaque were terrified by the war, the rationalization and migrated to Barangay Santo Rosario.

- Sapang Balen

It is bounded on the North by Barangay Atlu-Bola and South of Barangay Poblacion on the East of Barangay Mangalit and on the West of Barangay

Bundagul, all of Mabalacat.

- Sapang Biabas

Sapang Biabas is made up of three Sitios: Sitio Mauli, Sitio Makabakle, and Barangay Proper. According to locals, a little river ran alongside the main road in the early days, and its water was free-flowing. Many lovely and growing guavas yielding large fruits are growing on both sides of the river. The river was spotless, and the water glistened like crystal-like a mirror. The water from the river may be used as a drinking source and for washing clothing.

- Tabun

Long time ago, Barangay Tabun, was divided into four (4) sitios: Sitio Apitan, Sitio Iba, Sitio Irong (a.k.a Donya Africa), and Barangay Tabun. Barangay Tabun symbolizes the vast storage of water supply of all the farmers living in the area, for most residents work in the agriculture field.

The researchers have included brief descriptions in the different barangays, including the logos to promote each origin. The city has 27 barangays. see appendix E.



SYSTEM DEVELOPMENT METHODOLOGY

The research design model used by the developers was the throwaway prototype model. The MAKIBALU KING MABALACAT is a software application that displays the application's functionality under development. The researchers used the Throwaway prototype model to validate the application functionalities and requirements. The researchers use this model to assess the application's feedback, adjustment, and evaluation over time. Throwaway or Rapid Prototyping means the prototype is revised and developed until the researchers meet the study's objectives. This method is ideal for experimenting with new concepts and receiving immediate feedback from the users.

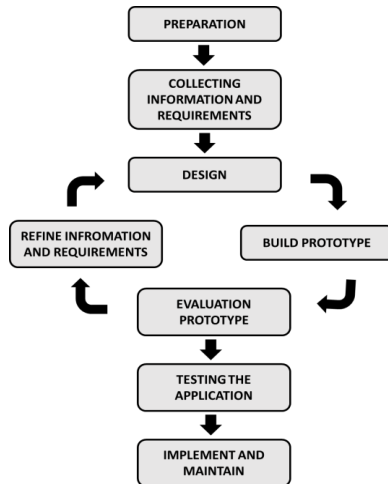


Figure 8. Throwaway Prototyping Model of the Study

Preparation

The researchers had a meeting to conceptualize and brainstorm the study and identify the scope of the application. The researchers gathered ideas about the application's content "MAKIBALU KING MABALACAT" Virtual Reality Museum of Mabalacat City.

Collecting Information and Requirements

In this phase, the researchers gathered all the possible required information and requirements about the application (see appendix N). The researchers find a suitable software application to develop the virtual museum and collect all possible content needed in the museum. The researchers gathered information about existing related studies.

First Instance Design

In this phase, the researchers brainstorm the design and layout of the "MAKIBALU KING MABALACAT" Virtual Reality Museum for Mabalacat City. Researchers started to develop the structure using Unity, a development platform used to create games, virtual reality applications, and experiences in both 2D and 3D.

Build Prototype

In this phase, the researchers identify and develop the initial prototype requirements, including the input and output of the application. The application design has three-part. The first part is the center is the main attraction of the museum Trivia's, and History and other categories are separately Old House and Tourist Spot. The application sounds have

background music and walking sound the control of the application depends on the user's movements.

Evaluation of Prototype

In this phase, the researchers evaluate the prototype to ensure the flow and maintain the building prototype if the application will work as it is supposed to and the risk and stakes of the virtual reality museum application. The result of the application on the first attempt during the evaluation is the application is working, and it can install on android phones. The smoothness of the application is good but needs to be improved. The application categories are in the application and their descriptions.

Refine Information and Requirements

In this phase, the researchers ensure and review every possible information and requirement to analyze the details and functionality of the virtual reality museum application or system if there is something lost or not yet included. The researchers gathered additional information and requirements needed and determined improvements of the application in its design and prototype, considering the result of the evaluation process.

Second Instance Design

In this phase, the researcher re-designs the application considering the evaluation results in the first instance. The gathered additional information and requirements and the panel recommendation are applied. The researcher again designed and layout the "MAKIBALU KING MABALACAT" Virtual Reality Museum for Mabalacat City. The developing tool is Unity, a development, Photoshop for enhancing images, Blender for 3D models, and C# codes and logic for the actions.

Build Prototype

In this phase, the researcher re-designs the application considering the design layout of the Museum. The application changes are the museum has different rooms in every category, it has four-part, and each part has a theater. The application includes choices of background music and narrator. The museum included Sculptures using 3D models, Animation, short film viewing, and Images converted into PNG. The application functions use joystick camera angle and user movements. The application

includes two options D-Pad and VR mode and Setting selection.

Evaluation of Prototype

In this phase, the researchers evaluate the prototype in the second instance to ensure the flow and maintain the building prototype if the application achieves the objectives. The application is completing the information and requirements gathered during the process. The design and colors changed, and it is now easy to use; Images convert into PNG; logos convert into animations; artifacts convert into 3D models (see appendix M); the application's smoothness is good, and the buttons work. The options for the D-Pad mode and VR Mode are working. The application can install on android phones and IOS phones 14.0 above.

Refine Information and Requirements

In this phase, the researchers ensure and review every possible information and requirement. The researcher gathered and determined information and needs, including each content's authorization to address the evaluation result. Note that the application process works until the researchers meet the study's objectives.

Testing the Application

In this phase, the researchers test the application to ensure the functionality of the virtual reality museum application and to find any possible error. The researcher tries the application to revise the virtual reality museum application. The researchers used the Meega+ for evaluation tool to test the application using survey form by selected users, respondents, and alpha-beta testers. The application is sent using google drive and google link. The application test results in Meega+ are based on the user's feedback, considering the testers and researchers used to average and equivalent during the evaluation by the questionnaires. The Average is the total response of the respondents' average score: Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, and Strongly Agree.

Implement and Maintain

In this phase, the researchers ensure that the application is running correctly. The researchers are updating and modifying the software of virtual reality applications to correct faults or improve performance. After finishing all the required documentation, the

researchers finished a series of testing and evaluation on the application. The application is ready for release and uploading to the Playstore. It can be downloaded and accessed by the users. The application is compiled into an APK to install by the users quickly. The application maintains and updates by adding new data and information about the current happenings about the Mabalacat City to ensure it remains productive and effective for learning and viewing purposes. More information and suitable content for each category, looking forward to other classes about the Mabalacat in the future. The researchers also consider the user's feedback, reactions, and comments about the application.

RESULTS AND OUTCOMES

This section presents the results and discussions to determine if the researchers met the study's objective. This chapter also includes the data and requirements gathering, development, and testing results of the application "MAKIBALU KING MABALACAT "VIRTUAL REALITY FOR MABALACAT."

Data and Requirements Gathering

The researchers collect all the possible requirements for the content of the Virtual Reality Museum. Note that the researchers conduct an interview and actual visiting of the location to gather the information, images, and others. The researchers message the person in charge of other content information required to the application. Note that the researchers ask permission to feature each content of the Makibalu King Mabalacat. The researchers used Unity and Photoshop to create the applications. The researchers plan and visualize the software design before starting the application. The researchers ask a respondent to give feedback about the application. Finally, after the researchers complete all the needed information, software, and hardware requirements, the actual process of creating and refining the application succeeds, and test cases are implemented.

Hardware and Software Requirements

The application goes through testing in different mobile phones with other android OS. The minimum requirement for the application to run smoothly is Android

7.0 (Nougat) with two (2) GB of ram and 16 Gb of internal storage using oppo a71 as a mobile phone testing. For a better experience and smooth playing, use at least 3-4Gb of ram and 32gb-128Gb of internal storage.

Table 1. Hardware and Software Requirements

Hardware Requirements	Software Requirements	Functions
Android Phone	Android OS 7.0 Nougat (minimum)	Mobile Operating System
	2GB RAM (minimum)	Memory
	3GB RAM (suggested)	
	16GB	Internal Storage
Virtual Reality (VR) Box		

Storyboard

The first screen shows a Home Screen Menu. The Makibalu King Mabalacat has two buttons to select which mode to play. D-Pad Mode will display the virtual museum's entrance and more by exploring the program's contents with the D-Pad and manipulating it with the hands using a thumb-operated and buttons in the application. VR mode is a real-time viewing experience with crisp displays that immerses the viewer visually and audibly while moving. By using mobile phones linked to a VR machine and moving the body to manage the application, VR mode will show the entry first and the rest of the program. The second screen of the application shows the instruction of the application to let the user know how to navigate the app. It's either D-Pad or VR Mode. After choosing which mode to play, the user can navigate the buttons to discover more about the application. The Makibalu King Mabalacat application will display the application's content, including old homes, images from Mabalacat's history, tourist attractions, artifacts, and the logos of each barangay in Mabalacat. see appendix f.

Application Processes

The figure on right shows the application user interface using D-Pad Mode: Figure 9 shows the application's loading when the user launches the app. Figure 10 shows the loading portion of the app. The application's logo and the Virtual theme are on the screen. In figure 11, it shows the title of the application. Figure 12 shows the title of the thesis capstone and application itself. Figure 13 shows the main

menu of the application and the two buttons. Users can choose D-Pad mode or VR Mode. The D-Pad Mode uses a joystick on the screen. While the VR Mode uses the movement motion of the user using the VR Devices.



Figure 9



Figure 10



Figure 11



Figure 12



Figure 13



Figure 14



Figure 15



Figure 16



Figure 17



Figure 18



Figure 19



Figure 20



Figure 21



Figure 22



Figure 23



Figure 24



Figure 25

In figure 14 it shows the instructions of the application. On the upper left part of the screen, indicate the back button. The button will go back to the main menu. The application's settings choices are in the upper right buttons. The joystick that indicates player movement is in the lower-left corner. The application camera angle is in the lower right corner. The arrows on both sides of the application show if the user will continue. If the user selects the indicator on the right screen of the program, the user will proceed to the Virtual Reality Museum's main entrance. In figure 15 it shows the first spot of the

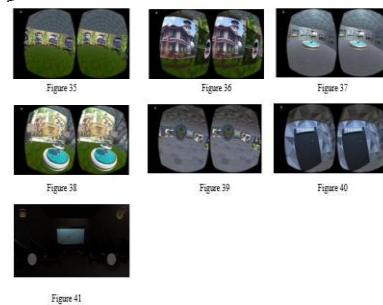
application. It Indicates the logo of Lungsod ng Pampanga. Figure 16 shows the settings of the application. Referring to Figure 34, which shows the application's instructions, the upper right button is the settings choices. These are the settings selection where the user can choose which voice would want to play and choose which category of the application users like to explore.



Figure 17 shows the different Barangays of Mabalacat, wherein users can explore using the player movement and camera angle joystick. Figure 18 shows the description and information about the specific Barangay. The data will automatically appear when the user moves in front of the selected Barangays and will automatically disappear if the user travels into another. Figure 19 shows the several antique mansions in Mabalacat that have become a tourist attraction for art and history lovers. Figure 20 shows the two buttons on the screen which the user can choose which voice would want to use. The representative will be the narrator, who will tell the specific Bale Matua information. Figure 21 shows the Different tourist spots where users can choose. Figure 22 shows the enter button that users can enter in a tourist spot and enjoy the 3D images. Figure 23 shows the different categories of the particular tourist spot. Users can explore the camera angle to see a better view. Figure 24 highlights the application's Theater section, which is also part of the app's first spot. Figure 25 shows the inside of the theater, wherein users can enjoy the film.

The figure above shows the application user interface using VR Mode: In figure 26 it shows the loading part of the application when the user launches the app. Figure 27 also shows the loading portion of the app. The application's logo and the Virtual theme are on the screen. In figure 28, it shows the title of

the application. Figure 29 shows the title of the thesis capstone and application itself. Figure 30 shows the main menu of the application and the two buttons. Users can choose D-Pad mode or VR Mode. The D-Pad Mode uses a joystick on the screen. While the VR Mode uses the movement motion of the user using the VR Devices. In figure 31, it shows the instructions for the application. The users will navigate the application using the VR Device. First, the users need to insert the mobile phone into VR Device and put it in the head. VR Device is Virtual Reality viewing. Users need to move their heads to trigger the player's movement. The app will walk if the users bow their heads, it will stop if the user's heads stay up, it will move the camera angle if the users move their head left or right. Figure 32 shows the application's settings and chooses which category of the application users like to explore.



Additional settings selection where the user can choose which voice they want to play. Figure 33 shows the different Barangays of Mabalacat in the Virtual Reality Museum. Figure 34 shows the description and information about the specific Barangay. The data will automatically appear when the user moves in front of the selected Barangays and will automatically disappear if the user travels into another. Figure 35 shows the several antique mansions in Mabalacat that have become a tourist attraction for art and history lovers. Figure 36 shows the description and will provide information about the Bale Matua. If the user has finished listening to the narrator, the user can tap the screen to exit and proceed to another Bale Matua. Figure 37 shows the Different tourist spots where users can choose. Figure 38 shows the different scenes of the specific tourist spot. Users can explore using the camera angle to see a better

view. In figure 39, it shows the other area of the application. It Indicates the logo of Lungsod ng Mabalacat. Mabalacat history and trivia that influences Mabalacat history. Figure 40 highlights the application's Theater section, which is also part of the app's first spot. Figure 41 shows the inside of the theater, wherein users can enjoy the film.

Design and Development phase

The researchers developed Virtual Reality for Mabalacat City by providing images, 3d designs, animations, videos, narrations, and text to design the mobile application better. In creating the mobile application, the researchers used unity3D to develop the application, Blender to provide 3D, and Photoshop to edit photos.

Additionally, the researchers use the C# script for the function of the animations.

Development and Testing results

In this section, the researcher uses an evaluation model, which is the MEEGA+ (Model for the Evaluation of Educational Games) and picks four testers (see appendix L) to play and test the application. The testers are Mr. Ariel Magsino, Software Engineer II (Cloudstaff). Mr. Ralph Cadalzo, MCC IT/ACT Instructor, specializes in Multimedia and Game Development, Ms. Kinah Ronquillo, Business Analyst/Quality Assurance Tester (Solvable Pty. Ltd) and Mr. John Roniel Gomez, MIS Team Leader (Analytical Support Services for Environmental Technologies, Inc.).

The researchers use the Likert Scale Pointing System and Range evaluation tools to gather feedback from the respondents to evaluate the Makibalu King Mabalacat application. The Average is the total response of the respondents and the Equivalents of the Average score, which are Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, and Strongly Agree.

Table 2. Likert Scale Evaluation Range

Likert Scale	Points	From	To
Strongly Disagree	-2	-1	-1.2
Disagree	-1	-1.3	-0.4
Neither Disagree nor Agree	0	-0.5	0.4
Agree	1	0.5	1.2
Strongly Agree	2	1.3	2

The researchers provided the Meega+ questionnaire (see appendix G) via google form to gather feedback from IT Experts as Evaluators. The researchers conducted the Usability and Player Experience test to ensure that the application has passed the requirements to develop the Virtual Reality Museum for Mabalacat City.

MEEGA+ has two (2) significant criteria: Usability and Player Experience.

Usability is a measurement method of how well the application can perform to achieve a defined goal and check the capacity of a system to provide a condition for its users to perform the tasks effectively and efficiently.

The researchers performed the usability test (see appendix I) through the following sub-criteria:

Aesthetic

The researchers performed an aesthetic test to check the overall appeal of the application's graphical interface. These criteria pertain to the user's visual and encounters in the game; users may form different impressions about the application's appearances that the researchers are unaware of yet. These impressions will serve as the basis for the feedback. The aesthetic test cases revealed that all of the tests have passed, showing that the application design has appropriate graphics, the application text is readable, and the font styles used are pleasing to the users.

Learnability

The researchers performed an aesthetic to ensure the users could play the application. Application may be hard to learn for some users; these criteria refers to the information of the application and the ability of the users to know the mechanism of the application that provides instructions and options that are easy to see and understand of a software program to teach the user how to use it. Based on the result of the learnability test, the application is easy to play and understand for the users.

Operability

The researchers performed an operability test to ensure the application was navigating correctly. An application's ability to act within the desired operational requirements is tested based on these criteria. Some users may have difficulty controlling and using the application, allowing researchers to learn about the

remediation and faults. The test result shows that the application's operability has passed the evaluation. The movements of the users' body, the tilting, and the application's controls are functioning well in application.

Player experience is one of the most significant factors in determining the success rate of applications based on how it fulfills users' satisfaction. Suitable applications have concepts such as fun, enjoyment, and happiness.

The researchers performed the player experience test (see appendix J) through the following sub-criteria:

Perceived Learning

The researcher performed a perceived learning test to check if the users could learn from the application. These criteria are the basis of the application if the users can obtain knowledge about it; it may be the users' evaluation of the information, content, and categories in the application and the user's ability to learn that use in the future. The result of the perceived learning test cases revealed that all of the tests have passed, showing that the application content provides learning to the users.

Satisfaction

The researcher performed a satisfaction test to check the user satisfaction in touring the application. The goal of this criteria was to assess the performance and enjoyment of the game after using it. The fulfillment of one's desires, expectations, or requirements, or the pleasure obtained from this can test the criteria. The satisfaction test cases revealed that all tests have passed, showing that the application satisfies the users.

Confidence

The researcher performed a Confidence test to check if the application is easy to learn. These criteria target the user's experience in playing the application. Users may use the application without hesitation and confidence that the application would provide the information needed for the user's learnings.

These also imply the users become frequent visitors of the application and may recommend it to other visitors or users. The result of the confidence test case revealed that all of the tests have passed, showing that the application content, instruction, navigation is easy to understand and easy to learn from the users.

Fun

The researchers performed a fun test to assure the application has enjoyment. Testing the user's entertainment, amusement, or lighthearted pleasure can be done using criteria fun. Knowing the reaction and feeling of the user after using the application is a good way of knowing what can improve or add to the application. The result of the fun test shows that the fun test has passed, indicating that the application has different animations and scenes that can give the users excitement while playing and having a virtual tour.

Table 3. Compatibility Test for Different Devices

Device Brand	Device Brand	Device Brand
RealMe 6 Pro	Android 11 (Red Velvet Cake)	Playable with no lags
	Android 11 (Red Velvet Cake)	Playable with no lags
Redmi Note 9s	Android 10	Playable with no lags
Samsung A9	Android 8 (Oreo)	Playable with no lags
Asus Zenfone 4 max	Android 7 (Nougat)	Playable with slight lags
Oppo A71		

The researchers used different mobile phones and OS to test the application "Makibalu King Mabalacat (see appendix K)." The phone experience in the RealMe 6 Pro (Android 11 (Red velvet cake) the application performance has no logs, the images are clear, the voice are clear that information and description are clear. The Redmi Note9s (Android 11 (Red velvet cake), the phone performance is no logs the buttons of images and 3D models functions well. The Samsung A9 (Android 10) also has no lags during the testing; all contents are working and available. The Asus Zenfone 4 Max (Android 8 Oreo) plays with no lags, movement is smooth, VR mode is soft, and the information, images, and sculptures are clear in VR. The Oppo A71 (Android 7 (Nougat) plays slightly during the testing because of the phone capacity, and the movements are somewhat unsmooth. The researchers tested the

application in all categories, including the music, narrator, camera angle, description resolution of the images, and the D-Pad mode and VR Mode using the mobile phones stated above.

DISCUSSIONS

This section consists of a summary of findings, conclusions, and recommendations based on the study results.

Summary of Findings

To develop the application "Makibalu King Mabalacat" Virtual Reality Museum, the researchers evaluated and tested the application. The researchers used the Meega+ questions to gather feedback from IT experts and evaluators. These criteria are parameters to achieve the accessibility of the application design and functionalities. The application's usability is how easy to use and learn the application to the users. During the evaluation, the application design is appropriate to its graphics, where the combination of the text and font styles is readable and pleasing from the user's point of view. The application's learnability is easy to navigate and used by the user's feedback. Users are easy to familiarize the features and capabilities of the application. Controlling the user's body movement and tilting features fall under the application's operability. The user's engagement with the application is the player experience. The Virtual Museum captivates the user's attention by providing information and insight about Mabalacat City. When it comes to audio, scenes, narration, and background music, functionalities satisfy the user's player experience. The content, categories, and structures would help the users to gain knowledge. The researchers tested the application on various mobile phones and for both application and system to ensure the application's functions and design.

Conclusions

The study focused on the design, the development, and the result of the Makibalu king Mabalacat. Based on the analysis and the testing results of the application prototype, the researchers draw the following conclusions: The Makibalu king Mabalacat was successfully designed and developed based on the required specifications. The software tools enabled the

researchers to build the Virtual Reality Museum prototype for Mabalacat City and added interactivity for users.

The researchers met the stated objectives of the study, and the basis of this interpretation is the application's evaluation results. The researchers evaluated the application prototype by utilizing MEEGA+ evaluation criteria and therefore concluded that the Makibalu king Mabalacat passed well in terms of Usability and Player Experience when it comes to Aesthetic, Learnability, Operability, Perceived Learning, Satisfaction, Confidence, and Fun. This study aims to design and develop virtual reality and android-based applications containing 3D models and interactive multimedia such as text, images, audio, video, and animation for the "MAKIBALU KING MABALACAT" Virtual Reality Museum for Mabalacat City. The application was developed using Unity3D/2019. Blender features include modeling the 3D objects that are included in the application. This application contains D-pad mode or Character navigation operated by game controllers (Joystick) and VR Mode using tilt movements.

Recommendations

Based on the findings and conclusion presented, the Researcher recommendations for the Applications future development are suggested:

- Additional Contents (Stories, Artifacts, and Tourist Spots)

Future researchers can add additional content for the application development and update such as stories, sculptures, and history that may not be collected and discovered yet. Different new tourist spots may emerge and find artifacts in other places that have not yet been found in the future stories about the Church and Saint in every Barangays.

- Additional Categories

Future researchers can add more categories such as beliefs, culture, Creatures in Mabalacat. Every place and barangay has its own stories and history passed down through the years, such as Folktales, Superstitions, Horror Stories, and creatures (Tikbalang, Tyanak, White Lady, etc.). Pampanga became the food capital of the Philippines; Kapampangan food also became

the tourist attraction in Pampanga, wherein Mabalacat City is part of the Pampanga.

- Augmented Reality (AR) Integration

Future researchers may update and develop the Virtual Reality museum into Argument reality. AR is an integration of the user in a real-time environment. Virtual reality produces a world; augmented reality works with what is already there and adds new information integrated with real-world objects.

For future development, the researchers are considering the recommendation listed above. The "Makibalu King Mabalacat" application may have additional features in the future. These additional features can provide users with more current access and other learning opportunities about the Mabalacat that may develop along the route. The Mabalacat City is upgrading such as Tourist attraction, etc. Over the years, some historical information may be revealed. Future users may have a better knowledge of Mabalacat City. It can also benefit researchers' expertise and success.

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MC BALANGAY: An Android Based Application about the History of the Barangays in Mabalacat City

Dolly Jean Balenton
John Ericson Canlas
Maria Lorraine Dingal
Kricyra Limjuco
Jonel Valdez
Engr. Ernie Lee E. Pineda, MIT (Technical Adviser)

ABSTRACT

History is critical for humanity's rich and diverse cultural expressions. Nowadays, documenting and having access to the history of a certain place can now be made easier through the use of Information and Communication Technologies (ICT). The researchers aimed to develop an online mobile application that contains historical information about the barangay in Mabalacat City. Hence, they developed a mobile application for Android 7 and up named, MC Balangay. The application was designed for locals and tourists to be familiarized with the City's history and what it has to offer. It also has a feature that allows users to watch infographic videos about the history of various barangays as well as a challenging quiz to take so that users can understand the historical information easily and effectively. Iteration Methodology was used in designing and developing the mobile application. Test cases were used to test the application based on the standard of ISO/IEC 25010, and the test results were described as "Passed". Overall, testing was done successfully that no errors were generated and the system was still correctly functioning. The objectives of the study were met; therefore, the application was ready to be used by the Mabalaqueños and other tourists in the city. Future researchers may add additional features such as reference numbers to track the users. Likewise, future researchers may also add security safeguards such as user account verification.

INTRODUCTION

History was critical for humanity's rich and diverse cultural expressions, as well as for their management, particularly through the use of information and communication technologies (ICT). It was also critical for the digital storage, conservation, reconstruction, and reuse of such cultural assets, attracting researchers from the fields of ICT, humanities, and social sciences. Simultaneously, global history management has emerged as one of the most pressing concerns for long-term development, raising a slew of questions, including the relationship between sustainable cities and history and how to manage sustainable tourism in the cultural world.

Digital technologies and management technologies have been used to detect, manage, and assess historic heritage, while 3D technology, laser technology [1], geographic information technology, content management system, visual system, network information acknowledgment communication system have been used to record, monitor, and plan local

cultures. Overall, cultural organizations such as museums have begun to investigate and adopt digital transformation initiatives to improve the user and worker experience. The objective of this paper was to better comprehend the digital transformation of cultural heritage management by collecting and mapping the most recent research findings to inform better decision-making in cultural history management research and development.

The evolution of android technology were currently fast; the technology was being utilized by users not only as a mode of communication but also to interact with the outside world, such as the internet. One of the applications of Android technology is a smartphone-based on Android. This Android system is a device that aids systems in developing more modern applications than the existing system. Because the technology is open and free, it receives a lot of support from a lot of different people all around the world [2].

As a result, knowledge is required that explains the Mabalacat City's culture in isolation from its Barangays. Based on this occurrence, it is required to research Mabalacat's culture, which was able to integrate into an android-based application.

A revolutionary approach for speeding up the process of locating both tangible and intangible information is proposed by the researchers, which is based on constructing an info application based on Android-based ports controlled. The information we're able to display by this application. With the design of this application, it is intended that it would assist the public in locating information about stories in a relatively short amount of time and with processes that are not replicated.

1.2 Background of the Study

Mabalacat is a component city in the northern part of the province of Pampanga in Central Luzon, Philippines. It consists of a land area of 83.180 square kilometers (32.12 sq mi) that is subdivided into 27 barangays politically. These are Atlu Bola, Bical, Bundagul, Cacutud, Calumpang, Camachiles, Dapdap, Dau, Dolores, Duquit, Lakandula, Mabiga, Macapagal Village, Mamatitang, Mangalit, Marcos Village, Mawaque, Paralayunan, Poblacion, San Francisco, San Joaquin, Sta. Ines, Sta. Maria, Sto. Rosario, SapangBiabas, SapangBalén and Tabun [3-4].

According to the Philippine Statistic Authority, Mabalacat City has a total population of 215, 610 in the year 2010 and it increased in the year 2015 with a total population of 250, 799. Mabalacat City was one of the ten most populous cities in Region III[5].

There are 31 educational institutions in Mabalacat: one state college, one private college, one technical training school, two secondary public, two private high schools, and 25 public elementary schools divided into two districts, Mabalacat North and Mabalacat South [6].

Since 2018, Mabalacat City College has been offering a new course subject named "MCC101: Mabalacat Studies: History, Culture, and Arts". Based on CMO No. 30 Series of 2006 & CMO No. 52 Series of 2007, this is a semester course that covers the history, culture, and arts of Mabalacat. It also gives emphasis and importance on instilling the value of

nationalism in every student of Mabalacat City College. The course is a general survey of the history of the Mabalacat City from pre-colonial times up to the present. It also includes a discussion on the present development and possible scenarios on past events as the historical circumstances. Its objective being – to re-introduce the history of Mabalacat Town to all Mabalacat City College students; to awaken in a sense of belonging to the town they call home; to anchor everyone with a sense of pride at knowing their hometown and its roots and development."

The researchers intended to develop an application entitled "MC Balangay: An Android-Based Application about the History of the Barangays in Mabalacat City" to help Mabalacat City students, and instructors to have a digitized book that would help in studying the history of their hometown.

1.3 Objectives of the Study

The general objective of the study is to develop an android based mobile application entitled "MC BALANGAY: An Android Based Application about the history of the Barangays in Mabalacat City" for the Android operating system.

In line with this, the study aimed to achieve the following specific objectives:

- To gather reliable information by conducting online research and interviews in identifying initial requirements for the application development.
- To design the system using Storyboards, Use Case Diagram, Context Diagram, and Entity Relationship Diagram;
- To design an application with the following features:
 - User access level:
 - Administrator;
 - Common Citizen;
 - Advanced search tools and filters.
 - Quizzes.
 - Branding
 - Etymology
 - Festivities
 - History
 - Past & Present Elected Officials
 - Audio and Visual Content

- To test the admin webpage and mobile application using test cases;
- To evaluate the application using ISO 25010 using the following criteria:
 - Functional Suitability;
 - Performance Efficiency;
 - Compatibility;
 - Usability;
 - Reliability;
 - Security;
 - Maintainability;
 - Portability.

Scope and limitation

The study covers the development of an Android-based application with two user access levels; the Administrator (admin) and the common citizen.

The common citizen must initially login to use the application. The common citizen must choose which method of registration to use. There are two ways to authenticate one's identity and prevent malicious identities from sending counterfeit warnings by signing up and connecting one's Google account or Facebook account.

The main features of this application are to allow the users to read and watch the infographic videos about the history of the barangays in Mabalacat City. They can also take quizzes which have three levels; Easy, Medium, and Hard for the users to familiarize the important details and historical information about each barangay in the city. Each level has different questions and has a timer when answering. At the end of the quiz, they can see the result and the correct answers.

The application has a back-end web page where the admin can create, update, and delete information about the contents inside the application. Admin can also see the user's information such as name, login method that they use, number of taken quizzes, and their scores.

Due to design constraints, it can only view the content and play videos online and this mobile application can't be used on IOS devices.

SYSTEM DEVELOPMENT METHODOLOGY

This section explains the study's techniques and methods in detail. The researchers have specified the System Development Methodology used for this study as well as the development

of the MC Balangay mobile app and web-based server. It entailed and discussed how the proper data and information gathered are employed in this study, which addresses the research goals, as well as the connection method, which is meticulously given and assessed. This section outlines the procedures and tasks that must be completed to complete the system or achieve the specified objectives.

SYSTEM DEVELOPMENT METHODOLOGY

The researchers of this study chose to use the Iteration method in designing and developing both the MC Balangay mobile application and the web-based administrator.

The iterative model is a particular implementation of a software development life cycle (SDLC) that focuses in an initial, simplified implementation, which then progressively gains more complexity and a broader feature set until the final system is complete. When discussing the iterative method, the concept of incremental development, which describes the incremental changes made during the design and implementation of each new iteration, will be used liberally and interchangeably [19].



Figure 5: Iteration Model

<https://airbrake.io/blog/sdlc/iterative-model>

Requirements:

Potential requirements, deadlines, and guidelines for the project are analyzed and placed into a functional specification. This stage handles the defining and requirements of the project without mentioning specific processes.

The researchers gathered all the data that are needed in creating the application; they interviewed known local historians through Messenger, asked some libraries who have the book that would help in the research, and

visited some of the barangays in Mabalacat City. (See Appendix A for Transcripts of Interviews)

Analysis

The system specifications are analyzed to generate product models and business logic that would guide production. This is also when financial and technical resources are audited for feasibility.

In this stage, the software and hardware requirements to create the application were analyzed by the researchers. The table below shows the software and hardware requirements used by the researchers. For the Software Requirements, the researchers used Android Studio v. 4.1.3 for developing the application. Adobe Animate v. 20.0.1 was used for creating infographic videos. Vue v. 3.2.1 was used for the web where the admin used it for creating, updating, deleting the content in the application, and Firebase was used for the Database so that the user's record was saved. For the Hardware Requirements, the developer used a Smartphone with an Android OS and Desktop windows 10.

Table 1: Development Software and Hardware Specifications

Hardware Requirements	Software Requirements
Smartphone	
Vivo Y91	Android Studio v. 4.1.3
Android OS v 8.1 Oreo	Adobe Animate v. 20.0.1
3GB RAM	Vue v. 3.2.1
	Firebase v. 20.0.2
Computer	
DESKTOP-RM87ELR	
Windows 10	
Processor-Intel(R) Core	
(TM) i3-7100 CPU @	
3.90GHz 3.91 GHz	
GHz	
8GB RAM	
64 Bit OS	

Design

Technical design requirements such as programming language, hardware, data sources, architecture, and services are outlined in a design specification document.

The developers used a storyboard to construct the application after collecting and analyzing

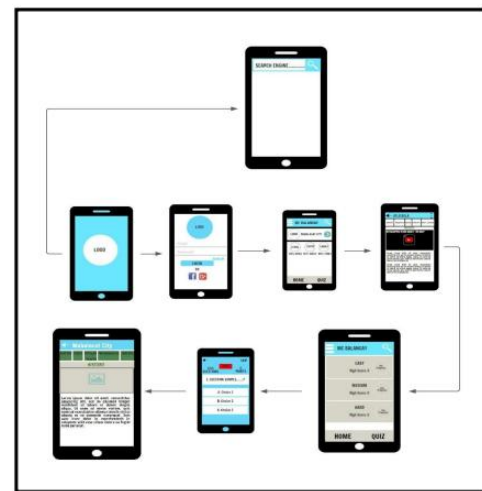
the data. The storyboard is critical in the development of an app since it aids developers in fully comprehending and defining the app's purpose. It allows developers to perceive the flow of the story. The storyboard served as a task board for developers to visualize the interconnectedness of user stories in a logical order. (See Appendix B for Storyboard)

The detailed design is also known as low-level design. The researchers used two diagrams which are Use Case Diagram and Entity Relationship Diagram.

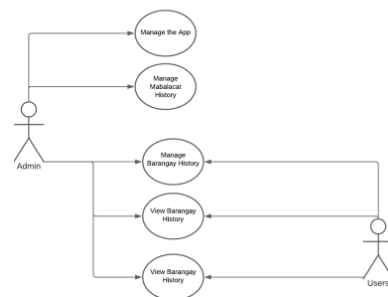
Use Case diagram is the note down the description of how the users will do the task. It is the list of activities or event steps normally describing the connections amongst roles (See Appendix D for Use Case Diagram)

Entity Relationship Diagram (ERD) demonstrates the connections of entity sets kept in a database. ER diagrams clarify the rationale structure of databases (See Appendix E for the ERD).

APPENDIX B
STORYBOARD FOR APPLICATION



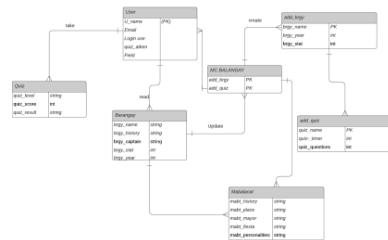
APPENDIX D
Use Case Diagram



Implementation

The source code is developed using the models, logic, and requirements designated in the prior stages. Typically, the system is designed in smaller components, or units, before being implemented together.

APPENDIX E
Entity Relationship Diagram



At this stage, the researchers used the most suitable programming language and picked depending on the detail and design of the application. The coding is executed based on the coding rules and criteria. The code goes across several code assessments and is enhanced for the finest execution before the final build is tested into the repository. Table 2 shows the software and hardware requirements in implementing the application.

Table 2: Implementation Software and Hardware Specifications

Hardware Requirements	Software Requirements
Screen Size At least 5 inches screen size	Android Version Android OS Lollipop (v. 5.0) up to latest Android Version
RAM At least 100MB RAM is available	

Testing

This is when quality assurance, unit, system, and beta tests are conducted to identify and report any issues that need to be addressed. Debugging may be required to repeat the coding stage as a result of this. The loop continues forward if the system passes the tests.

The researchers employed test cases to ensure that the application did what it was supposed to accomplish throughout testing. These were used to assess the application in terms of its Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability, Security, Maintainability, and Portability. The scope and limits of the program were used to create test

case scenarios. (See in Appendix F for Test Cases Questions)

Deployment

The product or application has been tested and found to be completely functional before being deployed in a live environment. During the distribution, the researchers were able to publish the program to the Google Play Store, where they were able to classify device compatibility issues based on customer comments and reviews.

RESULTS AND OUTCOMES

This chapter shows the outcome or GUI of the system as a response to the objectives which used appropriate diagrams, tables, or screenshots for a better presentation of its specific functions and the analysis results of test and evaluation.

4.1 System Development Process

In the development process of the study, the developers chose to use the Iteration Method in designing and developing both the MC Balangay mobile application and the web-based administrator. The iterative model is a particular implementation of a software development life cycle (SDLC) that focuses on an initial, simplified implementation, which then progressively gains more complexity and a broader feature set until the final system is complete. When discussing the iterative method, the concept of incremental development, which describes the incremental changes made during the design and implementation of each new iteration, was able to be used liberally and interchangeably.

In the development process of the application, the developers used Iteration Method wherein it served as a guide to performing the process correctly. Iteration Method

In the initial phase, the developers discussed the plans of the MC Balangay mobile application and came up with a better idea that includes the topic proposals. The Design phase is what the project looks like from scratch to the final design. A result of having good communication with the co-developers gives an attractive design that catches the attention of the Barangay Officials. An ideal collaboration was built up, performing brainstorming with the members that came up with a good project. Next, the developers proceed to the

Graphical User Interface



Figure 6: Screenshot of MC Balangay Mobile Application's Main Screen

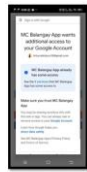


Figure 7: Screenshot of MC Belangay Mobile Application's authenticating User's Google or Facebook Account

Figure 6 shows the screenshot of the main screen of the MC Balangay mobile application when it is successfully installed on the android device. Figure 7 shows the screenshot of a user created an account using Google or Facebook and anyone who does not have one is unable to use the Application, unless the appropriate account is provided.



Figure 8: Screenshot of the Main page of MC Balangay

[illegible]

Figure 9. Screenshot of history page of the Barangay



Figure 10. Screenshot of history page of the Barangay

Figure 11: Screenshot of the Fiesta of in the Barangay



Figure 12: Screenshot of the Statistics of Barangay

Figure 13: Screenshot of Branding, Vision, and Mission of the Barangay



Figure 14: Screenshot of List of the Barangay Captains

[illegible]

Figure 15: Screenshot of Mabalacat City History Information



Figure 16: Screenshot of Festival/Fiesta in Mabalacat City

Figure 15 shows the screenshot of the history and economic profile of the City of Mabalacat.

Figure 16 shows what and when the festival of Mabalacat City is celebrated.



Figure 17 shows the screenshot pictures and information of the popular personalities in the City of Mabalacat. Figure 18 shows the popular places that people visited in Mabalacat City. Figure 19 shows all the past and present mayors that have been elected in the City of Mabalacat.

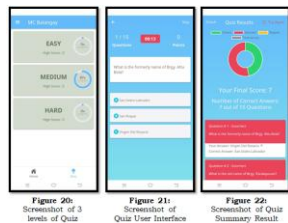


Figure 20 shows the 3 levels of quizzes that the users can take. Figure 21 shows the interface of the quiz where it has a timer and users can skip the quiz if they wanted to. Figure 22 shows the quiz result of the user's correct and incorrect answers and users can also see the correct answer in each question.

User Acceptance Testing

After finalizing the survey questions/statements, the developers selected 20 individuals from Mabalacat City to answer some questions. The developers distributed the questionnaires through Google Forms. (See in Appendix G for proof of respondents)

System Testing

Researchers used different platforms and operating systems (e.g. Lollipop, Marshmallow, Nougat, etc.) to test the compatibility of the application. (See in Appendix H for System Testing)

Testing Results

The researchers of this study used the Iteration Methodology in designing and developing MC BALANGAY as a whole integrated system. This methodology includes a test scenario

evaluation process. A test case is a set of steps taken on a system to see if it meets the system's requirements and performs properly. Its objective is to verify whether or not different components of a system are performing as expected and to confirm that the system complies with all applicable standards, guidelines, and user requirements. The mobile application's testing was based on the ISO/IEC 25010 for Software Engineering international standard.

The researchers of this study used testing cases in terms of Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability, Security, Maintainability, and Portability of the mobile application before deployment.

The mobile application has passed all the testing cases set by the researchers in terms of Functional Suitability, (See in Appendix I for functional suitability testing cases results). Functional Suitability is the quality that signifies the level to which a system stipulates tasks that encounter specified and indicated requirements when expended beneath stated situations.

The mobile application has also passed all the testing cases set by the researchers in terms of Performance Efficiency (See in Appendix J for performance efficiency testing cases results). When it comes to using mobile data, the applications play the infographic video based on the speed of the available signal on the data subscription. The researchers used DITO 3GB Data to test if the application can work by using only mobile data. (See Appendix K for Proof of Using Mobile Data to test the Application). The quality that exemplifies the functioning qualified to the number of means consumed beneath affirmed stipulations is called Performance Efficiency.

The mobile application has also passed all the testing cases set by the researchers in terms of Compatibility (See in Appendix L for compatibility testing cases results). Compatibility is the level to which an invention, system, or module was able to swap data with other inventions, modules, and systems, and/or execute its expected operations, at the same time as sharing a similar software or hardware environment.

The mobile application has only passed the 5 questions in the testing cases set by the researchers in terms of Usability (See in Appendix M for usability testing cases results). Because the users cannot manipulate the data of the app only the admin can manipulate it. It is the extent to which a system that able to consume by quantified consumers to attain definite objectives with proficiency, usefulness, and gratification in a stated perspective of consumption called usability.

The mobile application has also passed all the testing cases set by the researchers in terms of Reliability, (See in Appendix N for reliability testing cases results). Reliability is the level to which a system or component achieves indicated tasks beneath indicated specifications for an indicated period.

The mobile application has also passed all the testing cases set by the researchers in terms of Security, (See in Appendix O for security testing cases results). Security is the extent to which a system or product safeguards all the data and information so that users or other systems have the extent of information approach that applies to their categories and modes of authorization.

The mobile application has also passed all the testing cases set by the researchers in terms of Maintainability See Appendix P for maintainability testing cases results). Maintainability is the quality that signifies the extent of productivity and efficacy with which a system or product was able to be customized to enhance it, fix it or familiarize it to alterations in requirements and environment.

And lastly, the mobile application has also passed all the testing cases set by the researchers in terms of Portability, (See in Appendix Q for portability testing cases results). Portability is the extent of efficacy and value with which a component, system, or product was able to be transmitted from one software, hardware, or other operating or custom environment to any more.

DISCUSSIONS

This section shows that after careful and critical analysis of the results of the study, the researchers were able to summarize their findings, make conclusions, and give recommendations.

Summary of Findings

The developers concluded that based on the findings, the Application met all the objectives. The findings show the interpretation of the testing which gained passed, which the survey questionnaire was based on eight Characteristics and sub characteristics of ISO 25010 Standard Model.

The developers successfully gathered all the information needed for data profiling which is needed as content on the Mobile Application. As a result, organized data of the Mobile app passed in the standard of the respondents as it attained the Objectives of the Study.

The findings of the second objective were attained in this study. Each user can easily monitor their scores; this feature serves as a systematic and alternative way to the traditional process of learning through books; it can be inserted into a database without exerting much effort and time.

The user can provide an organized list of the barangay's data using the application as it attained the third objective of the study, this helps to easily know the history of all the barangay. These features also help the user to save time in finding the information needed by the Users unlike the traditional way of collecting and storing information using paper which can lead to misplaced, damaged, and time-consuming procedures.

Conclusions

All features indicated in the scope of the study for the MC Balangay mobile application and admin web-based server are functioning as expected, based on the results of planning, development, and testing.

The researchers were successful in developing a mobile application that provides information about the history of the barangay in Mabalacat City. The infographic videos were successfully played, and the search bar returned accurate results.

The mobile application succeeds in providing users with a quiz to help users educate themselves with historical information about the city in which they live.

Recommendation

- Tracking reference numbers can be added to the system for better tracking of users.

- Future researchers can add more security precautions to the system such as verification of user accounts.
- Future researchers can add google maps to locate each barangay.
- The system can be implemented for other campuses of Mabalacat City for learning to be fun.
- The app can be used in the city museum in the future so that visitors can easily find and understand the historical information about the City and its barangay.

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MONICON: Development of a Microcontroller-Based Home Air Conditioning Power Management System

Jhedon C. Caniel
Erick C. Delos Santos
Jacqueline G. Rosal
Harley Jay O. Sibal
Jirah Jazz T. Untalan
Engr. Robbert M. Bamba, MEECE (Technical Adviser)

ABSTRACT

The window-type air condition is one of the most extensively utilized types of air conditions in the Philippines. Aside from its capacity to provide thermal comfort in a tropical environment, it is also well-known for its affordability. Due to design that does not provide complex functions, owning multiple air conditions and utilizing them all at once may be time-consuming and difficult to effectively handle the energy monitoring because of how they are built. This study aimed to develop an IoT-based Air Conditioning Power Management System prototype model for window-type air conditions. The prototype model was utilized to design both the hardware and the graphical user interface (GUI) for the mobile application to accomplish and meet the objectives of the study. To regulate and monitor the air conditioners, and they are plugged into the outlets of the prototype model, which is equipped with solid-state relays capable of handling the high current generated by the air conditioners. The prototype model also includes a microcontroller, which is used to transfer data to display the current state of each of the air conditions in the GUI. To assess the functionalities, test cases were created to validate specific features of both the prototype model and the mobile application interface in accordance with the objectives of the research. Based on the test case results, the output and control on the mobile application interface correspond to what the prototype model shows. The researchers were able to demonstrate the controlling and monitoring of the air conditions and display the amount of energy consumed through the use of the GUI.

Keywords: window-type; graphical user interface; microcontroller; mobile application interface; solid-state relays; Wi-Fi; google firebase

INTRODUCTION

Over the past decades, the demand for air conditioning units in the Philippines has increased. Consumers purchase it for its provision of thermal comfort, especially at an average temperature in our country of 26 degrees Celsius, considering this is a tropical country [1]. Unlike any other country in Southeast Asia, the Philippines is the only country that has dominated in using window-type air-conditioners with up to 62% of usage [2]. From residential households to big establishments, an air conditioner is an essential appliance needed for the comfort of patients, workers inside a building. Mainly, this comfort could help workers escalate their productivity over time [3].

Thorough monitoring is needed to ensure that all air conditions are working correctly. The optimizing of tracking of each air condition and its energy consumption has been such an intricate task because of the hand-operated and manual checking of individual appliances. Consumption cannot be seen early on because it needs to be computed.

Energy consumption is also a significant factor that needs to be considered when using air conditioning. Thus, a power management system is a fundamental tool that can benefit from maintaining and observing the energy flow of an air conditioner. A power management system facilitates the detection, control, and measurement of all energy resources. Consumers will be able to track the cost of the energy they consume in this manner. It has been demonstrated that by closely monitoring energy consumption, costs can be decreased by up to 15 to 30 percent each year on average [4].

The development of today's technology has brought a tremendous change in our ways of living because of its efficiency in our day-to-day lives. The Internet of Things (IoT) is an enormous asset in today's world. It has been ingrained in our devices, creating further innovative and progressive automation. With the use of IoT, the devices can administer and monitor the devices at any given range at any time [5]. With the additional advancement in the development of the user interface of machineries and appliances, mobile application would be an additional tool to open the door for manually and automatically controlling devices.

This project aimed to build a power management system that will help automate the air conditioner's power supply by using a microcontroller controlled through a mobile application user interface. An option of manual controlling of the source of power is a must when there is a need to bypass the automatic power scheduling of the system.

Background of the study

The air conditions' primary purpose is to remove heat and control the humidity of the air within a building to attain a more comfortable flow of air in the surroundings. Its function is to continuously circulate the internal and external air in the room. In the Philippines, Window Type Air Conditions are mostly used either on households or establishments. For the most part, it is purchased for its affordability and provision of comfort since the Philippines is known for its tropical weather [1]. Thermal comfort is one of the essential factors for an individual's productivity based on the temperature of the surroundings. Temperature preferences may differ among individuals, and there is no specific temperature that can satisfy everyone because each body heat index varies depending on the health aspect of a person. However, having a comfortable and cool place can elevate a person's productivity removing irritability from an uncomfortably heated environment [3].

The researchers have decided to focus on the Window Type Air condition. According to studies, this is the most commonly used air conditioner in households and commercial facilities in the Philippines. Based on these, the researchers had an idea of how to help every

household in the country maximize the use of this type of air conditioner. Since this is known as being one of the most affordable air conditions, it is meant for greater manual control compared to the other type of air conditioner that already has an automated function.

Since the Philippines is a tropical country, the use of air conditioning is prevalent. Nevertheless, the problem is that the energy consumed in each household is not monitored efficiently. Improper management and usage of air conditions could also possibly lead to higher electricity consumption and bill. As a result, consumers gravitate toward more energy-efficient cooling appliances. However, because window-type air conditioners are the least expensive and most widely utilized in the Philippines, customers rely on them the most to save money. Additionally, having numerous air conditioners in a single household or establishment and monitoring them individually and room by room is a time-consuming process that can waste more time.

As a result, this has led the researchers to develop a prototype model that will help consumers use and monitor the power management of window-type air conditions more efficiently. Moreover, customers will benefit from a more automated household as a result of the built prototype. From the design, the concept of having the control of its on and off multiple air conditions using a mobile application interface gadget without needing to do so manually was developed. In accordance with this, a review of relevant literature was conducted in order to gather ideas on how to develop the prototype effectively.

The researchers were able to develop a prototype model of a Microcontroller-Based Home Air Conditioning Power Management System Thru Mobile Application. This study aims to address the need for power management, monitoring of the energy consumption of air conditions. Moreover, this study aims to automate the scheduling of individual air conditions within a household or even up to a small building.

General Objectives

The general objective of the study is to develop a Microcontroller-Based Home Air Conditioning

Power Management System Thru Mobile with the following specific objectives:

- To gather data for the study by conducting a thorough review of all previously related published research papers.
- To develop a conceptual framework, a block diagram, and a storyboard to depict the system's flow.
- To determine the hardware and software specifications necessary.
- To develop an IoT-based prototype system and implement a mobile application interface for the prototype.
 - to monitor the power system of the air conditions.
 - to manually turn on or off the air conditions through Wi-Fi
 - to set real-time scheduling for the air conditions power system.
 - to display a real-time energy meter for each air condition within each room on the mobile application.
- To integrate the IoT-based prototype system and mobile application interface
- To assess the quality standard of the hardware prototype system and mobile application with the use of ISO 25010 test case criteria.

Scope and delimitation of the study

This study focused on household window-type air conditions to be monitored, scheduled, and controlled using a mobile application. It will provide convenience to the user to control the power system of their air conditions. Furthermore, it also allows users to set schedules to automatically turn on and off all the air conditions and allow other users to access the manual power button when it is turned on and within the scheduled time, while totally disabling the manual power button when it is turned off and out of the scheduled time. The air condition used is the Window Type air conditioner with 0.5 hp. It is the most commonly used type of air condition in a household.

The interior of the prototype contains a case in which the NodeMCU microcontroller and the SSR 40a relays are located. The relays can hold up to 380 volts alternative current. The researchers powered the microcontroller with a

5V regulator while the whole prototype is powered by an external power source. There are also three outlets attached to the prototype device. These outlets are used to plug the air conditioning units. To ensure the power management of the device, the researchers have utilized a breaker switch and terminal which are mounted on the prototype's exterior. The terminal enables power to be safely transmitted from a single external source to the SSR 40a relays. The relays then respond to the microcontroller's automated control of switching the power on and off at any given time. The breaker switch protects the device from receiving excessive current flow, which could result in additional damage.

The mobile application interface was developed through the use of MIT App Inventor and firebase as its database. The mobile application interface displays manual control, schedule control, and status information for the air conditioning controls. The manual control displays the button for individual air conditions and all air condition button for manually turning on and off the power. The schedule control displays the drop-down selection for the air condition the user wants to schedule, the start and end time, and the selection of hour intervals. The display also shows the clear set, reset schedule, and clear button for any changes the user wants to make. The status page displays the current status of each air condition's scheduled time, and the About which displays the description of the system.

Through the integration of this system with the mobile application, the users can manage the use of air conditioners to minimize the costs of electricity as it shows the energy consumed on the interface.

The assessment of the functions of the prototype and the mobile application interface will be performed through a series of test cases to ensure that the devices operate properly, and that errors and defects are avoided.

Due to design constraints, the temperature, fan speed, and thermostat control of the air conditioners are not included in the control mechanism of the mobile application. The system is limited to one mobile app user only that limits the system from having log-in details. Additionally, the system is limited to

residential properties and compact structures with a limited number of rooms.

Conceptual Framework

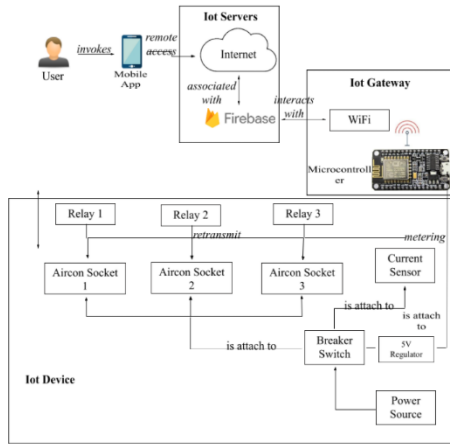


Figure 1: Conceptual Framework

SYSTEM DEVELOPMENT METHODOLOGY

Requirement Analysis

In this stage, the collected data are from the brainstorming session with the whole group. In addition, the gathered data is piled up through researching and browsing related theses, literature, and related systems/applications. On the market, air conditioners are available, but some older models are outdated with the current automation. With that, researchers devised a system to make them with an additional function of controlling the power source of the air condition unit aside from the usual turning on and off in the front panel buttons. Additionally, a current sensor device was considered to obtain the real-time energy consumption of individual air condition units.

Experimental Design

This part of the process is where the architectural design of the project is being developed. Since the project is limited to accessing the whole house wiring, the researchers were allowed to design a miniature model. The researchers started with a block diagram for the prototype model to visualize the bird's eye view of the whole prototype model. Following the development of the block diagram, the researchers designed a prototype model that included the flow of the whole

system, connectivity, and arrangement of the electrical components. It is all constructed and planned to use a conceptual framework. The researchers also implemented the use of a storyboard for the mobile application user interface for it to function accordingly together with the sensors and proper transmission of data from the code onto the application.

Experimental Prototype

In this stage, the actual prototype was built and developed. The researchers tested the turning on and turning off function of the individual relay switches by activating the individual Arduino integrated development environment code prior to the integration of all the hardware components of the prototype system. One of the researchers was able to implement the electronics circuit, and safety knowledge learned from the technical adviser in wiring and testing connections between components. At the same time, the other researchers are trying to relate the individual functions of hardware components in the mobile user interface buttons. See Appendix F.

Testing

This step is the phase of trial and error. The prototype and the mobile application are then put forward to the clients as a trial to observe and examine their possible strengths and faults. The researchers proceeded with various tests to evaluate the prototype model and mobile application interface using ISO 25010 test case criteria. ISO 25010 Systems and software engineering – Systems and software Quality Requirements and Evaluation (SQuARE) – System and software quality model whereas used to assess the system's quality standard. These test cases included all the functionalities that needed to be assessed to determine if there were defects within the system. The efficiency, compatibility, security, usability, and reliability of both hardware prototype and mobile application were also tested. The electrical wiring was also tested with precautionary measures if it works accordingly.

Refining Prototype

In this stage, after determining the faults within the prototype, the researchers proceeded to refine those defective parts and went ahead to examine furthermore to assure that there are no present errors within the whole system.

After the trial testing and obtaining the response from clients, determining the faults, the researchers took all of that into consideration to further refine the prototype to meet the exact requirements needed. The researchers used all the feedback to enhance the prototype for the client's gratification.

Final Product

After several trials and modifications, the researchers were able to develop a working prototype as well as the mobile application at this phase.

RESULTS AND OUTCOMES

In this chapter, were established to examine whether the researchers fulfilled the project's objectives.

As a result of this, the researchers did a relevant literature study to obtain thoughts and ideas from previous researchers before brainstorming and going to the planning step, which they described as follows: Using the planning and requirements analysis processes, the researchers were able to quickly discover the following needs, which are listed in the table below.

Table 1: Software and Hardware Specification Used for the System Development

Hardware				
Software				
Intel	i3	3.8	GHz	Processor
IDE Software				
4GB				RAM
MIT App Inventor				
1TB				HDD
Google Firebase				
NodeMCU				
Solid State Relay (SSR)				
Breaker Switch				
Current Sensor				

Table 2: Smartphone Specification Used for the Testing and Integration

Hardware	
Software	
1.84	GHz
Android 8 (Oreo)	
64GB, 4G RAM	

The development phase was broken down into two synchronous parallel tasks: first is the diagram design for the development of the electronic circuit and the development of the mobile application user interface. Thus, to activate and terminate the current flow from the power source to the outlet of each air condition, Solid State Relays with 40a each was used. The relays regulate the current flowing from the power supply to each air conditioning outlet.

The next step was wirelessly transferring the measurements data from the mobile application that was uploaded to the firebase database that was read by the NodeMCU, which gives a signal to the Solid-State Relays as the main objective to activate and terminate the flow of current.

The mobile application was connected to google firebase. The code blocks of this were done using an online mobile app developer together with the User Interface (UI) of the mobile application. The UI of the mobile app was now ready to display active current actions in the prototype on the mobile application interface.

To activate and terminate the flow and functionalities of solid-state relays the mobile application sends data to firebase and is fetched by the microcontroller. The energy monitoring screen on the UI, based on the main research objectives, a Non-invasive Current Sensor with 100a was used to each air conditioner to read and take all the current used and taken by each outlet installed. After validating the functionalities using the test case results (See Appendix E), the researchers' goal that the output measurements from the serial monitor of the microcontroller are the same as the output measurements being displayed by the mobile application UI has been determined. The mobile application displayed the exact sensor measurements of the microcontroller serial output for activating and terminating. Thus, the current time to turn ON and OFF the power used is measured by kilowatt per minute readings.

Software, Product/Processes

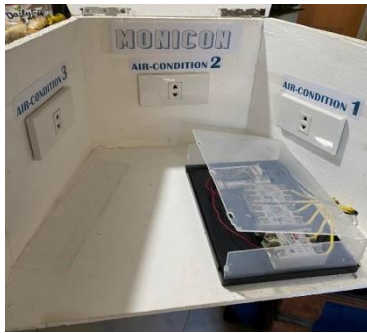


Figure 2: Connectivity of the mobile application and the prototype

Figure 2 shown above is the mobile application interface displaying the manual switch button is correctly connected and responding to the user's input. Relays were also used to identify which air-con sockets were on or off to verify the mobile app switch control buttons. To assure the switch buttons are connected correctly on the specific air-cons.

Development and Testing Results

PROTOTYPE/ HARDWARE

Table 3. Prototype Test Case Results

MONICON Prototype Test Cases	Evaluation		
	Yes	No	Others. Please specify
Prototype Test Cases			
1. Does the NodeMCU connect to WIFI when turned on?	√		
2. Does all the relay modules respond to the ON switch on the app?	√		
3. Does all the relay modules respond to the OFF switch on the app?	√		
4. Does the relay module of the first air condition respond to its ON switch on the app?	√		
5. Does the relay module of the first air condition respond to its OFF switch of the app?	√		
6. Does the relay module of the second air condition respond to its ON switch of the app?	√		
7. Does the relay module of the	√		

second air condition respond to its OFF switch of the app?			
8. Does the relay module of the third air condition respond to its ON switch of the app?	√		
9. Does the relay module of the third air condition respond to its OFF switch of the app?	√		
10. Does all the relay modules respond to the scheduled time?	√		
11. Does the relay module of the first air condition respond to the scheduled time?	√		
12. Does the relay module of the second air condition Respond to the scheduled time?	√		
13. Does the relay module of the third air condition respond to the scheduled time?	√		
14. Does the current sensor respond to the flow of the current?	√		
15. Do the wirings of the outlets are correctly connected?	√		
16. Does all the modules used are correctly connected and working?	√		

Table 3 shows test cases are the cases tested to test the functionality, usability, reliability, maintainability, and portability of the prototype developed. To assure that the modules used are working properly, each of them were tested three times. ISO 25010 was used to test the quality of a system to the degree to which the prototype satisfies the stated and implied intentions of the study. At the initial stage of testing the prototype functionalities, it was found out that the speed of the Wi-Fi connectivity, together with the speed of the microcontroller to fetch data from the database, directly affects how instantaneously the system responds. Eventually, each air condition's solid-state relays responded and managed to turn on and off the flow of electricity to each outlet.

Regarding the schedules set through the mobile application, the solid-state relays respond to activate and terminate the flow of electric current to each outlet according to what the microcontroller fetches on the database. The relays actively responded to what the microcontroller was getting on the database. Another module used was a digital non-invasive current sensor primarily used to measure all the current consumed by all the air conditions. While reading all the consumed electricity, values were automatically uploaded by the microcontroller to the database which were shown on the user interface. On the latter part, after finalizing the prototype, securing all the wiring connections, and adding a 15a breaker switch for additional safety of modules and air conditions, all the modules reacted according to the user interface actions and were found out to be working properly.

USER INTERFACE/SOFTWARE

Table 4. User Interface Test Case Results

Mobile Application User Interface (UI) Test Cases	Evaluation		
No. of trials= 3	Yes	No	Others. Please specify
User Interface (UI) Test Case			
User Interface (UI) Test Case	√		
1. Does the ALL AC switch turn on all AC	√		
when switching to ON?	√		
2. Does the ALL AC switch turn off all AC	√		
when switching to OFF?	√		
3. Does the AC1 switch turn on the AC1	√		
when switching to ON?	√		
4. Does the AC1 switch turn off the AC1	√		
when switching to OFF?	√		
5. Does the AC2 switch turn on the	√		

AC2			
when switching to ON?	√		
6. Does the AC2 switch turn off the AC2	√		
when switching to OFF?	√		
7. Does the AC3 switch turn on the AC3	√		
when switching to ON?	√		
8. Does the AC3 switch turn on the AC3	√		
when switching to OFF?	√		
9. Does the scheduled set on ALL AC works on time?	√		
10. Does the scheduled set on AC1 works on time?	√		
11. Does the scheduled set on AC2 works on time?	√		
12. Does the scheduled set on AC3 works on time?	√		
13. Does the clear button remove all the values on the start time and end time label?	√		
14. Does the 1-hour time interval add 1 hour in the end time label?	√		
15. Does the 30 minutes time interval add 30 minutes in the end time label?	√		
16. Does the minus sign button subtract the end time label depending on the time interval was	√		

chosen?			
17. Does the plus sign button subtract the end time	√		
label depending on the time interval was chosen?	√		
18. Does the set button set the rate and automatically	√		
compute the electric bill when clicked?	√		
19. Does the energy monitoring show the accurate	√		
Kilowatt per Minute (KPM)?	√		
20. Does the energy monitoring show the computed	√		
electric bill?	√		
21. Does the status screen show all the turned on	√		
AC via the schedule?	√		
22. Does the status screen show all the set	√		
schedule?	√		

Table 4 shows the test cases for the mobile application user interface functionalities. Three trials were done for each test case to assure that the hardware prototype responded according to the corresponding action. Button, switches, textboxes, and dialog boxes are assembled for simplicity but are fully functional for the user to engage with it easily. The compatibility, security, efficiency, and usability of the created mobile application were done under the system quality standards of ISO 25010. The mobile application performed its required functions while sharing the same hardware or software environment, protects the information and data thru a single user, performed specified functions under specified conditions and effectively, efficiently, and satisfactorily achieved specified goals and actions.

The switches of each air condition are indicated red when they are off and green when turned on. All AC/ first switches on the manual screen

can manage to turn on and even turn off all the air condition switches. But the other three switches were allotted for each air condition to allow the user to control each manually. After testing, it was found out that each of the switches was actively reacting to the action being done by the user.

Users were also allowed to set schedules for the individual air conditions. Also, users can manage to set schedules for all the air condition in one action. After selecting air condition on the drop-down list, the user can now set a starting time. One hour time interval and 30 minutes time interval were also placed on the scheduling screen to make a shortcut for the user to input an ending time. In addition, users are allowed to add and subtract the time according to its desired ending time using the minus and plus button. The clear button was assigned to remove all the starting and ending time labels' values. After picking time, the set schedule button was responsible for the time preferred to be declared and uploaded to the database for the microcontroller to execute after fetching. The reset button was programmed to remove the time schedule uploaded to the database.

Total kilowatt per minute consumed and total electric bill was displayed on the energy monitoring screen. It also allows the user to manually input the kilowatt per minute rate, which was used to calculate the electric bill. Since this screen shows the kilowatt per minute consumption, it refreshes the values every second, allowing users to view only the most current consumption.

Air conditions that were turned on during the schedule were being displayed on the status screen. All set schedules on the schedule control screen were listed below the on via schedule to remind the user when air conditions are turning on and off.

Finally, the user interface test case was tested and found out that they are actively sending actions to hardware prototype which were properly executed by the microcontroller. Security of the mobile application was also included in the log-in system. The mobile app can only handle a single user at a time.



Figure 3: Prototype

As shown in Figure 3, there is a continuous flow of outlet relays in the air condition. From the breaker connected to the terminal block, the outlet of the relays takes place. The breaker switch acts as an on-and-off switch, preventing any electrical circuit from being destroyed by excessive current. Thus, the terminal block functions to secure wires connected together. The outlet relays are used to switch on and off to control the flow of alternating current in the air conditions. The user had the option to manual control, schedule control, energy monitoring, and check the status of the scheduled air conditions through the mobile application to operate the air conditions.

Implementation Results

It has been validated that the mobile application and the prototype have been successfully connected via Wi-Fi. All switch buttons are operational and properly connected to their respective air-conditioning units. The researchers have tested them three times to ensure that there is no technical fault regarding the functionality and connection of the device.

The researchers successfully accomplished the expectation based on the panelist's recommendation by making necessary modifications to the mobile application and adding functionality to the scheduling control buttons.

DISCUSSIONS

The researchers considered the previous related literature to easily determine all the specific requirements needed to achieve the

prototype MONICON and mobile application integrated output product.

The researchers followed the diagram to complete the study, such as conceptual framework, block diagram, and storyboard to develop the prototype model. The mobile application was essential to control the whole function of the prototype.

The researcher performed experimental trials to check the integrity of the mobile application and the prototype model to satisfy specific criteria. Through the experimental test cases that were formulated, the researchers confirm that all the functionality of the mobile application and the prototype model are worked and communicated with each other.

Panelists recommend using the Wi-Fi module for a wide use of the mobile application for better communication of the mobile application and the prototype model. Panelist suggestion for the real-time bill amount that showed on the mobile app was also achieved.

Conclusion

The researcher's objectives were achieved. The researchers developed a system that can control the switch manually on/off, set the schedule, and monitor the current bill amount of the air-condition through a mobile application. With the use of different materials such as NodeMCU with built-in Wi-Fi that can receive input from the mobile application and distribute the output to the 3 Solid State Relay (SSR) to let the current flow on the specific air-condition. The current sensor was able to count the flow of the electricity, and the device was able to send data to the mobile application.

The developers made login security that needed a password to prevent the mobile application from being used by multiple mobile devices. It has a change password to update the security password.

The researchers made it more secure for the safety of the device, and the researchers installed a 15amp breaker switch to protect the prototype model from damage caused by excess current from the short circuit.

Recommendations

Along with the study's findings and conclusions, the researchers made recommendations for the system's future development, including the following:

- Future researchers may improve the mobile application's graphical user interface (GUI) design.
- Future researchers may create a web-based system/ application as an alternative resource in the absence of mobile applications.
- Future researchers can create an additional switch per air conditioner to operate one of each.
- The researchers may improve the power using a meter to provide per day usage.
- The researchers may develop the structure of the system when installing the air conditions.

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Multi-Purpose Anti-Theft Box

Gerald U. Anunciacion
Earl Gerard A. Dizon
Dizon, Norvin D.
Raidan T. Lacsina
John Paul E. Manalili
Frederic D. Santos (Technical Adviser)

ABSTRACT

The researchers developed a “Multi-purpose Anti-Theft Box” with real-time location tracking using the application. The box consists of three levels of security, the first one is a keypad lock security located outside of the safety box, the user should input the correct passcode in order to open the safety box and if the passcode is incorrect, the box will not be going to open. The second level is the lift detection security, the safety box is equipped with an ultrasonic sensor which will give the box the ability to detect if it got lifted by a thief, and the buzzer will alarm to alert the thief and the safety box will send a message to the owner via smartphone and the alarm will only stop when the box is put back in place again and lastly is the real-time location tracking, the owner has the ability to track the box in real-time using the “Safety Box Tracker” application developed by the researchers, the owner must log in first using the username and password provided by the researchers to view the position of the safety box in the map. Both mobile applications and prototypes have separate tables of test cases. Each test case was repeatedly performed to ensure that the functionalities were achieved according to the design requirements.

INTRODUCTION

Theft is misconduct that is driven by the title "larceny." Generally, a crime is committed when a person takes another person's belongings without authorization and with the purpose of stealing them from the owner.

In the Philippines, approximately 22.5 thousand theft incidents occurred in 2019. Carnapping of motor vehicles, on the other hand, occurred 353 times in the country. As per the World Data Atlas in the year 2017, this country had 15.3 reported thefts every 100,000 people. While the robbery rate has varied innocently in present years, it still continued to increase in number from 2003 to 2017, topping at 15.3 cases every 100,000 people in the same year.

The researchers have come up with an idea to develop a research project called "Multi-Purpose Anti-Theft Box." to help individuals by alerting and locating safety box that got stolen, the device is made specifically for a safety box and it has a lot of security features that is why it's called a multi-purpose anti-theft box.

An anti-theft device is a tracking gadget that can locate your belongings that were stolen using GPS, Global Positioning System (GPS), is

a universal map reading satellite structure that offers area and time administration.

The device is also equipped with an ultrasonic sensor which whenever it senses any suspicious movements, it will show signals to the high decibel buzzer to ring.

It can also trace the whereabouts of its safety box in real-time when using the app. It also has a 9v battery to maintain the power of the device and is ready for long-term use and whenever it runs out of battery life, you do not have to change its battery since it can be recharged using a USB port.

The "Multi-Purpose Anti-Theft Box." Is equipped with a membrane keypad module for the keypad security method and the researchers also used key lock as another security method. The device is also equipped with a 180 servo motor that is responsible for the locking mechanism in the safety box, the 180 servomotors will only unlock the safety box once the person which most probably the owner input the correct password or use the key lock to the safety box and the device also have LCD which shows if the password is correct or incorrect.

The researchers decided to use Arduino Uno and Node MCU to make the Multi-Purpose

Anti-Theft Box". The most significant advantage of the two is Arduino's built-in features. Arduino is accessible in a comprehensive array which consists of the 5V regulator, a burner, an oscillator, a microcontroller, a serial communication line, an LED, and connection headings. An open-source Lua-based firmware and development board aimed at IoT-based applications is called Node MCU. Espressif Systems' ESP8266 Wi-Fi SoC is also an included firmware and hardware as per the ESP-12 board.

This anti-theft device will surely make everyone's life stress-free. The mission of the researcher is to finish or at least lessen all crime-related cases in the country, and therefore people live worry-free from having their things being stolen.

Background of the Study

Multi-Purpose Anti-Theft Box is a device that can be used to track the location of the thief. Multi-Purpose Anti-Theft Box protects your valuable things inside. The device runs through Global Positioning System (GPS). The device features two types of security, the first one is membrane keypad security and key lock security. Once the owner uses the correct passcode the 180 servomotors will execute the unlocking mechanism for the safety box.

The Multi-Purpose Anti-Theft Box will also need a smartphone to navigate the item that got stolen and the user is also required to install the app that is made specifically for this Multi-Purpose Anti-Theft Box.

The researchers developed and provide an accessible app to the owner. The owner can use the app to track the location of his/her safety box. Having a multi-purpose anti-theft box will make everyone's life easy and also feel more secure

Objectives

The general objective of the research is to develop a multi-purpose anti-theft box. Specifically, it aims to address the following concerns:

- To create an anti-theft device:
- Track the safety box through GPS.
- Unlock the safety box using the key and keypad.
- Lock the safety box using a key and keypad.

- To secure the things inside the safety box.
- To develop a mobile application that will integrate into the system hardware that will allow monitoring the current device location.
- To test the device and system using ISO 25010 criteria for test cases and experimental tests for mobile app functionalities.

Scope and limitations

The researchers gathered information and formed an idea of a multi-purpose anti-theft box. Articles from the internet about the anti-theft process were collected. After collecting the needed information, a series of diagrams were created to have a visualization of how the system works in real-time monitoring the safety box.

The study introduces an inexpensive yet reliable Anti-Theft Tracking Scheme based on IoT services with microcontrollers for tracking things that got stolen in real-time controls in case of theft and notifying the user in a short period.

The study is focused solely on constructing the Multi-Purpose Anti-Theft Box. The mobile application will let the owner view what is happening to the safety box itself.

The researchers automate the anti-theft device process such as when the safety box got lifted by the thief, the SIM800L will send SMS to the owner's smartphone and the buzzer will start to ring to alert the thief.

There will be an ultrasonic sensor placed below the safety box to detect if the box is being lifted. Aside from lift detection, the system is also equipped with a keypad membrane module which will require the owner to use the correct password. The 180 degrees' servomotor will only unlock the safety box if the password entered is correct.

The researchers developed a mobile application to locate and track the intruder in real-time using firebase. The user can check the status of the safety box by the mobile application.

The researchers used ISO 25010 criteria as a guide for test cases. Characteristics and sub-characteristic criteria are called ISO 25010. It caters reliable terms in describing, measuring, and evaluating the product structure and software attribute. Furthermore, the proposed

user interface, which would be based on the MIT app, would include features such as real-time tracking of the safety box and text notifications to the owner.

The main purpose of the study is to secure valuable and hard-earned materials, properties, and possessions such as money, jewelry, and accessories of the owner while they are inside the safety box.

The study will not address human errors that interfere with the safety box device's functioning. This study excludes GPS devices when data cannot be connected to a particular location due to environmental factors. In addition to the study's limitations, the health of the battery will not be addressed in this project, and the mobile applications will only update the tracker's pin on the map if there is internet access.

Conceptual Framework

Based on the foregoing concepts, hypotheses, and findings of related literature, studies introduced, and insights taken from studies, a conceptual model is created as demonstrated below.

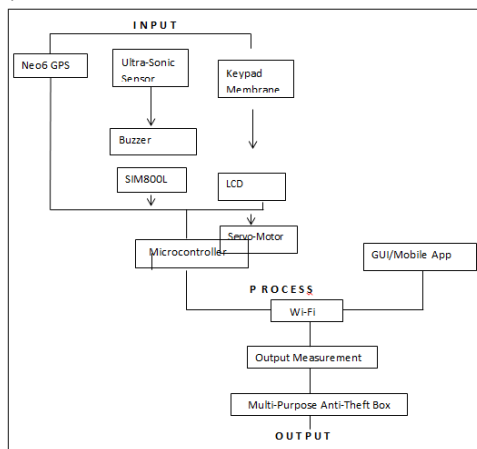


Figure 1. The Conceptual Model of the Study

The conceptual framework of the Multi-Purpose Anti-Theft Box is demonstrated in Figure 1. A conceptual framework is used to transform concepts, skills, and experience into effective performance. An Input, Process, and Output (IPO) diagram is used to represent the proposed Multi-Purpose Anti-Theft Box.

The researchers consider the requirements in order to achieve the intended results. The researchers must first learn Arduino electrical

circuitry, application designs, and programming skills in order to build the application and device. In addition, the researchers looked at relevant literature and articles.

After analyzing the data gathered through observation and related articles, the researchers created the initial design of the device. To construct the prototype, the required devices were obtained. The researchers created the device's system design and schematic diagram using the "Fritzing circuit." The researchers coded the device using the "Arduino IDE," and for application design and development, the researchers used "MIT App Inventor." The researchers conducted the analysis using test cases.

After the assessment phase, the researchers would repeat the process if there are any recommendations to strengthen the methods used in developing the system and further improve the device functionality.

SYSTEM DEVELOPMENT METHODOLOGY

In this section, the design and the methods were explained to meet the objectives of the project using the microcontroller board, Integrated Development Environment (IDE) programmer, IoT devices, and mobile apps developer

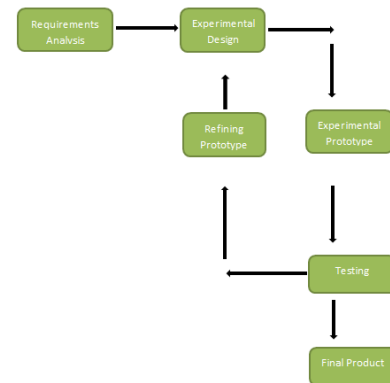


Figure 2: Prototype Model

Figure 2 shows the Prototype Model used in developing the hardware prototype and the mobile application. A prototype procedure is a Developmental software approach wherein a prototype is structured, assessed, and revised as needed until one meets the satisfactory stage.

Requirements Analysis

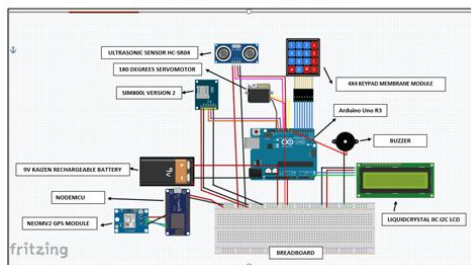
At this stage, all the necessary data were gathered and evaluated. These requirements were crucial in the system's development. Also, it serves as a guideline for identifying the system's functionality and limits. The researchers obtained the necessary information through studying and reviewing previous related literature on the proposed study. This was done in order for the researchers to gain a better understanding of the system.

Experimental Design

Based on the gathered information, the construction of a preliminary design or the quick design was implemented on this stage. It was not yet a detailed design; however, it provided a brief aspect of the system which the user would understand.

Following the planning and gathering of all necessary data, the researchers created a planned prototype that comprised a block diagram of the system's intended output and a conceptual framework of the system's flow. A storyboard was also utilized by the researchers to build a mobile application that would function with all of the module and offer correct data transmission from the prototype to the mobile application.

Appendix F
Schematic Design Circuit Diagram



Experimental Prototype

This stage included the creation of a physical prototype as well as a mobile application. Although a small working model of the system based on the block diagram and conceptual framework was created for the hardware, and a storyboard for the mobile application was created from quick design, the versions were incomplete. These prototypes were tested, and the changes, revisions, and improvements that resulted were recorded and determined.

Appendix H
Storyboard

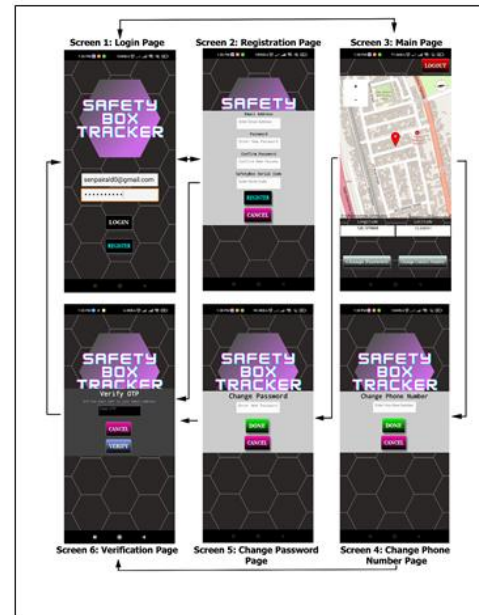
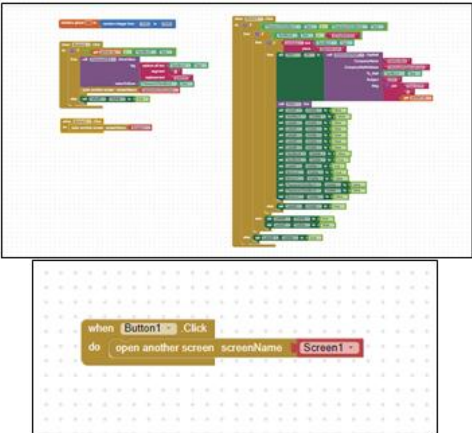
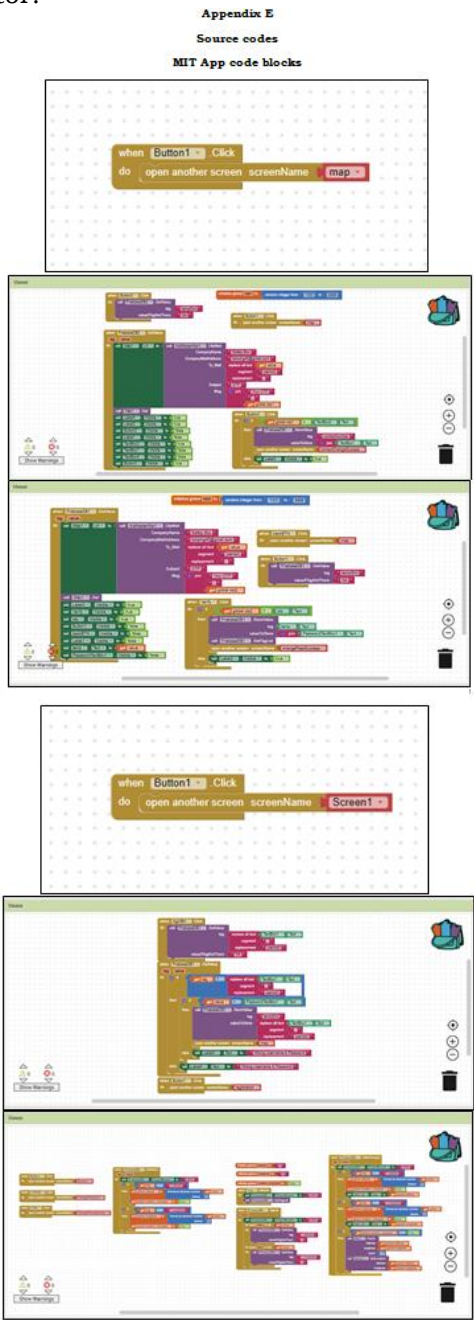


Table 1: Software and Hardware Specification Used for the System Development

Hardware	Microcontroller and Module	Software
Intel i3 3.8GHz Processor	Arduino Uno	IDE
4GB RAM	Node MCU	software
1TB HDD	Buzzer	MIT App Inventor
	Ultra-Sonic Sensor	
	Servo 180 degrees	Firebase
	Keypad Membrane	
	SIM800L V2	
	NEO6M GPS	

At this stage, the researchers created a prototype that is based on the system design. The device was developed using several modules such as a keypad module and servo-motor module, a buzzer module, and others to control the various sections of the system to work properly. Additionally, its program was coded using the IDE software and uploaded into the microcontroller's memory at this time. All the devices functioned as one to complete the prototype which determined if all the devices worked properly.

For the development of the mobile application, the researchers coded all of the design and features that were planned and examined based on the prototype hardware. The mobile application that was embedded into the prototype hardware was developed using an application development tool like the MIT app inventor.



Testing

After their building, both the prototype and the mobile application the researcher go for initial testing to find out the strengths and weaknesses of the working models.

Table 2: Smartphone Specification Used for the Testing and Integration

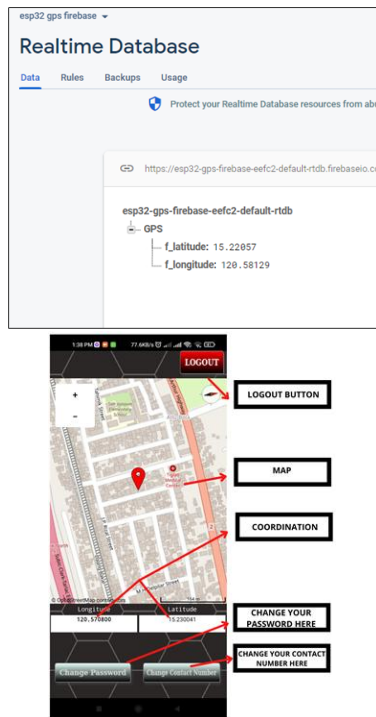
Hardware	Software
2.00 GHZ	Android 11 (MIUI)
128GB, 6GB RAM	

Table 2 shows the smartphone specification that was used in testing and integration to immediately identify and fix defects and errors When one of the criteria was not met, the prototype was refined. At this stage, the researchers asked for further feedback and suggestions from experts on how to improve both the prototype hardware and the mobile application.

Refining Prototype

In this stage, all the researchers’ feedback, additional features, suggestions, and recommendations were taken into account and implemented to improve both the hardware prototype and the mobile application. This stage did not end until all of the researcher’s specifications were met, and once the prototype was refined, the process returned to the Experimental Design stage.

The researchers needed to make some changes to the prototype based on the feedback. Consideration of all these suggestions and recommendations as needed to improve the prototype.



Final Product

When all the stages and several iterations were done, the researchers were able to come up with a working prototype – the prototype hardware was integrated into the mobile application providing accurate information.



RESULTS AND OUTCOMES

The results and discussions were laid out in this chapter to see if the researchers met the project's objectives.

As a result, before brainstorming and moving on to the planning stage, the researchers

conducted a related literature review to gather concepts and ideas from previous researchers. The researchers were able to easily identify the following requirements from the planning and requirements analysis, which are shown in the table.

Table 3: Hardware Requirements

Arduino components	Functions
Arduino UNO	Microcontroller
Node MCU	Google Firebase
9 volts Kaizen rechargeable	Power Source
NEO6 GPS	GPS
Ultra-Sonic Sensor	Distance Sensor
Servo-Motor	Lock and Unlocking Mechanism
Keypad Membrane	Input Data
LCD Liquid Crystal	Display Information
Buzzer	Giving Alert
SIM800L	Sending SMS

Table 4: Mobile Application Requirements

Application	Functions
MIT APP Inventor V.2	Mobile Application Developer/Programmer
Google Firebase	Online Database Account

The development phase was divided into two parallel tasks: the design of the electronic circuit diagram and the design of the mobile application user interface.

To track the device location, NEO6 GPS was used (See appendix H). The detected location was processed and converted into digital format by the Node MCU microcontroller.

The next step was wirelessly transferring the measurements data to the online database of google firebase through the use of Node MCU ESP 8266 Wi-Fi module while including the online database address, SSID, and password into the program of the Arduino (See Appendix D).

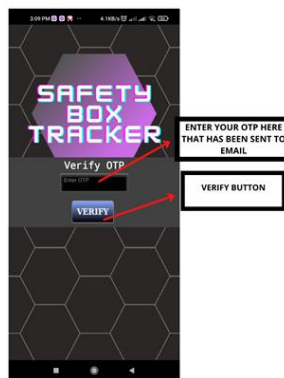
To connect the mobile application to the google firebase, the code blocks of the mobile application were included in the online address of the google database account and the Application Program Interface (API) key. The

GUI was now ready to display GPS location on the mobile application (See Appendix H).

To validate the specific functionalities of both the hardware and the mobile application GUI based on the research specific objectives, test cases were used (See Appendix M, N, and O).

After validating the functionalities using the test cases, the researchers were able to determine that the output coordination from the serial monitor of the microcontroller is the same as the output coordination being displayed by the mobile application GUI.

In the registration details, once the user is done inputting his/her details and clicking register, after that, a verification code will send to his/her Email account. The third screen has login details. One correct user name and password was entered the second screen will display the Global Positioning System (GPS). The fourth screen is an option to change the user phone number with Email OTP verification and the last screen is to change the password with Email OTP verification.



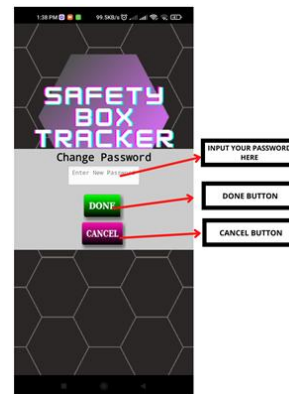
Mobile Application GPS Display Three Different Locations

The mobile application interface displaying the correct location of the box, the researcher also tried the mobile app into three different locations, in San Francisco, Dau, and San Joaquin to verify the accuracy of the app and to assure that the output of GPS was displaying correct location. the multi-purpose anti-theft box mobile application was displaying the same location.

The SMS System module. When the safety box was lifted or moved the Ultrasonic Sensor will detect that movement, after that the buzzer will ring then the safety box will send text thru the use of the Sim 800L Module to the owner.

The Anti-Theft Box Prototype

The Multi-Purpose Anti-Theft Box prototype product. The box used is commonly used to keep valuables, important documents, and sentimental keepsakes protected. The lock mechanism was achieved thru the use of a 180-servo motor. A Matrix Keypad was used for password input and changing the password of the box. for the lock and unlock mechanism used in the system. The 180 Servo motor is used to provide good torque and holding power motor which is high enough to lock and unlock the system.



Functionality Test

A various functionality test was done by the researchers to ensure that the prototype will work according to the intended outcome. The researchers ran a functionality test (see Appendix M) to see if the modules in the safety box were working properly. The results of the functionality test revealed that all of the modules used in the safety box functioned as intended. The researchers conducted this functionality test to ensure that the safety box will meet the security needs of future user.

Usability Test

The researchers conducted a usability test (see Appendix N) to ensure that the mobile application is pleasing and satisfying for the user. The app's user interface (UI) is simple and straightforward. The aesthetic design for the mobile application is also considered by the researchers, as it is the second most important factor after app security and to ensure the owner of the safety box will have a better user experience of the mobile application.

Mobile Application User Interface Test

The researchers conducted a mobile application user interface test (see Appendix O) to ensure that the application's user interface is

satisfying and that it is operating properly. The researchers tested the mobile app on various smartphones to ensure that the desired data output is correct and accurate for real-time tracking. Since the mobile application is designed for the safety box, the app's security is the most critical factor. According to the test results, the user can register for the mobile application and can change his/her password at any time, but it will require a one-time password (OTP). Finally, the researchers were able to create a mobile application with high security.

DISCUSSIONS

This section consists of the summary of findings, conclusions, and recommendations based on the result of the study of Multi-Purpose Anti-Theft Box.

Summary of Findings

The researchers used prototyping to develop the prototype "Multi-purpose Anti-Theft Box," and mobile application integrated output product. Specific goals were developed based on the functionalities and design elements. To confirm the intended outcome, the researchers performed test cases to measure and test the state of the mobile application and prototype. The researchers added a login and register option as well as strengthening the security of the mobile application, which was accomplished by creating a new application using MIT app Inventor a web application. The application's usability is straightforward and easy to understand. It is simple for users to become familiarized with the application's features and capabilities. The application design is suitable to its graphics, with the combination of text and font styles that is readable and appealing to the user. In addition, the researchers developed a method for assessing the prototype and mobile application in various locations. One of the researchers used the safety box to test its functionality, such as to check if the safety box detects if it's being lifted, the keypad lock mechanism and the changing password option, buzzing, and the data transmission to the mobile application. The second researcher used the mobile application to check if it functioned correctly by sending and receiving responses from the connected prototype.

Conclusions

The proposed system adheres to its clear objectives, in which researchers created a safety box that assists user in safely store their valuable things inside the box and navigate and avoid theft even if the user is far from the safety box. The prototype was constructed using ultrasonic sensors, microcontrollers, keypad membrane and servomotors, and is linked to a developed mobile application that allows user to track the location of the safety box. The user will also receive notifications from the safety box by using the mobile application. To verify the expected result, the researchers developed test cases to measure and secure the functionality of the prototype and mobile application. All phases were checked and tried time after time until an acceptable, complete, and successful prototype and mobile application were achieved.

The researchers used experimental test cases to test the hardware and software functionalities. Based on the results of the experimental test case responses, the researchers have found out that both hardware and software are working properly.

The developers were able to create the functionality of the mobile application's login and register features for security purposes. Using the developed mobile application, they were also able to display the user's safety box real-time location. In conclusion, the researchers were able to create a functional IoT-based safety box as well as a mobile application that is intended to assist users in keeping their valuable items inside the box.

Recommendations

In addition to the results and conclusions of the study, the researchers mentioned some future improvements of the system, thus the following recommendations are listed.

ESP8266 that can send data to the internet without Wi-fi

- Future researchers can improve the current existing safety box by adding ESP8266 that has a feature to send data to the internet database without needing any Wi-fi connectivity.
- Operate keypad membrane using mobile application

- Future researchers can improve the system if the user can use the keypad membrane to type the password to the safety box on his/her mobile application.
- Single module for GSM and GPS
- Researchers in the future can use and find a single module that has already GSM and GPS to conserve more space for the safety box and less wirings.
- Run the safety box using only one microcontroller
- Researchers in the future can conserve more space inside the safety box with the use of only one microcontroller to run the whole system. Currently the safety box uses Arduino uno and NodeMCU

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NO THEF-IER and Real-time GPS Tracking for motorcycle

Mark Justine Autor
Mark Martin Mendoza
Steven Menguin
Joshua Tuazon
Frederic D. Santos (Technical Adviser)

ABSTRACT

The No Thef-ier is an IoT-based anti-theft device that consists of the Arduino Nano as the microcontroller, SIM800L, and GPS NEO6 as the module. The proponents of this study aimed to develop an anti-theft device and mobile application capable of adding security to a motorcycle and preventing it from falling into the thieves' possession. The device consists of three main features: locate, kill switch, and horn alarm. First, the location in which the mobile application can request the current location of the motorcycle and then display it on the mobile application screen. Next is the kill switch feature, which can immobilize the motorcycle and prevent it from starting again while the button is ON. Lastly, the horn alarm feature can be triggered when the motorcycle stand is moved from its position while the device is on. As a whole, the device and mobile application provide security for motorcycles. The integration testing was for the prototype, and mobile application was made successfully, and no errors were generated. The device and application run perfectly. The study's general and specific objectives were met. The device and mobile application were ready to be deployed on a motorcycle. Future researchers may improve the scope of the study and add features that will improve the security of every motorcycle.

INTRODUCTION

Most individuals rely on their motorcycle as they use it for everyday life like transportation, hobby, etc. According to statistics, roughly 200 million registered motorcycles globally [1]. As the number of motorcycles increases, the rate of motorcycle thieves also increases. According to the National Insurance Crime Bureau (NICB), 46,467 motorcycles were reported stolen in 2016 alone, a 2% increase from the previous year [2].

This tally for one motorcycle being stolen every 11 minutes across the country. Then, from 2017 to 2019, motorcycle theft incidents dropped by 12%, from 46,467 to approximately 41,000 cases [3]. Many riders are worrying about the safety of their motorcycles if they park them in a spot that they cannot see and far away that they cannot respond if something happens, even if the motorcycle is parked in the home garage, the rider cannot guarantee that the motorcycle is safe from the thief.

In Southeast Asia, the Philippines has the second most motorcycle riders. Approximately 32% percent of households own motorcycles [4], the number of motorcycles that are being stolen is also alarming, jumping from 2,500 motorcycles taken from the previous year,

which shows an 11.89% increase. Despite the increasing number of motorcycle stealing incidents, there is a particular motorcycle that thieves are eyeing the most. These are the small ones, classified as the automatics (scooter type) and the manual transmissions (under bone and back bone types).

The big bike-type motorcycle is missing on the list because thieves refuse to steal this type of vehicle. Although it is more expensive than the mentioned above, it is also hard to sell because it is easily recognizable, has low market demand, and is hard to sell in spare parts [5].

In this generation, technology continues to develop rapidly. Many inventions are developed and provide convenience in human activities. Internet of things plays a significant role in innovating the quality of life of every individual, whether in the field of health, technology, and security systems. Most individuals want to ensure that their Motorcycles are safe when parked on the street or in isolated areas that are at high risk of being stolen. Internet of Things can help address these drawbacks by innovating the old motorcycle securities. A security system for motorcycles with SMS notifier and GPS tracking is needed to prevent motorcycle theft and improve the safety of every

motorcycle user experiencing security problems.

Background of the study

Carnapping is one of the significant problems of vehicle owners in the Philippines. Van, cars, motorcycles, and even scooters are known as one of the significant targets of car napping in an isolated parking area. They are classified as warm in the eyes of thieves because they can easily

steal this in a blink of an eye. The motorcycle is one of the least expensive and convenient modes of transportation, but unfortunately, it is easy to steal, disassemble, and ship as parts [6].

With the growth of motorcycle popularity, the rate of motorcycles stolen also increased. Motor napping has become one of the major problems of the community. Although riders do their best to ensure that their motorcycle is safe, they can assure that the motor napping incident will not occur as this crime is commonly committed on the streets every day.

In today's world, security is crucial. Every private and public vehicle owner understands the importance of vehicle safety. As a result, different security mechanisms have been implemented. However, most of these security devices are costly and ideally suited to automobiles. In the case

of motorcycles, a simple and inexpensive alarm device can only activate a siren and create a series of noises, which will alarm people. However, if the rider is too far away from the motorcycle, he will not hear the warning.

Physical countermeasures, such as padlocks, disk brake locks, and other similar devices are also used to deter theft. While this is a preventative measure, it is not sufficient.

Many previous studies aim to address these setbacks and developed many IoT-based devices capable of notifying the user if the motorcycle is on the threat of being taken. Other apps can track the position of the motorcycle in real-time, which is a big help to prevent the current problem of motorcycle stealing in the community.

Objectives of the study

The primary goal of the research is to develop a motorcycle anti-theft and notifier system that can assist people in protecting their

motorcycles and alerting them to potential threats. In specific, this study's objectives are the following:

- To collect credible data in order to establish the system's initial requirements for the development of the system;
- Design and develop the system with the following features:
 - Kill switch
 - Phone call notifying
 - GPS tracking
 - Horn blow alarm
 - Motorcycle registration
- To develop a prototype and android based mobile application formotorcycle users to locate, immobilize and activate an alarm on the motorcycle.
- To test the prototype and mobile application using test cases scenarios in terms of functionality, usability, and reliability.
- To implement the prototype on a user's motorcycle and deploy the application on the motorcycle user's mobile phone.

Scope and limitations of the study

The study covers the development of an anti-theft and notification system that is efficient in improving the security of a motorcycle. Furthermore, the study aims to gather reliable data that will help the researchers in the development of the system design and develop a system that has the following features: kill switch, phone call notification, GPS tracking, horn blow alarm, and motorcycle registration. The study also covers the development of an Arduino prototype and an Android-based mobile application for users to locate, immobilize, and alarm the motorcycle with the use of mobile phones. Its purpose is to prevent motorcycle carnappings in the community and improve the security of a motorcycle.

Due to design constraints, this study does not cover the ability to connect with multiple motorcycles with one mobile app. The application also doesn't support iOS devices and other operating systems other than Android devices. The users' mobile devices and the microcontroller GSM module also need prepaid load in order to communicate with each other. The study also does not cover the

implementation of it into web applications etc.

SYSTEM DEVELOPMENT METHODOLOGY

The approaches and procedures employed for this investigation are fully outlined in this chapter. The proponents identified the system development methodology that the researchers will utilize for this study to create both the No Theft mobile application and the prototype. It entailed and discussed how the relevant data and information gathered are employed in this study, satisfying the research objectives, and the connection process is thoroughly documented and examined. This section explains the procedures and tasks that must be completed to complete the system or achieve the specified goals.

The Prototyping Model is a software development model in which a prototype is built, tested, and reworked until an acceptable prototype is achieved. It also creates a base to produce the final system or software. It works best in scenarios where the project's requirements are not detailed. It is an iterative, trial and error method between developer and client. For this research, the proponents employed the Prototyping approach to ensure that the entire system would succeed in achieving its aims and providing advantages to its users with efficiency and accuracy.

Furthermore, the proponents employ

Evolutionary Prototyping, which starts with a product that fits the basic system requirements and adds new features and functions as testing and evaluations are performed.

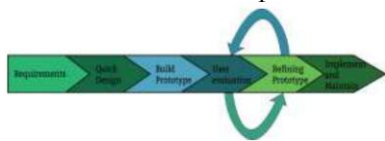


Figure 1: Prototyping Methodology.

Gather requirement

Requirement analysis is the first step wherein researchers gather all the needed data to conduct the research. The researchers collect valuable data through the internet to help them develop. The system's specifications are specified in-depth during this process. The researchers list down all the materials needed for building the prototype. In this phase, the researchers narrow down the sensors, microcontrollers, and modules required for the

development process. These are the following items: For the microcontroller, the researchers' first choice was an Arduino Nano for its compactness, but later on, the researchers realized that the Arduino Nano only has four digital and six analogue pins, which is limited to what is needed on the microcontroller, so they settled for the Arduino UNO for its coverage of multiple digital and analogue pins. Next, the researchers browsed through the internet for what sensor they could use that covers the need for specific movements. They saw a tilt sensor triggered if the sensor senses a particular activity. For other modules, the researchers chose the SIM800L and GPS NEO-6. These modules are responsible for the communication between the microcontroller and the user's mobile phone

Quick design

A preliminary design is made. In this phase, the researchers made a draft of the prototype of what it will look like in both software and hardware, speculating the functionalities of the two. The researchers designed a circuit diagram for the complete prototype and the projected mobile application interface in this phase. On the hardware side, the researchers outlined the interconnection of the modules in order for them to work with each other and generate the flow of the system. The first quick design was to put a tilt sensor on the motorcycle stand so that it would be initially triggered if the motorcycle stand was moved. At this stage, the first design that the researchers made for the kill switch is to tap it with the motorcycle ignition wiring. Moreover lastly, for the real-time tracking, the first design was to collect the logged coordinates and paste them with a web application on the internet to see the route. However, later on, the panel suggests that GPS tracking must happen inside the mobile application of the project. Hence, the researchers implemented Google Maps inside the mobile application.

Build a prototype

The knowledge gathered from rapid modeling is used to create an actual prototype in this process. The researchers have already found a motorcycle to be implemented into the prototype at this stage. The motorcycle is an SYM Bonus 110, which is perfect for

implementing an anti-theft device because older models of motorcycles do not have antitheft mechanisms. During the test stage, the researchers first tested the GSM module with AT commands to check if the GSM module could communicate with other mobile numbers. After the module was sent and received, the researchers tested it with a red light. The led light must turn on when the GSM module receives an ON text message. The led turning was then switched with the motorcycle ignition. The microcontroller was connected with a 12v relay, and the 12v relay was connected with the motorcycle ignition. As a result, when the GSM module receives the OFF message, the 12v relay will cut the power to the ignition, immobilizing it and preventing it from starting again no matter how hard a thief tries to.

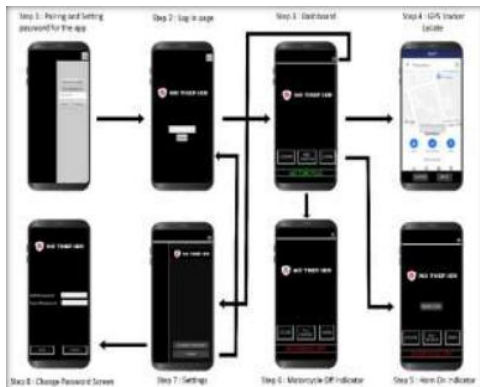


Figure 2 Story Board for No Thief-ier

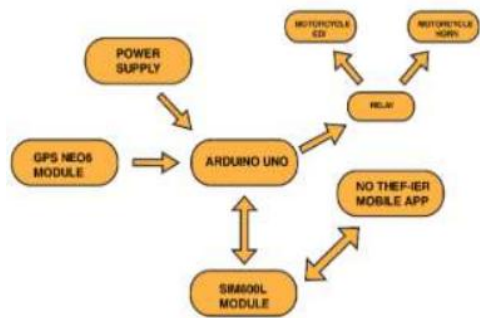


Figure 3 Block diagram for No Thief-ier

As a result, the 12v relay making the ignition ON/OFF was also the same as the horn ON/OFF feature of the prototype. After successfully developing the kill switch feature,

the researchers implemented GPS tracking. Requesting for the current location of the prototype is done with the help of the GSM module. If the microcontroller receives a text message with the subject "LOCATE," the GSM module replies with the current longitude and latitude of the prototype. After receiving the coordinates, it will then open on the application's maps and locate it. At this stage, the locate feature uses a manual locating mechanism, which is then changed after being recommended by the panel to remove the button for manual locating rather than change it with an automatic locating mechanism.

Table 1: Hardware Requirements for No Thief-ier Prototype

Software	Description
Arduino IDE	Is an open source software used for writing and compiling the code into the Arduino Module
MIT App Inventor	Is an intuitive, visual programming environment that allows to build functional application

Table 2: Hardware Requirements of the No Thief-ier Prototype

Hardware	Description
Intel i5 9300H	Processor
4GB RAM	Memory
500 GB HDD	Hard Disk Drive free space

Arduino Board and Sensors

Arduino UNO	Open source microcontroller board
SIM800L	Send and receive sms module
GPS NEO6V2	Module that provide gps location

User evaluation

In this phase, the researchers have proposed the system's hardware and software to the client for an initial review. It aids in determining the working model's strengths and weaknesses. Customer feedback and suggestions are gathered and will be taken as pointers. During this phase, the researchers have already made the kill switch, located and horn alarm features. Following the development of the features, the researchers test them one by one to see if they work, and if they do, the researchers move on to the next feature. This merging of the features makes the mobile

Refine prototype

In this phase, the prototype and application were already 100% functionalities and carefully tested for anomalies. During this phase, the prototype and the mobile application work perfectly and have full functionality. After implementing and testing the following features, the motorcycle can be immobilized with a button on the mobile app. The motorcycle can be located accurately via the mobile app. Last, if the motorcycle stand is moved, it will call the registered mobile number of the owner. The researchers found some bugs wherein if the prototype is on all the time, it cannot distinguish if the user was the one who moved the motorcycle stand, so the proponents came up with the idea of adding a switch so the prototype can be turned off if the user is the one who will be using the motorcycle and turned on later when the user parks the motorcycle. At first, the researchers added a manual switch. However, later on, they upgraded it to a remote relay that could remotely control the prototype's ignition.

This section discusses and explains how the study's main objective is met during the process. Also included in this chapter is the discussion of the requirements gathering, design and development, and testing results. The researchers conducted virtual planning meetings and gained intellectual ideas through internet research. As a result, the proponents discovered and fulfilled the criteria required to accomplish the characteristics of the entire integrated system of mobile application and hardware prototype. The proponents practically illustrated every feature and flow of the system that it wanted to deliver by constructing Hardware Circuit Diagrams, Block Diagrams,

have a better understanding of the circuit wirings. The researchers used Adobe Photoshop and Adobe Illustrator to achieve the two graphics for the Block diagrams and Mobile Applications designs.

```

graph TD
    Start([START (Initialization)]) --> Definition([DEFINITION])
    Definition --> ReadFile([READ IN A SELECTED FILE])
    ReadFile --> IsCriterion{IS THERE A STOPPING CRITERION?}
    IsCriterion -- Yes --> StopCriterion([STOPPING CRITERION])
    IsCriterion -- No --> ReadStopCriterion([READ IN A STOPPING CRITERION])
    ReadStopCriterion --> Definition
    Definition --> Testing([TESTING])
    Testing --> RedefineCriterion([REDEFINITION OF STOPPING CRITERION])
    RedefineCriterion --> Definition
    RedefineCriterion --> End([END (TERMINATION)'])
  
```

According to the findings of the design, development, and testing, all of the features specified in the scope of the research for the No Theft-ier hardware prototype and mobile application function as intended. The researchers were able to create a prototype that allows the users to locate their motorcycle via a mobile application. The mobile application proved effective in locating the motorcycle's present position and tracking its path.

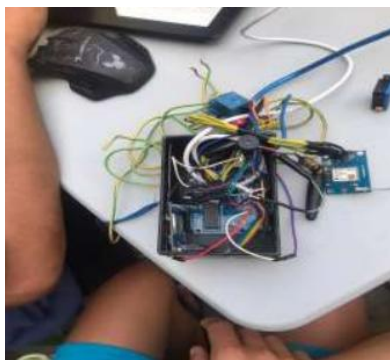


Figure 5. No Thef-ier Prototype

The mobile application is also successful in activating the horn alarm on the motorcycle with a single click on mobile application. The researchers were also able to develop a kill switch feature that is able to immobilize the motorcycle preventing it from starting again. This features is done with the KILL SWITCH button on the mobile application.

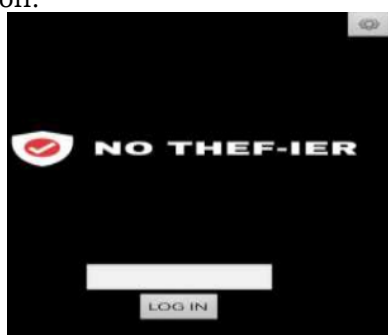


Figure 6. No Thef-ier Mobile Application

The mobile application and hardware prototype are both able to pass all the test cases and scenarios in terms of functionality, usability, and reliability that are set by the researchers to test them and produce a working hardware prototype with a mobile application that can help motorcycle users improve the security of their motorcycle. The researchers concluded that the No Thef-ier mobile application and hardware prototype fulfilled all of the requirements specified in the study's objectives and scope.

The researchers were able to successfully develop a hardware prototype with a mobile application that helps motorcycle users locate,

immobilize, and alarm potential threats. The prototype was able to track the location of the motorcycle with the No Thef-ier mobile application maps. The prototype is also able to immobilize it with the kill switch feature using the mobile application buttons. Lastly, the prototype is also able to activate an alarm using the motorcycle horn to alert nearby people using the mobile application. Furthermore, the results of the test cases confirmed that every feature in the project functioned as planned. In conclusions the researchers are able to develop a working prototype with a mobile application that helps motorcycle users to add security on their motorcycle and solve their problem on worrying the security of their motorcycle when they park it on an area that they don't have vision.

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Online Appointment System for Sudah Vet

Jose Ulogio S. Dizon
Lailah Jane R. Lucena
Irma M. Pandong
Girly Valencia
Pauline T. Valencia
Frederic D. Santos (Technical Adviser)

ABSTRACT

The purpose of the project is to develop a web-based appointment and inventory system, and eliminate the manual business process of Sudah Vet. Sudah Vet offers veterinary services and pet supplies in seven of the clinic's branches in Pampanga and Tarlac. The project's focus for the website is to have separate accounts for employees and clients, product catalog, an appointment booking system, and an inventory management system for handling pet product stocks. The Scrum methodology was used for planning and developing the web-based system. After a series of testing and evaluation of ISO 25010, the website has achieved the four access account levels, e-mail verification, e-mail appointment schedule notifications, product catalog, appointment system, and inventory management system. The recommendations for the project are e-consultation so that veterinarians can reach out to the client's concerns, e-commerce to increase profit, and mobile applications for the convenience of appointment booking on Android and IOS devices.

INTRODUCTION

Technological advancements in the world change rapidly due to the increasing and newly discovered ideas that ease people's work. Most transactions are now done on computers online or offline. One example of organizations or businesses that use technology are hospitals and clinics.

Since hospitals provide healthcare for humans, the use of technological equipment will bring convenience in handling the growing number of patients but on the other hand, some veterinary clinics don't because of the limited budget. Even before, veterinary clinics were only limited in the Philippines but as time went by, veterinary clinics started to bloom because of the increasing number of pet owners in the country.

Computers are on demand since most people rely on computers for entertainment, news or shopping. In view of Jaypee D., as the years passed, the number of discovered animals has grown and various medical cases like the manual method of managing animal records, prescriptions and appointment schedule are no longer practical [1]. The ever-changing and dynamic environment of veterinary practice means that what works in the past may not work in our present times. Even pet owners are becoming more educated because of

technology, and that is why clients expect more from veterinary clinics [2]. An increase in career prospects and entrepreneurially motivated veterinarians running separate clinics as semi-independent business units also resulted in the growing competition for veterinary clinics. Since most of the clients are looking for the best and inexpensive services available, veterinary clinics should be aware and be able to cater to the client's needs to stand out [3]. Overall, veterinary clinics should adapt to the use of technology for smoother, accurate recording, ease of transactions, and increase in profit.

Veterinary clinics can find technology helpful in solving problems that are being encountered in the vet, one example is the competition on how to promote the vet in an effective way and reach thousands of potential clients by using social media or websites. Owners should also consider the use of Online Appointment and Management Information System since COVID-19 is being experienced worldwide and health protocols limit people from going in and out. With the use of online transactions and management in inventory, the clients can book an appointment anywhere and anytime and help eliminate paperless transactions.

The above idea made the researchers come up with the project entitled: "Online Appointment

System for Sudah Vet”, a web-based and management system for veterinary clinics that can be used for pet owner’s help get a scheduled appointment to Sudah Vet clinic.

Background of the study

Sudah is an Arabic word which means “prosperity” and also came from a Hotel name located at Magalang, Pampanga. Sudah Vet is a veterinary clinic owned by Ms. Glenda David. The first was established in June 23, 2014 and located in Dau, Mabalacat, Pampanga. Sudah has seven branches in total, and the main office is located in Angeles City. Back then, Sudah was a mere grooming area and pet supplies, but as the demand of veterinary grows, licensed Veterinarians started to come by and catered to various animals and the services grew larger. The clinic offers an affordable consultation fee for pet owners, and licensed veterinary doctors handle pets.

The following are the seven branches of Sudah Vet;

Dau

- Magalang
- Sunset Village, Friendship Highway
- Bamban
- Capas
- Hensonville, Angeles City
- San Fernando

The Sudah Vet clinic offers several services in each branch which are: consultation from the licensed veterinarians, vaccination, deworming, confinement, surgery, x-ray, ultrasound, laboratory test, vet dental clinic, vet pharmacy, pet wellness, emergency services, pet grooming, pick-up and drop-off grooming, home service, pet boarding and lodging, anti-ticks and flea, spay and neuter, complete blood count, blood chemistry, major surgeries, and pet supplies which are available at the clinic.

According to Dr. Arvin Cuevas, the services that can be done at the same time are Complete Blood Count and Blood Chemistry. These two services are taken at the same time because getting the blood sample from the animal is easier to perform. Also, the time consumed for vaccination is 5-10 minutes, 5 minutes for deworming, and check-up is 30 minutes. The other services cannot be exactly measured. 20 clients can be accommodated daily, 10 clients in the morning and 10 clients in the afternoon.

The hierarchy of the Sudah Vet clinic depends on the position and job of each employee. Miss Glenda David is the highest in the ladder and the owner who established and operates the Sudah Vet Clinic. Next in line are the veterinarians in each branch who medicate and consult the patients. After that, the cashiers who handle the payments and generate the bills at the cashier. Lastly, the assistant/groomers who assist the veterinarians in performing surgery, grooming and other services that the clinic provides.

Sudah Vet promotes the clinic on social media, specifically on the Facebook page. The Facebook page contains detailed information about the available services, contact number, location, products, and posts of recently treated animals. All records such as the client's appointment, pet's history records, and products are done manually.

The business process of Sudah Veterinary begins with the client walking towards the person in-charge in the front desk and filling out the registration form to be able to avail the services of the vet. After the registration, the client, proceeds to the veterinarian's office first for consultation about the pet's condition and what other measures are needed for the pet's condition. The client will then go to the station where the services are performed. If the client wants a wellness check, then the pet will undergo vaccination or deworming. For check-ups, out-patients are given prescriptions, while in-patients are given medicines which are available at the clinic. If a confinement is needed, the veterinarian will let the client know how long the confinement lasts. After the client is done with the appointment or services, the bill will then be generated and the client pays the amount directly at the cashier's area.

As the researchers investigated the clinic's needs, the business processes, such as appointment scheduling, records management, and other transactions, are all done by hand. The process works as follows; clients may schedule an appointment through phone calls, messenger, or visiting the clinic. Staff will look for the pet records for old clients, and new clients will need to register by filling out the information needed. Next is consultation and treatments, then reschedule if needed, especially for vaccination purposes and then

proceed to payment. The client can now decide to have another service for a go, such as grooming. The clinic sells food and supplies for animals. However, as the staff stated, inventory is done manually and has discrepancies in the account. Since the company is getting bigger, a great advantage to have a new and organized system is needed. Therefore, the researchers came up with an idea and recommended a system that creates an online appointment and inventory system that will help the veterinary clinic.

The researchers have investigated the problems of Sudah in terms of appointment booking and inventory booking. First, the records and appointment schedules of the clients are done on paper. The employee has to look up for records and appointment schedules of the client one by one, and it takes time. The second is that employees have to remind the appointment schedule of each client through calls or text. The inventory system has the same problem. The records of the products are manual, and employees have to rewrite the number of stocks. The researchers decided to develop the web-based appointment and inventory system due to the stated problems and growing number of Sudah's clients. With the help of the system, the records are kept digitally and the employees will be at peace when it comes to searching.

Objectives of the study

The main objective of the project is to develop a friendly-user interface system for the administration and clients:

- To gather all the needed information in the Sudah Vet Clinic.
- To identify all the needed hardware and software for the development of the system.
- To create a system that has:
 - Four Access levels: Admin, Secretary, Vet, and Client
 - Branch Map
 - Online booking appointment
 - SMS notification
 - Pet portal
 - Digitized card
 - Products Catalog
 - Inventory Management
- To test the system by the use of test cases in terms of ISO 25010 evaluation.

- To manage the website through a webhost.

Scope and limitations of the study

The system is a web-based system that caters to the clients of Sudah. The main features are online appointment and inventory management system.

Admin Portal. The admin manages all the records in the clinic, the admin has an account by logging in the Login Portal which can be accessed on the website. The admin can navigate the "Schedules" tab composed of the date, branch name, vet, and maximum number of appointments for A.M. and P.M. and an action to edit and delete such records. In the "Patients" tab, all the records of the clients composed of the image, name, owner, species, breed, and DOB are shown. The admin cannot delete or edit the records of the website's users/clients. In the "Vets" tab, the admin can view the name of the assigned veterinarian, e-mail, contact, and in which branches of Sudah the vet is assigned. The "Log Out" lets the admin out of the portal and be redirected on the Sudah Vet clinic website.

Client Registration. The client uses the web-based system using computer for the registration. The "Login" button can be seen on the top bar, when clicked, a login form that asks for the username and password is shown. The registration form which is similar to the form in the Sudah Vet, the client will be redirected on the registration form and asks the user to input the last name, first name, middle name, contact number, email address, username, password, address and date of birth. The inputs from the client will be validated based on the correctness and if requirements are met on the form. The password must contain a lower and uppercase letter, number, and minimum of 8 characters. All fields are required to be fulfilled, except for the weight and image which are optional. Once the registration is complete, the client will then receive a verification email and must click the "activate here" button. The client will return to the website and login form. The client can now provide the username and password and will be redirected to the dashboard which has an appointment, pets section, my account, and logout.

Appointment System. To book an appointment, the client needs to log in first to reach the “Appointment” tab located in the “Pet Portal” and unregistered clients will not be able to book an appointment. Once inside the “Pet Portal”, the client clicks the “Set an Appointment” button for the online appointment located in the upper right side of the appointment list. The appointment has a form that requires the client to pick one of the branches of Sudah, a calendar picker for the date of the appointment, time which is readily available from A.M. to P.M., provide the patient/pet information, the reason for the appointment, and lastly, the services the client wants to request. Once the client clicks the “Submit” button, the page will be redirected to the “Appointment” tab. The appointment record will be shown which is composed of the chosen date, name, branch, status, and the “Actions” button composed of “Edit” or “Cancel”. If the client clicks the “Edit”, the newly created appointment can be modified as long as the secretary hasn't approved, declined or re-schedules the said appointment. If a scenario where the appointment has already been approved and the client wants to change the information, the client may contact the branch of the vet for modification.

Appointment Status. If the secretary approves the client's appointment, the client will receive an SMS notification and email, and the status tab on both client and secretary's appointment list will change into approved on the appointment's tab. The client can now visit the clinic based on the given date of the appointment. If the appointment is declined, the client will receive an SMS notification, email and the status tab on both client and secretary's appointment list will change into declined on the appointment's tab, which could be due to several reasons such as: incomplete requirements or unavailability of the veterinarian or clinic. If the appointment is already done, the appointment will be recorded as a completed status on both client and secretary side.

Pet Portal. The client cannot delete but can view, add, and edit the “Appointment” and “Pets Section” tab in the “Pet portal”. The “Appointments” list all the present and future appointments while “Pets Section” tab has all

the list of the owner's pet. In the “Add Pet” button, the client can add a new pet by entering the pet's name, birthday, gender, species, breed, color, weight, and an image. In the “Pets Section” tab, the name, species, breed and actions which have a view button is presented. In “My Account”, the client can modify the general information such as first name, middle name or last name. The pet information can be modified too such as name, photo, breed, species and etc. The “Change Password” can be modified by typing the old password and creating a new password that meets the requirements of the system. The “Logout” tab logs the client out of the pet portal.

Forgot Password. Once the username or password of the client is forgotten, a “Forgot password?” can be clicked located at the “Login” form. The client 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 client's current password. If the client is simply mistaken or no longer needs to know the username or password, the e-mail can simply be ignored.

Inventory Management System. The secretary can access the inventory on the “Login Portal”. The inventory has “Available Stock” and “Out of Stock” tab where the secretary can view, modify and add a new product. The secretary cannot delete the product records but instead if the stock is zero, it will automatically be listed on the “Out of Stock” tab. The inventory lists all the monthly, weekly and daily reports having the product name, date, and stock of the products. In the “Add a new product” tab, the secretary inputs the product name, date, and stock of the item. The secretary can also generate reports and readily print on the “Generate Report” button in an excel and pdf format.

Product Catalog. The clients cannot buy the products and instead, clients can view the catalog by clicking the “Catalog” tab, inside are three categories: food which is composed of dry food, wet food and milk/liquid, the next one is treats and lastly, toys. The image of the

products being sold at the vet is previewed along with the product name, grams/kg and price. Once the user clicks the product, the information about that product such as nutritional benefits, ingredients or description is shown as well.

Other features. The clients can navigate the “Our Services”, “Our Team”, and “Our Locations” on the “About” dropdown button which can be viewed on the website. On the “Our Services” tab, lists all the services of the vet and the information and image of the services provided. On the “Our Team” tab, the veterinarians, assistants and groomers of Sudah along with the Facebook of each person on the Facebook Icon by hovering the person’s image are shown. A map where clients can locate the branches of the clinic on the “Our locations” tab. In the “Our Gallery” tab, the images with captions of the vet clinic are shown to the clients. Features a digital card that tracks the pet’s vaccination and medication information based on the manually written card given to the clients of Sudah.

Technology used. To develop the system, the researchers used computers and mobile phones to test whether the system functions correctly and the design is not all over the place. HTML, CSS, and Javascript were used for the design of the webpage and Mysql for the database. Laravel for the framework and Git for version control. Visual Studio Code is used to code the web application of Sudah vet. Clients cannot purchase a product online and can only view the available products on the pet shop. The receipt or generation billing are given after the client’s appointment in the veterinary clinic. Other information unrelated to appointment reservation.

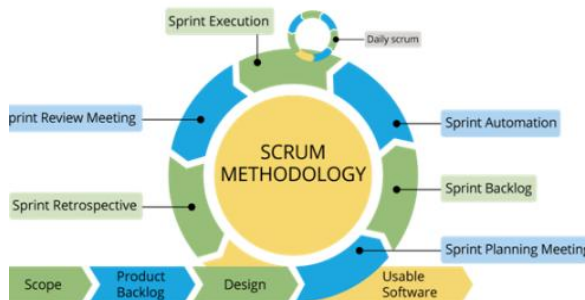


Figure 1. Scrum Methodology

SYSTEM DEVELOPMENT METHODOLOGY

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.

The “Product Backlog” composed of interviews, questionnaires and observation of the researchers on their visitation to Sudah Vet Clinic. The information gathered were all about the services provided by the clinic, prices of each service, business process, the history and names of the employee, and photos that can be used on the website. The next stage is the “Sprint Planning Meeting”, the leader conducts a meeting via messenger and video call, and all the gathered data and information are sorted out whether it is needed or unnecessary for the development of the website. The adviser is also contacted for further information such as what are the needed functions for the Appointment system and Inventory system. The next step is the “Sprint”, the leader distributed all the tasks piece by piece to build the website. For the development of the web-based system, the software used for the design and functionality was HTML, CSS and JavaScript. For the database of all the records of the client and admin, the software used was MYSQL. The hardware requirements for the website are computers and smartphones for the mobile browser testing. The sprint was repeated until all the tasks given for each member are done successfully and the website is functioning well. Each task was repeatedly tested to ensure that no bugs or problems will happen. The next stage is “Sprint Review Meeting”, the researchers will now visit Sudah Vet to evaluate the system and gather feedback on what the product owner like, dislike, improvements, and suggestions based on the website's design, appointment system, inventory management system’s design and functionality. Finally, the “Sprint Retrospective”, after the researchers gathered all the feedback, the system will go under another update based on what Sudah suggested for the deployment of the system.

Scrum roles

The Sudah Veterinary is the product owner for the website. Sudah is the basis of the website’s appearance, information, and process for the

appointment booking and inventory management. The development team are the researchers responsible in communicating with the product owner about the data and information needed for the development of the project. The other members were behind the evaluation and documentation. The development team planned which task should be done first, conducts meeting, program the website, and testing. The team leader is the Scrum Master that is responsible for managing and handing out the tasks to each team member.

Scope

The development team has researched the veterinary industry in the Philippines for the enhancement and development of the system. The researchers then discovered that some of the veterinary clinics are still using the manual process in appointment booking and inventory management. Social media was mainly used to look for more veterinary clinics in Pampanga.

Product Backlog

The development team made a product backlog during the meeting. The team ranked the product backlog based on the task's highest priority. The first is Website Analysis, the team went to the vet clinic for a span of 3 weeks to investigate and interview the employees to have an idea of how the website should look and function. The next is Homepage, the team decided to program the homepage to have a better view of how the users can perceive the page and have a full understanding of how the website should work. After a week of making the front end of the website, the team developed the client page to start the appointment system and management of the pet records. The next is the vet page, the vet account is connected in the appointment since the vet is part of handling the pet's medical records. After that, the secretary account was done by the team since it is a crucial part of accepting and rejecting the appointments. Inside the secretary account, the team started coding the inventory too. The next part was the admin account, the team developed the admin account since it is responsible for handling the main inventory and accounts of all users. After the completion of the website, the development team tested the project and evaluate using ISO

25010. Lastly, the documentation for the project.

Design

The development team made a blueprint for the website's design. All the needed pages, functions, and contents were thought of to have a clearer view of the tasks that were needed to be done first.

Sprint Planning Meeting

After gathering the information, photos, and data from Sudah Vet Clinic, the development team has conducted a meeting to select all the needed, irrelevant, important data, information, and features that need to be worked for the system based on the priority. The developers behind the development team used Bootstrap Studio for the front-end and Visual Studio to code the website's functionalities. HTML, CSS, and JavaScript for website development and Laravel for its framework. The researchers decided to go for the website's design first to fully understand how the system functions and if it is user-friendly for the product owner. The creation of the admin, client and secretary account was next to make the appointment system possible since both have roles in the system. After that, the inventory management system was implemented using the products of the Sudah Clinic.

TASK	MAY 2021	APRIL 2021	JUN E 2021	JULY T 2021	AUGUST R 2021	SEPTEMBER R 2021	OCTOBER R 2021	NOVEMBER R 2021	DECEMBER 2021	January 2021
Website Analysis										
Homepage										
Client Page										
Vet Page										
Secretary Page										
Admin Page										
Evaluation										
Documentation										

Figure 2: Time Table

Sprint Backlog

For the first task, the development team has done the design and logical analysis for the website for 3 weeks since it is the blueprint of the whole system. Next, the team worked on the overall content of the website, which are home, about, services, products catalog, teams and contacts. The team then made the login and registration page so that clients and employees can access the main function of the website, everything was done in last week of May and June. The next task was the client page, the team developed the client account to start the booking of appointment, inputting the client's pet, and editing the user's account. The

task started in last week of April and ended in June. The team then developed the vet page, which is composed of checking the current scheduled appointments of the clients in calendar form and the records of the patients. The task was done in 2 months and a half. The Secretary page was then developed by the team. Under the secretary page, the checking of appointments, records of patients, adding, editing, and archiving of pet products were done. The next is the Admin Page, the team then developed the page which manages the user, schedule, branch, inventory, file, and logs of the users. The team finished the admin page in December as seen in the Figure 3. In January, the development team started testing and evaluating the website since it was already completed. The documentation was done on the very first month of May until January since the document keeps up with the system.

Sprint Automation

The development team acted out as the client, to have a better judgement whether the website is usable. The team tested the registration and login page to check if the forms are working properly since that is what most clients use to book an appointment. After testing the client side, the secretary, and admin portal were tested. The inventory was checked if it properly shows all the list of available products and out of stock products. Each new completed task is tested to ensure that the system has no errors or missing contents.

Daily Scrum

The development team has conducted daily meetings through video calls and face to face meetings to monitor the progress of each task. The members reported all the errors found in the website. The errors addressed during the meetings were updated and fixed in order to polish the system.

Sprint Execution

Each member of the development team performed all the tasks given to them in order to make the system run. The task that has already been done were reported to in the meeting for the members to proceed in the next task for the website's functionality.

Sprint Review Meeting

The development team has conducted a meeting to evaluate and test out the system design, appointment system, information

system and inventory management system. The completeness, accuracy of information regarding the vet clinic, ease in navigation of the website and system requirements were also checked.

Sprint Retrospective

For the last meeting, a discussion happened about all the accomplished tasks and refinement of the system. The scrum developers worked to look for the bugs, and test the system's functionality all over again to ensure the system's readiness for deployment.

RESULTS AND OUTCOMES

The section illustrates and examines how the project's goals, which are primarily to develop a web-based appointment and inventory management system for Sudah Vet Clinic, are achieved.

Requirements

The researchers have gained an understanding of the topic through internet search and after interviewing specialists. As a result, the researchers discovered and finished the criteria for the system.

Table1. Hardware and Software Requirements

Hardware Requirements	Software Requirements	Function
Desktop	Windows (minimum) 7 4GB RAM (minimum) Google Chrome ver. 97.0.4692	Operating System Memory Browser

Software, Product/Processes

The researchers finished the criteria for the system. After data collection and analysis, the researchers designed the web-based system.

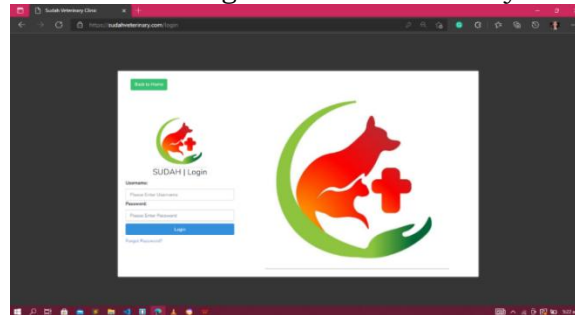


Figure 3. Login Page

Client User Process. Figure 3 shows the login page of the website. The client enters a username and password in order to login in. New users may create an account using the “Register” button. Upon logging in, the client may browse the Appointment list, Pets Section, and My Account. In Appointment List section, the client sees the status and schedule of the appointment. The client is able to cancel the appointment even if the status is approved or pending. In the Pet Section, the client’s pets are listed and able to add or edit the pet. In My Account, the client is able to edit and change password.

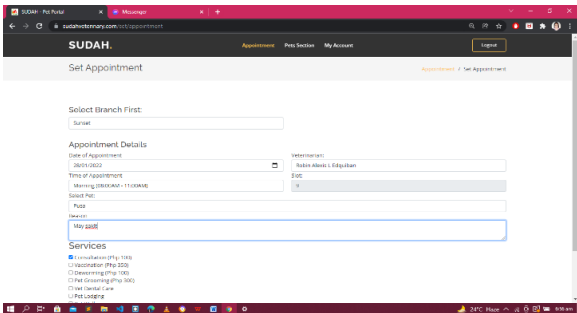


Figure 4. Setting an Appointment

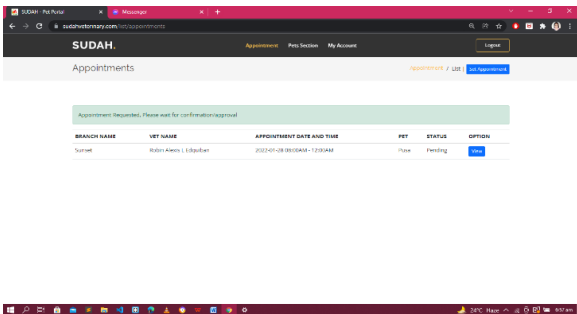


Figure 5. Appointment Success

The Figure 4 shows the process of booking an appointment. The client chooses a branch among the seven branches. After choosing a branch, the client has to input the date of appointment, select pet, reason, and services. The veterinarian for the said appointment will then appear. The client is able to choose several services by clicking the checkbox. The Figure 5 shows the successful setting of appointment in the Appointment tab.

VET USER PROCESS.

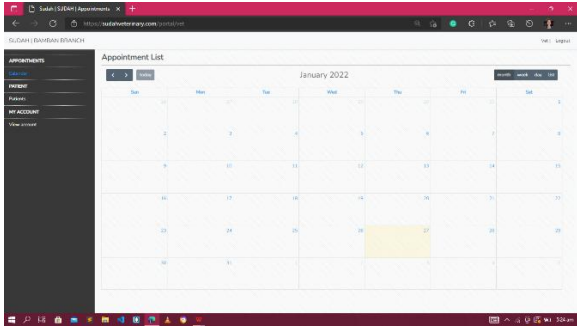


Figure 6. Vet Dashboard

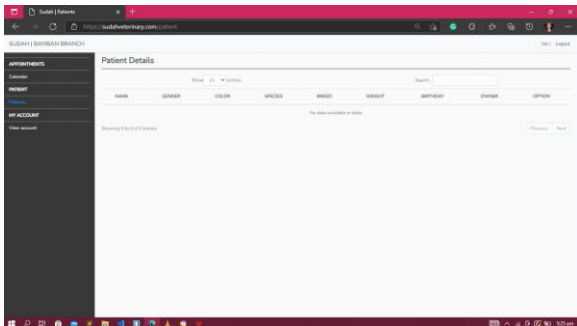


Figure 7. Patient Details in Vet Account

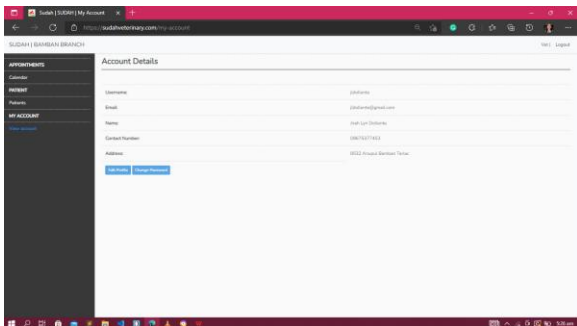


Figure 8. Account Details

After logging in, the vet is able to see the client’s appointment in a calendar structure. Upon clicking the available appointment, the vet is able to see the pet information, services requested and medical record of the said client. In the Figure 7, the Patients details tab shows the list of the patients along with the medical records. In the Figure 8, the vet is capable to edit profile and change password.

Secretary User Process

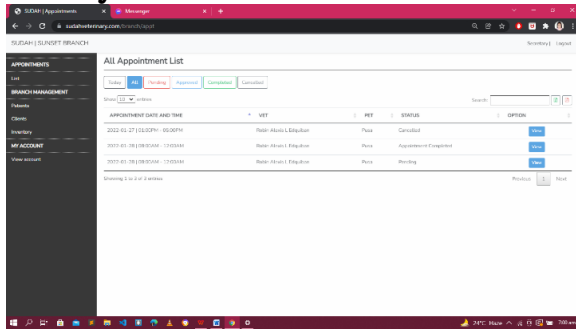


Figure 9. Secretary Dashboard

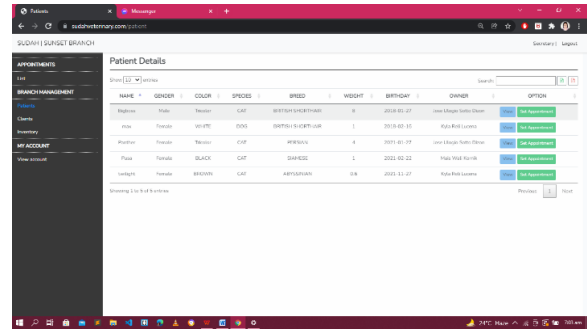


Figure 12. Patient Details in Secretary Account

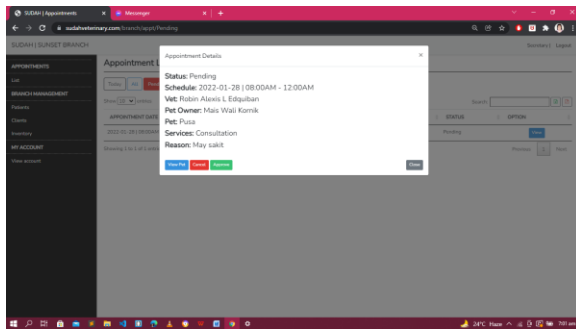


Figure 10. View Appointment

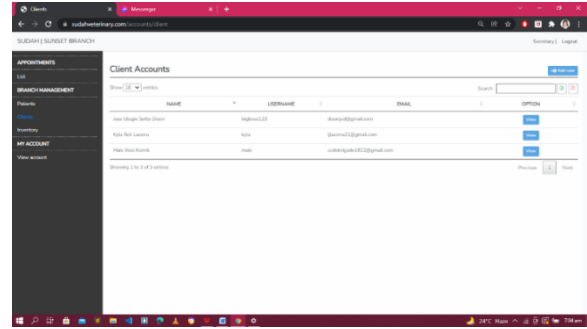


Figure 13. Client Accounts in Secretary Account

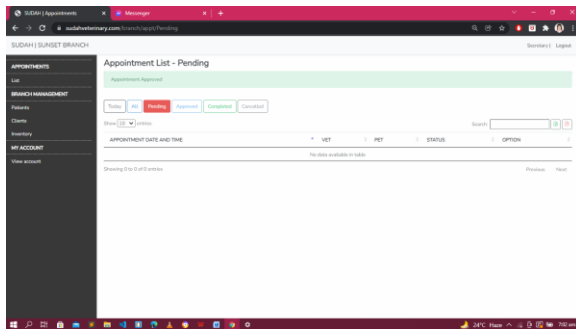


Figure 11. Appointment Approved

After the secretary logs in, he/she will be able to see the list of appointments. In the Pending button, the secretary will be able to view pet, cane, and approved the list of appointments. In the approved button, the secretary will be able to view the appointment details and pet details. In the completed button, the list of approved appointments will be shown and the secretary will be able to set another appointment for the client. In the cancelled button, the secretary can see the list of the cancelled appointments along with the reason. In the Figure 11, the approved appointment will notify the secretary that it is successful.

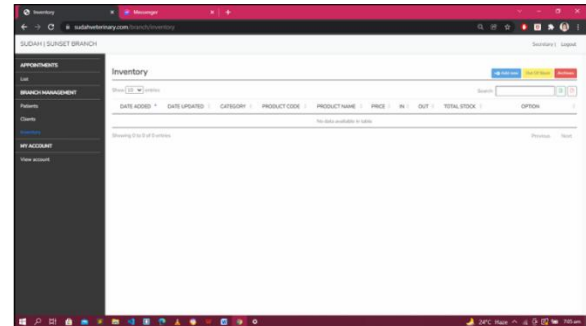


Figure 14. Inventory in Secretary Account

In the Inventory tab, the secretary will be able to view products, out of stock products, add a new product, and archives. In the Inventory list, the secretary will be able to edit the "Product In" and "Product Out". In the Add Product, the secretary will be able to add product quantity. In the Archives button, the records of all products are listed.

Admin Process

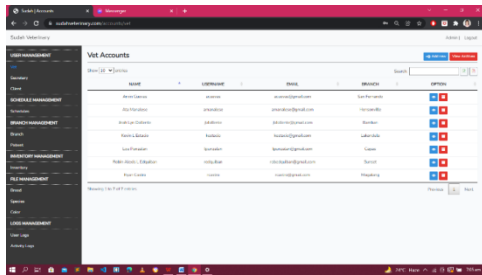


Figure 15. Vet Accounts in Admin Account

After logging in, the admin can view all vet, secretary, and client accounts. The admin has the option to view the details and deactivate the account if the client wanted to. A search bar is also present for each account for the convenience of looking up a certain record.

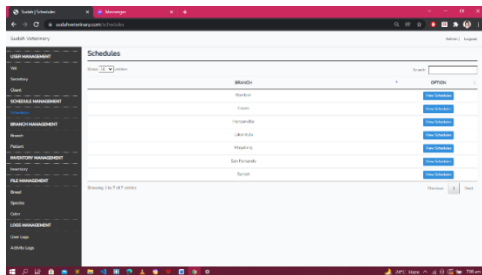


Figure 16. Branch Schedules

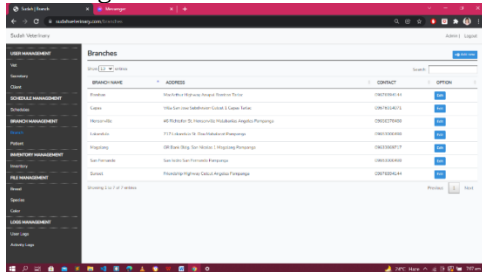


Figure 17. Branch Records

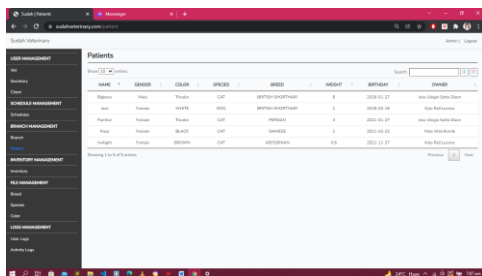


Figure 18. Patients Records

In the schedules tab, the admin will be able to view the opening hours of each branch of Sudah. Under the Branch Management, the can view the list of branch and patients. The

admin can edit the branch information in case something has change with the address or contact details. The Schedules, Branch, and Patient has a search bar for easy searching.

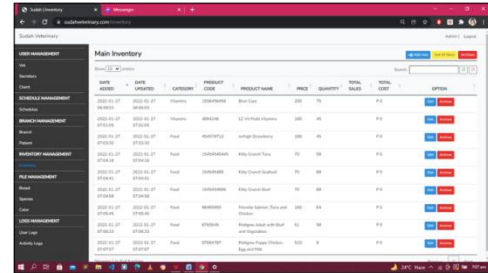


Figure 19. Main Inventory

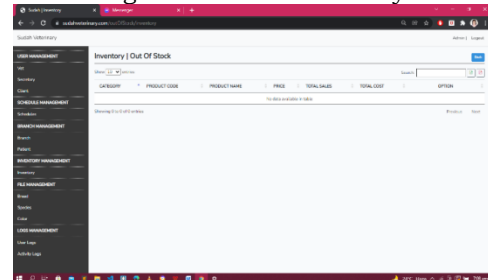


Figure 20. Out of Stock Records

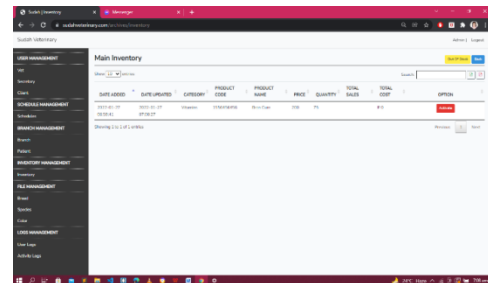


Figure 21. Archives

The Figure 19 shows the main inventory, wherein the admin can view the products of Sudah. The admin can also edit and send the products on the Archive. In the “Out of Stock” button, the admin is able to add stock for the products shown. In the “Archive” button, the products can be activated in case of human error. A search bar is also present for each tab to make it easier for the admin to look for a certain record.

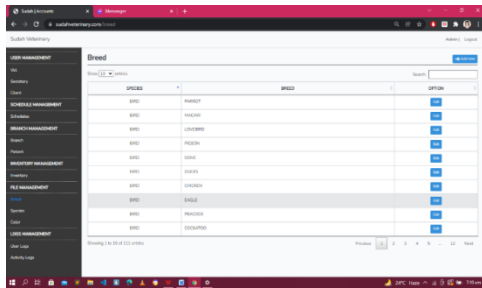


Figure 22. Breed Records

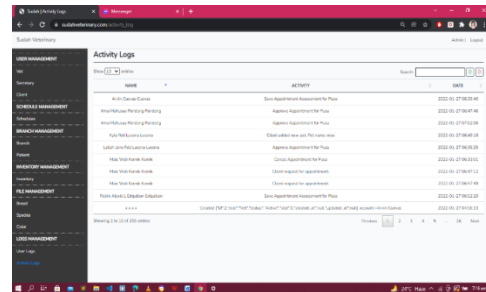


Figure 26. Activity Logs

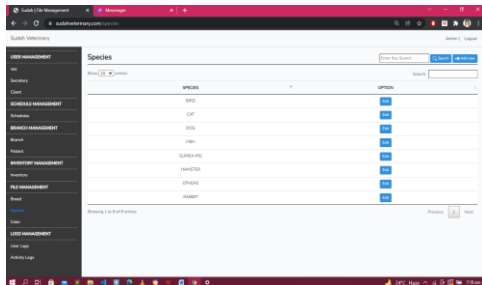


Figure 23. Species Records

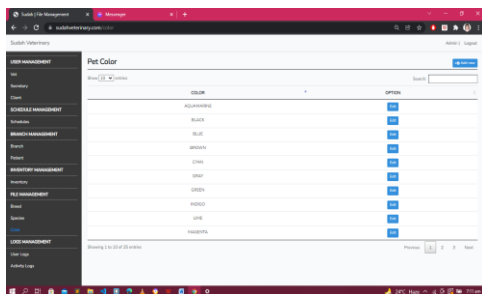


Figure 24. Pet Color Records

Under the File Management, the admin is able to see the list of Breed, Species, and Color for the pet's categories. The admin is also able to update and add new of the following categories in case Sudah can now accommodate new animals. A search bar is also present for each tab for a convenient search of records.

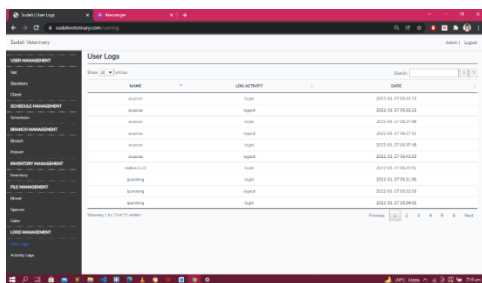


Figure 25. User Logs

In the Logs Management Tab, the admin is able to see the log activity of the clients, secretary, and admin under the User Logs Tab. It states whether the user logs in or log out and the date of the said activity. In the Activity logs tab, the admin is able to see the activities done of each user along with the date.

Development and Testing Results

After the completion of the website, the researchers conducted a series of testing on the website using the ISO 25010 evaluation standard. The researchers tested the system 5 times per category based on ISO 25010 evaluation. As a result, the website passed the criteria though a series of testing.

Functionality Suitability. The Functional Suitability test was used to evaluate whether the website is fully functional and met all its objectives. The testing took 5 tries to make sure that no errors were found. The test IDs, “FSTC” stands for Functional Suitability Test Case, these are unique IDs for the sub-characteristic of Functional Suitability. The website has passed all the test according to its Completeness, Correctness, and Appropriateness.

Reliability. The Reliability test was used to test if the website can perform all the system functions despite problems or specified conditions. The testing took 5 tries for the sub-categories of Reliability. The test case ID, "RTC" stands for Reliability Test Case. The test results shows that the website has passed the Maturity, Availability, Fault Tolerance, and Recoverability which are under the Reliability test. It means that the website is operational and accessible despite of human error, software and hardware malfunction, and conditions for every functions.

Compatibility. The Compatibility test was done to evaluate how well the website performs

in different platforms, browsers, and software and hardware requirements. The test took 5 tries for Co-existence and Interoperability, which are under Compatibility Test. The “CTC” IDs, stands for Compatibility Test Case. The website has passed all the test, which means the system is capable of running simultaneously and respond to the functions that were performed by the user on the website.

Usability. The Usability test was done to evaluate how the website fulfilled the objectives, user interface, and functions in effective, efficient, and satisfactory way. The testing took 5 tries for the overall subcategories of Usability test. The “UTC” IDs, stands for Usability Test Case. The test results shows that the website has passed the Appropriateness Recognizability, Learnability, Operability, User Error Protection, User Interface Aesthetic, and Accessibility. The test proves that the website is user-friendly for both clients and employees of Sudah because of the simplicity in design and proper labeling.

Performance Efficiency. The Performance Efficiency was used to test the website’s loading and processing times and the overall performance whenever it performs a function. The table above shows that the website passed the Performance Efficiency test. The test took 5 tries on Time-behavior, Resource Utilization, and Capacity, which are under Performance Efficiency. The “PETC” IDs, stands for Performance Efficiency Test Case. The test results indicates that the website is able to load and process efficiently based on the system functions.

Security. The Security testing was done to test how well the website protects the information and data from security flaws. The test took 5 tries for assurance. The “STC” IDs, stands for Security Test Case. The website has passed the Confidentiality, Integrity, Non-repudiation, Accountability, and Authenticity that are under Security test. The test proves that the website has security features that keeps the user information and data from unauthorized person. The system also has verification for the authenticity of the people registering on the website.

Maintainability. The Maintainability test was done to test how the website can be modified,

adjusted, corrected, and adapt to changes in given conditions. The test took 5 times for Modularity, Reusability, Analyzability, Modifiability, and Testability. The “MTC” IDs, stands for Maintainability Test Case. The test result proves that the website has passed the Maintainability test because of the response on each of the sub-categories of the said test. The test means that the website is able to adapt and change based on what the user inputs and edits on the system.

Portability. The Portability test evaluated how the system can be used on different platforms and ever updating devices. The “PTC” IDs, stands for Portability Test Case. The test took 5 tries and has passed the Adaptability, Installability, and Replaceability, which are under the Portability test. The test proves that the system is capable of running on desktop and mobile browsers and the latest software and hardware requirements for different platforms.

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Pawtify: Global Positioning System Tracker for Pet Safety

Elaine Asis
Maricar P. Cabrera
Maria Cela V. Oscares
Eugine E. Pakingan
Antonette Sandoval
Lorenzo C. Macam (Technical Adviser)

ABSTRACT

Pets require special attention and a monitoring device to follow their movements in case they become separated from their owners. Due to our hectic lifestyle, this task is no longer as simple as it once was. Many people worry about losing track of their dogs, which is why pet trackers provide relief by instantly navigating a person's pet's activity. The researchers used a prototyping method as a guide to developing a pet tracker device called "Pawtify" using various hardware components that can locate their pets and alert the owners. A QR code-enabled smartphone application was also developed to generate and scan pet information. Two modules are activated when the pet's geofence range is exceeded, as well as when the pet owner selects the "Locate Pet" button in the application. While the buzzer is only triggered when the pet owner presses the buzzer button, the buzzer button also gives the owner an alternate means of recognizing the pet inside the geofence by hearing the buzzer's sound. The researchers utilized test cases to ensure that the mobile app and system prototype were both functional. Researchers tested each device's functionality ten times to fulfill the objectives and system requirements. The Pawtify prototype met the research goals and objectives based on the data collected. The researchers recommend improving the mobile application that will notify the Pet owner via a pop-up notification, as well as making the device more compact by switching to a smaller battery to power the modules, as well as using another small GPS and modules to accommodate all IoT components used in the Pawtify prototype.

CCS Concepts: • Computer systems organization → Embedded systems; Internet of Things; • Mobile Application Development → Android Application

General Terms: Design, Algorithms, Performance
Additional Key Words and Phrases: ACM proceedings, Word, text tagging

INTRODUCTION

Pets are not just animals; they are also considered as family members or friends to humans. When someone significant to a person is missing, that person will be willing to find that someone because of the attachment involved in their relationship. The same effect goes when it comes to losing a pet. It will be alarming to the owner not knowing where his pet is. The owner will have no idea if his pet is safe or is further away from the owner [4]. The more time the owner lets pass by while the pet is missing, the lesser the assurance of seeing the pet once again. "The odds of finding

your dog within 24 hours are around 90%," Williams explains, "and this potential reduces to approximately 55% to 65% after 24 hours". These odds would decrease much lower if you do not take any steps to locate your dog" [21]. While it is not too late, exerting an effort to search for the missing pets will result in a more significant potential to find them. 49% of the successful methods were used to find lost pets is by searching within the neighborhood, 20% of their pets returned on their own, 15% was contacted because of tag/microchip, 7% was brought home by their neighbor, 6% was helped by animal control and 3% was from other methods. This shows that the most effective way of reuniting with your pet is by literally going out and searching for it [21]. But what happens when the owner is clueless regarding his already missing pet? What if the owner finds that out when it is too late? What will happen to the pet? Will it still be found despite the hours passed, or will it remain missing? Of course, the owner cannot afford to let his pet remain missing.

To give light to this problem, pet owners should always assume the terrifying scenario to happen. How would the pet owners monitor their pets' safety and location while away because of work, school, or any errands?

The good thing is that, nowadays, anything can be possible with the help of the present technology. Things can be accomplished much more easily, including searching for lost pets. As mentioned above, going out and searching for missing pets is very efficient, and with the use of technology, searching will be made faster and easier.

Background of the study

The researchers decided to conduct the study using the Global Positioning System for Pet Trackers since pet trackers are extremely useful, especially for pet owners. Having the application placed on a pet owner's smartphone would allow them to quickly discover or locate their pet by just accessing the application, and the user would be able to track it since it is a real-time map that provides altitude measurements as well as distance calculations between two locations, and it is easily trackable. Therefore, the proposed study would assist pet owners in discovering and locating more efficiently, reducing the risk of losing a pet. The tracker contains many components that work together to show the pet owner, via application device techniques, when the pet is no longer with them. As a result, it quickly identify they pet's exact location, which can help increase security for pet safety. However, the pet tracker system is not new. Several studies and methods have been developed, but due to modernization and continuous evolution, such procedures should continue to be upgraded to perform correctly to their essential specifications and standards.

Objectives of the study

The general aim of the study is to scheme and develop an Arduino-based tracking device that tracks the pet's current location as well as develop a device that uses GPS to determine the geo-fenced position of the pet/s and assist the pet owner/s by easily tracking pets' location.

The study aims to achieve the following specific objectives:

- To design and build an application that can receive pet updates, operate the

application's buttons, and locate the pet.

- To develop a mobile application that contains a pet's registration feature that includes the pet's identification.
- To include a buzzer if the owner wants to track the pet that is still within the range of the geofence at home.
- To have an emergency alert that triggers if the pet exceeds the geofence's range.
- To notify the user via textual sounds, showing that the pet is already outside the geofence's range.
- To generate a unique QR code for each pet, which may be scanned and provides information about the specific pet's location
- To create a feature for setting the geofence range's minimum, maximum, latitude, and longitude coordinates.
- To test the initial system prototype and mobile application functionalities.
- To include additional recommendations into the system prototype and documentation.
- To develop a package for the Pawtify prototype, as well as to analyze the system and mobile application using ISO 25010 test case criteria.

Scope and limitation of the study

The scope of this study was to primarily focus on the development of a pet tracking application that can easily track lost pets and alert owners by notifying them via a mobile application. Pet owners can track the location of their dogs by installing and using the Android mobile application and registering their information. The pet owner would enter his or her pet's information through the smartphone and would automatically provide a unique QR code that would help track the pet. The application has 2 options in monitoring the pet: either click a button on the application that will locate it inside the range of the geofence at home, or click a button that will locate the pet outside the range of the geofence at work. The user must verify with certainty that the tracking device is attached to the pet. The study will not address human faults that interfere with the Pet Tracker device's functioning. This study excludes GPS devices

when data cannot be linked to a specific location owing to environmental considerations. Due to the size of module components, the tracking device's size and compactness will not be addressed. The health of the battery will not be addressed in this research. The mobile applications will only update the tracker's pin on the map if there is internet connectivity. In addition to the study's limitations, the map on the mobile application only shows latitude and longitude rather than the street due to a lack of resources. The mobile application can only be used on Android smartphones; it cannot be used on IOs devices since the researchers have made it open-source under the name Kodular.

Conceptual Framework

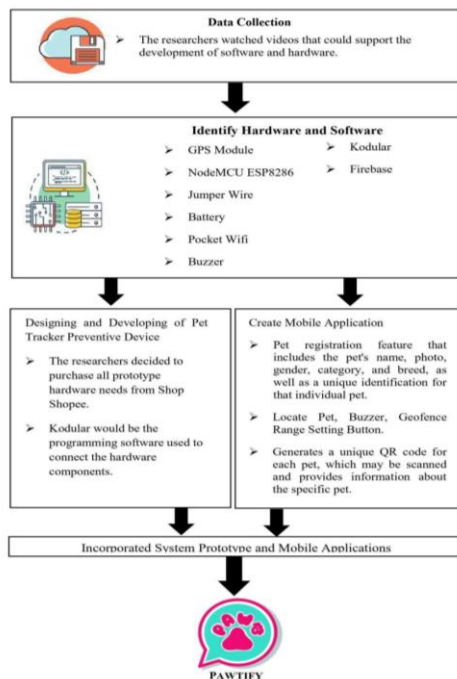


Figure 1 Conceptual Framework

Figure 1 describes the graphic idea of the study. The researchers read and collect data relevant to the study to organize ideas and serve as a starting point to plan the system prototype. The researchers purchased hardware components needed in the system, including Node MCU ESP8266, Neo6m0001 GPS, Battery, Buzzer, Pocket WIFI, and Jumper wire. The study also used Kodular in creating

and designing the mobile app. After acquiring the needed hardware and software for the study, the researchers began to put the devices together and program them to operate as one, including the mobile app. Lastly, after creating and testing the system prototype, the study will then produce the Pawtify.

SYSTEM DEVELOPMENT METHODOLOGY

The researchers used evolutionary prototyping as part of the SDLC prototyping methodology, or Software Development Life Cycle, a method for developing software with the most excellent quality at the lowest possible cost in the shortest period. An SDLC prototyping model is a systems development method. A prototype is built, tested, and then reworked until an acceptable outcome is obtained from which the entire system or product can be developed. It is also making preparations for the final system. In addition, it allows the researchers to have in-depth knowledge about the study and effectively enhance and develop the processes to finish the study. The prototype method phases include requirement analysis, quick design, prototype building, user evaluation, refining, implementing, and maintaining.

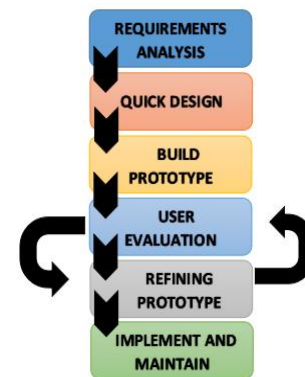


Figure 2 Prototyping Model

Requirement analysis

In analyzing the requirements, the researchers looked over the project's usability and performance for potential users and brainstormed on what the application should accomplish. The discussion was conducted through video chat via Messenger and focused on the overall strategy for completing the research. The researchers were divided into

four groups: one for the study's documentation, one for the hardware and prototype assembly, one for the application design, and two for the system prototype code. The study also considers that developing an application rather than a website will be far more appealing, easier to build, more accessible access, and more user-friendly. This part will also consider the device's usefulness in meeting the user's demands for information, notifications, and other features.

Quick design

In the quick design phase, the researchers decided to purchase all the prototype hardware needs (see figure 3.) from Shop Shopee because online shopping platforms give easy access and reduced pricing for large products. It was also agreed that the Kodular would be the programming software used to connect the hardware components. The researchers also decided on the device's design. The researcher agreed to set up a time to meet face-to-face to execute the application development better.

Build a prototype

The prototype phase is responsible for bringing the system design to life in the build. The researchers began by inspecting each hardware component to identify which were working and which were not. After that, the system prototype team began connecting all components, including the Node MCU ESP8266, Neo6m0001 GPS, Battery, Buzzer, Pocket WIFI, and Jumper wire. Additionally, the researcher started coding to build a precise set of steps for the IoT devices to communicate and operate as one. This phase should meet the objectives and scope of the study and progressively accomplish the aims of this research.

User evaluation

The user evaluation phase begins when the initial prototype development has been completed, and the researchers have undertaken an in-depth evaluation with the capstone adviser and capstone panelist. The extended requirements for the system prototype were thoroughly discussed to improve the device. The first device shown comprises a Node MCU WIFI ESP8266 module, a Neo6m0001 GPS, alert notifications, and a buzzer. It aimed to alert the pet owner by textual sound notification via the mobile

application. The researchers will also gather initial feedback on design, usability, and user experience from the adviser, panelists, and target consumers.

Refining Prototype

In the refining phase, the researchers studied what caused the errors in the device and code. Eventually, despite the team's difficulty resolving flaws due to the complicated parts of the system prototype, research is ongoing, and constant teamwork made the GPS pet tracker device a reality. In addition, the refining phase is where the prototype is to be kept and utilized to build the actual application. Refining will continue until the final system is built. If the prototype aims to solve a technical problem, it is refined until a solution or unsolvable issue is discovered.

Implement and maintain

Lastly, the product is offered to the intended audience in the implementation and maintenance phase. After verifying that everything functioned properly, the researchers presented the finished product, a GPS pet tracking device, to the capstone adviser and capstone panelist.

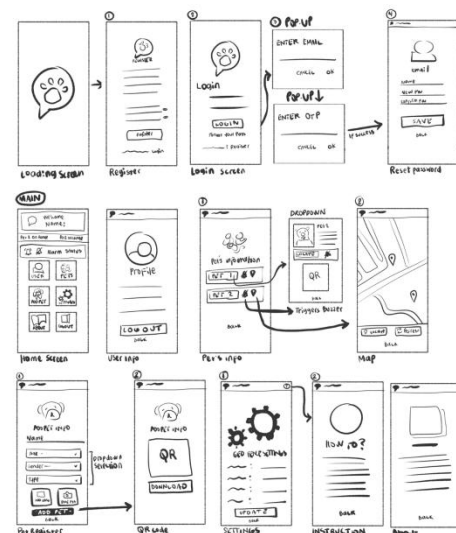


Figure 3. Story Board of Application

RESULTS AND OUTCOMES

Requirements

The researchers have accomplished the prototype requirements and the objectives of the study. The purpose of the Pawtify application and pet tracking device is to

acknowledge the awareness of one's pet's status using the Global Positioning System and Geofencing. The application features a pet registration that includes its identification. The system also has a buzzer if the pes cannot be found but is still within the range of the Geofence; otherwise, there will be a trigger where the application will notify the user by textual sounds. And lastly, to provide information of the owner once the pet goes missing, a QR code attached to the device is to be scanned by a mobile phone scanner.

System design

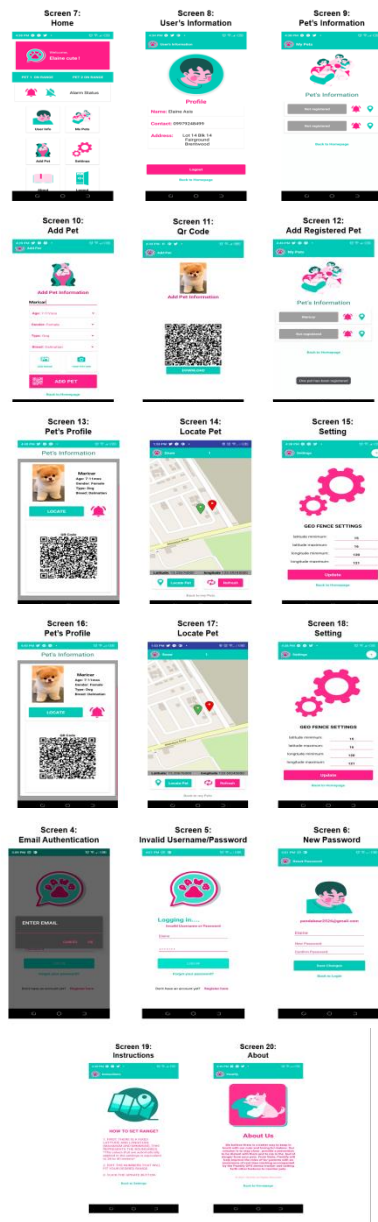


Figure 4. System design (Screenshots of Mobile Application)

Figure 5 shown above displays the first screen is prompted as a loading screen. Once the application is loaded, the Login screen will be prompted. The user will have another option if the user has not registered. On the Login screen, there is a "Register" button that will direct you to the third screen, which is the "Register" screen. The user is required to enter their name, contact number, address, username, and password. Once the user enters the correct user and password, the "Enter OTP" will appear on the screen, and the OTP will be sent to your email. The user must check their provided account on the application to log in successfully. Then there is a "forgot password" button. If the user forgets their password, it will prompt an "Enter email" where they must input an email address, click the "OK" but to their email. Once the user enters the OTP number and clicks "OK," it will proceed and display the screen for the "Reset Password," where the user may change the number, send the OTP new password and click "Save Changes."

Once the login or registration is done, the seventh screen will then be shown, the home screen. The Home screen includes the status of the pet/s and buttons such as "User's Info," "Pet," "Add Pet," "Settings," and "About."

The eighth creation is the user's profile screen, where the user's registered information is displayed.

The ninth screen is the Pet's Information screen, where the user can see the pets being added. The name of the pets will be prompted as buttons that will lead to their respective profiles, the ninth screen. The Pet's profile screen or the thirteenth screen will display the name, age, gender, breed, and category of the pet, so the 'Locate' button and the 'Bell' button will activate the buzzer of the collar.

Once the 'Locate' button is clicked, it will display the fourteenth screen, the Locate Pet screen. In the Locate Pet screen, the user can see the map location of the selected pet. Latitude and longitude are displayed below the real-time map. There are also buttons below, such as 'Locate Pet' and the 'Back' button.

The tenth screen is the "Adding Pet," where the user can input the name, age, gender, breed,

and category of the pet. Below those text boxes, there are four buttons: 'Choose Image', 'Take picture', 'Create QR code' and 'Back'. When the 'Choose Image' button is clicked, it will proceed to the phone's gallery and the user will be able to choose the desired profile image. When the 'Take picture' is clicked, it will proceed to the phone's camera.

The "Create QR code" button will take the user to the eleventh screen of the application, where they can generate the QR code and download the image that is to be attached to the pet's collar.

The fifteenth screen is where the settings take place. Here, the user can adjust the parameters or the desired range for each latitude minimum, latitude maximum, longitude minimum and longitude maximum. Below are the buttons: 'Back', "Update" and the question mark button.

When the question mark button is clicked, it will proceed to the tutorial for the users on how to set the Geo Fence settings.

Build a prototype and processes

The researchers designed a pet tracker device based on the panel's recommendation and objectives of the study. When the group's programmer completed the system's primary functionality, the other members performed a series of tests to ensure that the device's features worked consistently and efficiently. The system prototype development and testing are depicted in the diagram below.



Figure 5 Pawtify IoT Components

In figure 6 shown above displays the beginning of the study. It has the Node MCU ESP8266, Neo6m0001 GPS, Battery, Buzzer, Pocket WIFI, and Jumper wire. The GPS module connected to the Node MCU ESP8266 is connected to the power bank to provide a power source to the IoT components. Furthermore, the packet Wi-Fi serves as a link between the Node MCU ESP8266 and Firebase. The prototype system also includes a buzzer for auditory signals if

the owner wants to track the pet inside the Geo-fence.

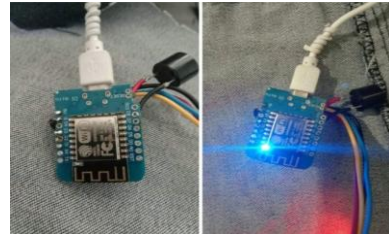


Figure 6 Testing of GPS Module

In figure 7 shown above presents the responsiveness of the GPS Module. A GPS module receives the longitude and latitude of the satellite. If the GPS module's LED indicator is not blinking, it implies it is looking for satellites; if it blinks every 1 second, it means the module has found satellites. The buzzer is included in the system. As a result, the researchers found out that the data received by the GPS Module depends on satellites.



Figure 7 Testing of NodeMCU ESP8266

In figure 8 shown above presents the responsiveness of NodeMCU ESP8266. A NodeMCU ESP8266 represents a bridge between the mobile application and the pet tracker device. As a result, the researchers found out that the NodeMCU ESP8266 can connect to the device and send notifications to the pet owners via the mobile application.



Figure 8 Testing of Buzzer

Figure 9 shows the buzzer testing and how the buzzer responds when the buzzer button in the application is activated. If the user does not turn off the buzzer, it will switch off after 5 seconds because the buzzer is only activated for 5 seconds after being clicked.

Evaluation with users

To elaborate on the details of the system, a video presentation and a live demonstration of the prototype were provided by the researchers. The features and functions of the system prototype are evaluated and discussed, including how well it responds when it comes to communication between the device and application, other functionalities, and the attributes that the system is lacking. The recommendations were discussed between the researchers, the capstone adviser, and the panelists for the systems to improve. Toward the end of the presentation, deliberation was conducted between the panelists and the adviser. The study was accepted with major revisions of both the system and the documentation. Lastly, for the improvement of the system, the panelists recommended modifications on the document (e.g. location diagram, scope, format, citations, objective, and methodology), a more compact design of the prototype, full simulation of the prototype, and test case of the prototype for at least ten (10) trials.

Refine prototype



Figure 9 Pawtify's Refined Prototype

The study's final prototype is shown in the diagram above. The study's IoT component is in charge of tracking the pet. The dog's collar belt contains the Packet Wi-Fi, GPS Module, NodeMCU, buzzer, and power supply. The researchers completely modified the device to match the panel's requirements and put it through a series of tests to ensure it worked correctly.

Feedback

The researchers were able to edit the document using Grammarly, the software that can identify wrong grammar and misspellings. The researchers successfully modified the document and system prototype again, using the capstone panelist recommendations as a guide towards the completion of the study.

Final product and test cases



Figure 10 Installation of Final Product

The figure 11 shows above illustrate the installation of the pet tracker on the neck of the pet. When the user clicks the "Locate Pet" button on the mobile application, it will proceed to locate the pet in real-time. The image on the right shows that the researchers included the "Locate User" button on the screen to show the owner's current location, the distance between the pet and the owner, and to refresh the user's location for accuracy.

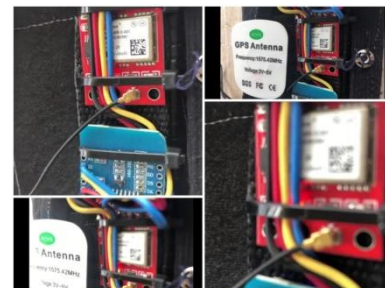


Figure 11 Test Case of GPS

Figure 12 illustrates GPS module testing and how the GPS responds when the user clicks the applications find pet button. The red pin represents the pet's position, while the green pin represents the user's location.

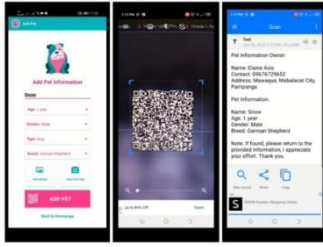


Figure 12 Demonstration of QR Code

Figure 13 demonstrates QR Code testing and how the QR code information will display after the Scanner scans the QR Code, showing that when you scan a QR code with your smartphone scanner, the information about the pet owner will appear.

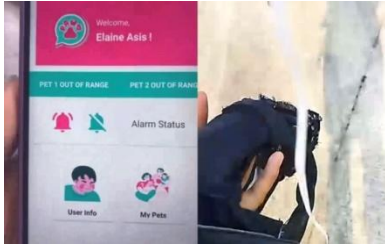


Figure 13 Illustration of Geofence Range in Application

Figure 14 illustrates Geofence range testing and how the Mobile application indicates if the pet is in or out of range. The mobile application will show and hear the textual sound if the pet is in range or out of coverage in the video.



Figure 14 Testing of buzzer

Functionality Test Cases Results of Pawtify Prototype

Test Cases Results Prototype

Table 1. Functionality Test Cases Results of Pawtify Prototype
No. of trials for each prototype testing = 10
Category/Characteristics = Functional Suitability

HARDWARE	YES	NO
Is the GPS working?	10	0
Is the Nodemcu8266 module working?	10	0
Is the Pocket Wi-Fi Working?	10	0
Is the Battery working?	10	0
Is the Buzzer working?	10	0

Table 1 represents the test cases shown in "Appendix L" for each functionality of the system prototype. Note that each IoT component is tested ten times to ensure that it's working accordingly. The researchers discovered that the GPS module needs to go outside or wait to collect data and is dependent on the satellite while completing the test cases. Finally, the researchers devised the concept of using an antenna to obtain data from satellites more quickly. Modules can be activated after electricity is supplied, and manual operation can be performed by pressing buttons on the mobile application. It's worth noting that the researchers only evaluated the functionality of two modules: the NodeMCU8266 and the GPS Module. The researchers discovered that the power supply was providing sufficient power to the modules. After completing all of the required test cases, it was determined that the system prototype met all of the study's recommendations and objectives.

Test Cases Results from Mobile Application User Interface

Table 2. Functionality Test Cases Results for Mobile Application User Interface
No. of trials for each prototype testing = 10
Category/Characteristics = Functional Suitability

APPLICATION	YES	NO
Is the "Register", "Login" "Forgot Password", "Logout" buttons functional?	10	0
Is the "User Info", "Pet's Information", "Add pets", and "Locate" buttons	10	0

working?		
Does the mobile application can enter and display the User and Pet's information to mobile application?	10	0
Is the real-time map functional?	10	0
Is the "locate pet" and "Refresh" buttons and their pins able to operate?	10	0
Is the buzzer button working?	10	0
Is the choose image and take picture buttons working?	10	0
Can a mobile app generate a QR code?	10	0
Can the settings button on the mobile app be used to adjust the geofence's maximum and minimum values?	10	0

Table 2 displays the test cases shown in "Appendix M" and used to validate the mobile application's functionality. For each test scenario, ten trials are performed to confirm that the mobile application responds in accordance with its corresponding features. When you enter the location of a pet, the program will display the correct real-time map position of the pet. Once the pet is outside of the geofence, the textual sound notification will be enabled, and it will continue to show the pet is out of range until the user sees it. Furthermore, the buzzer button functions efficiently. When the user presses the bell button, it activates the buzzer, and it will buzz the pet's collar, but if it is turned off, the buzzer will not stimulate. The setting of the geofence range was also achieved. It was tested ten times to ensure that it worked properly. To conclude, the researchers guarantee that the program functions well despite its simplicity and ease of use. Eventually, the researchers were able to validate the usefulness and capabilities of the mobile application by running consistent test cases.

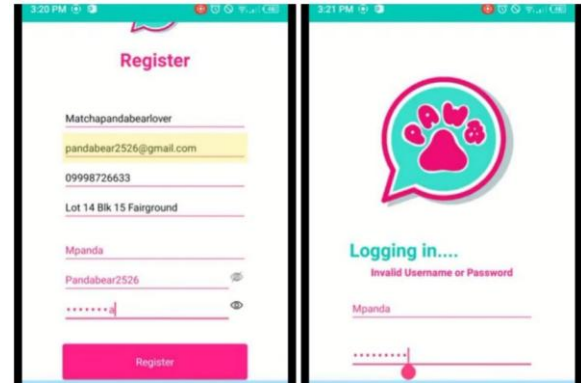


Figure 16 Register and Login

Table 3. Usability Test Cases Results of Pawtify Category/Characteristics = Usability

System Feature	YES	NO
Can you fill the credentials?		
Is the register and login button working?		
Are the buttons working when you command them?		
Is the add pet button working?		
Can you locate pet?		
Is the mobile application display user and pet's information?		
Is the real time map location working?		
Is the choose image and take pictures button working?		
Is the buzzer button working?		
Can a mobile app generate a QR code?		

Table 3, shown in "Appendix N," contains the test cases for the system prototype's usability. The researchers verified Pawtify mobile application is user-friendly and easy to use and that the user is not constantly confused. Aside from being simple to use, the program was also created with the user in mind. The group's mobile application developer added images, an appealing color palette, legible context, and minimalist buttons to make it simple and easy to use. Even though the program is basic and

easy to use, the researchers ensure it runs well.

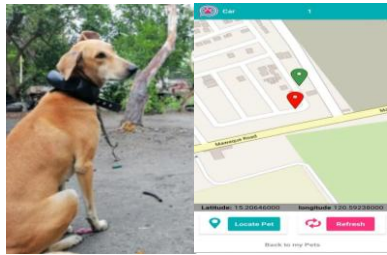


Figure 17 Pet Tracking

Table 4. Reliability Test Cases Results of Pawtify Category/Characteristics = Reliability

EXPECTED RESULTS	YES	NO
The mobile application should provide the exact position of a specific pet on a map in real time.		
The mobile application should display the textual sound when the pet is out of range of the Geo-fence set in the settings.		
The mobile application buzzer button should give the owner with an alternate feature of recognizing the pet within the geo-fence by hearing the buzzer's sound.		

The system's reliability is shown in table 4. It's important to note that the researchers ran a total of seventeen scenarios to ensure that the system was functioning correctly. The researchers ran a total of 17 test cases to ensure that the system was working correctly. During the test cases, the mobile application will display the exact location of a specific pet on a map in real-time. The mobile application will also play the textual sound when the pet is outside of the geo-fence set in the settings. Additionally, the buzzer button on the mobile app offers the owner an added feature of recognizing the pet inside the geofence by

hearing the buzzer sound. Lastly, the researchers guarantee that the application works properly despite its simplicity and ease of use.

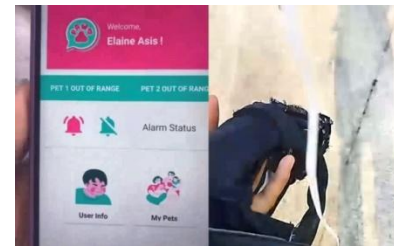


Figure 18 Textual sound

DISCUSSIONS

This section covers the summary of findings based on the objectives and chapter 4 and the conclusion and recommendations based on PAWTIFY: Global Positioning System Tracker for Pet Safety's findings.

Summary of Findings

To achieve the prototype pet tracking device and mobile application, the researchers used the SDLC prototyping model phases to create the prototype Pawtify, and mobile application integrated output product. Specific objectives were developed based on the functionalities and design elements. Experimental trials were performed to check the mobile application's functionality and the pet tracking device. The researchers ran test cases to measure and test the state of the mobile application and the prototype to confirm the intended outcome. The panelist recommended adding account validation and forgetting the password, and strengthening the security of the mobile application, which was accomplished by creating a new application on a different platform. Furthermore, the researchers devised a method for evaluating the prototype and mobile application in different locations. One of the researchers tested the prototype's functionality, which included registration, logging in as a user and forgetting their password via email and OTP authentication, adding pets and generating QR codes, setting a geofence range, sounding a buzzer, and transmitting data location to the mobile application. The other research members tested the mobile application by sending and receiving answers from the linked prototype and

evaluating all of the prototype's components. Finally, the pet tracking gadget is functional without any issues.

Conclusion

The researcher conducted test cases to put the system prototype and mobile application's functionality to the test. According to the results of the test cases, both the application and the prototype are functional. Additionally, ten trials are carried out, five test cases for Hardware and ten trials, while seventeen test cases and ten trials each of the system functionality.

The researchers were able to determine the needs for developing a pet tracker device. The acquired related literature and studies were utilized to expand the researchers' understanding in order to assist build the Pawtify system.

The researchers were able to design a working mobile application with the use of Kodular. It informs the user by textual sound or auditory signals whenever the pet is within or outside the Geo-fence range. It also allows the user to quickly locate the pet using the application's locate buttons.

The researchers were able to develop the study's basic prototype. The system's essential features, such as a textual sound signal, a buzzer, a QR code, Geo-fence range setting, and a real-time tracking map, have been completed.

The researchers were able to run a series of tests to determine that the initial system prototype was functional. According to the findings, all IOT components put into the system prototype operated well.

The researchers were able to re-align the system with the recommendations of the capstone panelists. The position of the GPS tracker was also included in the system prototype. When a pet owner cannot see their pet, they may easily monitor it by pressing the "Locate My Pet" button, and there are two pins for the user and pet to check how far the distance between them and their pet is.

The researchers put the whole Pawtify system package in the pet's collar belt. It enables the capstone panelists to view the system in a real-world setting.

Recommendations

The following are the recommendations to improve the developed Pawtify device prototype:

- Improve GPS devices in cases where data cannot be linked to a specific location due to environmental factors.
- Upgrade the battery with a higher mAh or capacity to ensure longer battery life.
- Enhance the size and the compactness of the tracking device.
- Change the latitude and longitude measurements in the map's streets.

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Perya 3D – 3D Carnival Game

Allen Bacho
Renz Regala
Paolo Pomarca
Tristan John Derrick Brewer
Niel Gregorio
Ronaldyn T. Domingo, MSIT (Technical Adviser)

ABSTRACT

The Peryahan is a fun spot to visit at night because it is set up in an open field with a variety of games to play. Perya is a part of Philippine culture, however, there are only a few places that operate Perya, which has gotten even worse due to the pandemic. In order to help the preservation of Perya, the researchers of this study came up with the concept of creating a 3D game called 3D Perya. The researchers made use of 3D technology to develop the Perya 3D so people who love Perya can now play it on their phones without going to Perya. The researchers used the Rapid Application Development (RAD) Model to create the 3D games since it is adaptable to modifications and accepts input. The researchers conducted a Functional test, a Compatibility test, and a Performance test to find if the game application is working properly, and an alpha test and beta test survey were conducted to get feedback from the users. The game application did not show any problems based on the findings in the three tests, but after the alpha test survey, the respondents reported several bugs in the game; after some adjustments, the researchers moved on to the beta test survey, where only a few people experienced a bug and reported it. The developer fixed all of the mentioned bugs.

INTRODUCTION

The word "Perya" refers to the particular place that carnivals hold in Philippine culture and society. Even with the introduction of modern media, the Perya, or fair, has remained a source of amusement as well as a shared expression of Filipino values, hopes, and even art [1]. The Perya is a popular attraction at town fiestas, attracting both children and adults. The excitement is intense, comparable to that of a foreign music act performing in Manila. The Perya is usually set up on an open field in the town center or next to the square if the plaza is large enough. It is a midnight business, a daytime wasteland of painted plywood and steel. Some tables are covered in a colorful mosaic, while others take on the appearance of a spread-out deck of cards. A table tennis ball tossed into a steel funnel determines the fate of a five-peso coin on these tables. A simple bet can double or triple in value, but a bet on the Joker can increase in value by up to fifteen times. That, or the arbiter sweeps it as part of the war spoils for the lucky, rowdy bastard pumping one fist in the air while clutching a bottle of Pale Pilsen in his other hand. For twenty pesos a cartridge, a pellet gun may be used to shoot plastic action figures at

arcade booths. One G.I. Joe down gets you a candy bar; ten gets you a tiny pack of Ding-Dongs, and twenty gets you a gigantic Chippy and a pair of fruity lollipops. It is not just about hand-eye coordination; the mild evening breeze can also be dangerous for aspiring marksmen [2].

Three-dimensional (3D) technologies have changed computer games to the point where 3D graphics are now used in almost every new game, according to Dalgarno, Barney in his study [3]. While there is no doubt that 3D games on mobile devices will become more popular, the resource limits of the devices themselves, as well as the highly changeable nature of the environment, provide significant hurdles for game producers. In this paper, the present limits are identified, as well as current and likely future developments in both the software and hardware of mobile phones that will allow for the development of more sophisticated games. A benchmark was done to some of the most popular and recent software and devices as part of this process to determine both the quality of the visuals produced and the implications on battery life. While 3D games will play an essential role in the success of future mobile services, the current

development baseline is highly variable, posing challenges for game developers in both development and wide-scale distribution [4]. Cell phones are famous in our general public, and the pattern of more individuals playing 3D games on cell phones is increasingly more obvious. This paper examined the scene optimization issues of cell phones dependent on the solidarity 3D, and depicted a few abilities of portable enhancement, and closed significant issues during the handling of improvement [5].

In this study, Perya games were adapted into mobile 3D games for a new level of experience, with additional features not seen in other Perya games, so that individuals who used to like playing Perya but no longer can due to various reasons, can now play Perya with accessibility and comfort using their phones.

Background of the study

Over the years, gaming development has had a huge impact on the technology world and is continuously evolving on technological aspects and one of them is 3D technologies. 3D technologies in games look forward to improving the design concept, designs of the mainframe, and even the characters. Designing such a game is much like designing an algorithm - it must be proven correct; its efficiency can be analyzed.

Many people have lost loved ones, jobs, and other things due to pandemic in recent years. Peryahan is one of the most popular ways for people to pass the time by playing games on the Perya, however, due to the epidemic, the city's Peryahan has disappeared. As a result, many people long for the Perya, where they can be pleased.

The researchers of this study have come to the idea of developing 3D games that resemble or simulate the different games that people play in Perya. The researchers aim to develop a 3D Perya game application for everyone, this application consists of Philippines cultural games that can be played only on Perya. 3D Perya is a hyper-casual game with a basic UI, a short play duration, a satisfying game, and it's simple to play. The Perya 3D game will let you experience the enjoyment of playing the traditional games on Perya like basketball, drop ball, and many more. This 3D Perya game could be the best representation of Philippine

culture in terms of traditional entertainment. This app can only be played on Android devices running the Kit-Kat version or higher.

General objective

This study aims to design and develop a game application named "Perya 3d- 3D Carnival game" that will adapt the games found in Perya into a mobile game.

Specific objectives:

- To obtain information by conducting online research, literature, and interviews.
- To identify the necessary hardware and software that are required to develop the game application.
- To design the game application:
 - Storyboard
 - 3D modeling of characters and objects.
- The researchers aim to create a Perya game application that consists of features.
 - 3D;
 - Perya Park;
 - Single Player.
 - Multiplayer.
- To develop eight Perya Games for android smartphones.
 - Basketball
 - Bucket ball
 - Ring toss
 - Balloon shooting
 - Balloon dart
 - Beto-beto.
 - Color game
 - Drop ball
- To test the game using the following criteria:
 - Compatibility test
 - Performance test
 - Functional test

Scope and delimitation

This study aims to develop 3D Perya games, allowing them to play eight different Perya games in an app without having to visit an amusement park or funfair, and it may be played single player or multiplayer. Single-player mode is designed for only one player while the multiplayer mode can allow two or more players to enjoy the entire game. The data gathered in this study are through an internet search and an interview. To ensure that the

game is functioning properly, the researcher conducted three tests and, if necessary, fixed any bugs or errors.

This research is limited to what the game engine can do with its current technology. Eight games on the Perya 3D available in single-player mode and three of the eight single-player games are multiplayer games. The app is compatible with Android smartphones running version 4.4 (Kit Kat) or higher.

To play the multiplayer mode on the Perya 3D game, the user must create a lobby or join an existing lobby on the multiplayer mode. The player who created the lobby will be the host of all multiplayer games on the Perya. Beto-beto is a game which can be a multiplayer and single-player game where the players place their bet on their desired number and the host player rolls the dice to determine the winner, the player's bet can be double or triple the amount depending on the result on the dice rolled. Color game is also a multiplayer and single-player game where the player places their bet on the color board, and the host player pulls the rope to determine the winner of the game. Bets of the player can be double or triple depending on the results of the game. Last game that can be played on single and multiplayer mode is the Drop ball, where the players can place their bet on the color board, the host player drop the ball on the table with a net on top of it, when the ball drop and stop on one of the colors on the table will be the winner.

Single-player mode where the player enjoys all the eight games on the Perya 3D alone and this is the single-player game; Basketball game is played by shooting the ball on the basketball court to gain coins. The player can shoot 5 basketball balls per game. Bucket ball is a game where the player needs to shoot the ball on the bucket to gain coins. For each game, players can shoot 5 balls in the Bucket ball. . Balloon shooting is played by shooting the balloons on the wall, every balloon has a specific amount of coins when popped depending on the color of it. The player has 15 ammo to shoot and 60 seconds time limit to play the game. Balloon Dart is a game where the player needs to pop balloons on a giant dart board using darts. Balloon has a specific amount of coins when it pops. The player of the

game has 5 darts only and a 60 seconds time limit. Ring toss game is played by tossing 5 rings on the bottles to gain coins.

The Perya 3D also has a store where the players can buy a collection of stuffed toys using their coins.

SYSTEM DEVELOPMENT METHODOLOGY

This section is all about the system development procedure, this procedure is all about the game-defining, creating, testing, and implementing a new software application or program.

In developing the 3D Perya the researchers used 2 different software, first is the blender for creating 3D models, objects and animations. Blender is free and open-source; it is a software toolset for making 3D models, visual effects, computer games, animations, etc. The researchers used the Unity 3D software for programming and building the game. Unity 3D is software used to create games such as 3D and 2D and it can also import models from the blender. The hardware used for the development is a Personal Computer (PC) and an android phone for testing.

In developing the 3D game, the researchers made use of the RAD Model. RAD methodology is designed to be flexible to changes and to accept new inputs, like features and functions, at every step of the development process. This will enable the rapid construction of a functional website prototype. It eliminates the standard software development life cycle's feasibility and analysis phases (SDLC). During the design and development of the prototype, the requirements are analyzed.

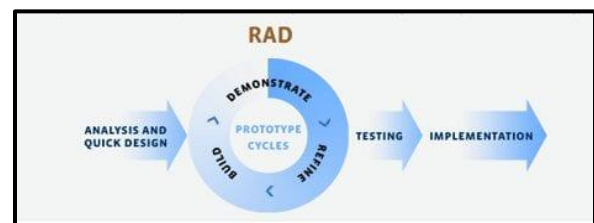


Figure 6: RAD Model

Analysis and Quick Design

In the Analysis and Quick Design, the researchers gather the information through internet research for knowledge requirements. In this phase, the objectives, scope, problem of study, and other requirements were identified.

The researchers decided to use the blender and Unity as game engines to develop the 3D Perya. The game flow, storyboard, and eight games refer to goals number five(5) included and other document purposes in the Perya 3D are already set and ready for the next phase.

Build, Demonstrate, Refine

At this stage, the researchers start to develop the project, creating the 3d model and writing the codes based on the gathered information. In this phase the knowledge and understanding of the researchers will be applied. The development method starts with the construction of 3D objects, characters, maps, and so on with the blender program, which is then transferred to unity as the game engine. The phase of refining, the proposed system would be redesigned and developed to improve the app. These cycles had undergone numerous revisions in order to improve the application.

Testing

In testing, the researchers will test the app if the requirements are met and it is functioning properly, the developer regularly tests the application in order to find and fix any error or bug to improve the game. During this phase, the researchers used Meega+ to conduct a survey, with 20 beta-test participants being mobile game target users and four Alpha-test participants being IT professionals or related.

RESULTS AND OUTCOMES

In this section, the results and discussion anchored on the objectives and procedures would be present in form of screenshots, tables, and texts.

Designing the game

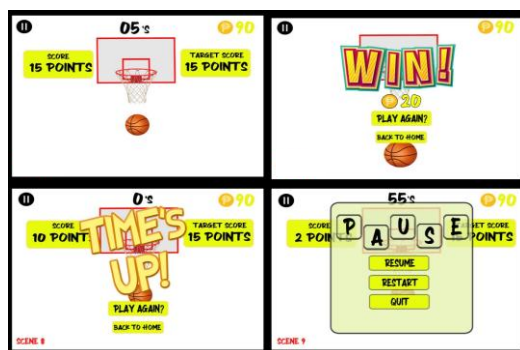


Figure 7: StoryBoard

The figure above shows the basketball storyboard that the researchers made. In designing the game, researchers created a storyboard for every game they want to build. This story board helped the researchers in developing the Perya 3D as a guide for every scene they want to achieve.



Figure 8: 3D Characters



Figure 9: 3D Objects

Creating 3D models is the primary step in developing a game. The figures show the 3D characters and objects made by the researchers using the blender software. The main characters in the game are male and female characters. The created 3D objects for the Perya Park scenery are similar to the real-life Perya scenery which makes every element in the game more realistic.

Screenshot of 3D Perya App



Figure 10: Main menu

Users can either load their previous progress or start a new game and select their gender from the main menu.



Figure 11: Quick Guide

The figure above is the Quick guide before the user could start playing the game a guide will display the tutorial about the interface in the game to make it easier for the new player.



Figure 12: Perya Park

The Perya park is represented in the figure above, the user can walk around and explore the Peryahan in 3D mode, just as they would, in reality, move from tent to tent to play different games and enjoy the Peryahan scenery. The map is displayed near the entrance so that new users can quickly locate the game they choose.



Figure 13: Game Shop

The shop in Perya 3D is shown above where the user can purchase items from the shop with coins and add them to their collection.



Figure 14: Bucket Ball Game

Bucket ball is shown above in which the user must have at least ten coins in order to start playing. The player had just five balls to shoot in the bucket and may earn three coins for each successful shot. This game is only available in single-player.



Figure 15: Basketball Game

The Basketball Game shown above in which the user must have at least ten coins to start playing. The user only had five balls to shoot in the ring, and each successful ball shoot earned three coins. This game is only available in single-player.



Figure 16: Balloon Dart Game

The Dart Balloon Game shown above requires at least ten coins for the user to start playing the game. The user had just five darts to throw in the balloons, and the number of coins earned was determined by the color of each

balloon. This game is only available in single-player.



Figure 17: Balloon Shooting Game

Balloon shooting is shown above, must have at least twenty coins before playing the game. The user only had fifteen bullets to shoot at the balloons, and each balloon successfully popped earned the user two coins. This game is only available in single-player.



Figure 18: Ring Toss Game

Ring toss is shown above in which the user must have at least ten coins to start the game. The user only has five rings to toss at the bottle, and for each ring successfully tossed into the bottle, the user gets five coins. This game is only available in single-player.



Figure 19: Creating multiplayer Lobby

Creating the multiplayer is shown above where a player can create a lobby on the multiplayer

mode of the game where other player can join and enjoy the multiplayer game.



Figure 20: Beto-Beto Game

Beto-Beto is shown above in which users can bet any amount and earn the amount of bet in each dice, which can be single, double, or triple the price. After placing the wager, the user can roll the dice to check if someone has won the wager. This game is available in single-player and multiplayer modes.



Figure 21: Color Game

Color Game is shown above where the player of the game can bet on any color they want to bet to, the player of the game can double or triple the price. This game is available in single-player and multiplayer modes.



Figure 22: Drop Ball Game

The figure above shows the Drop ball game available as a single and multiplayer game. Players on the drop ball can bet on any color

and any amount the players want; the bet of the player can be doubled. The game will drop a ball on a net and the will land on the color, where the ball landed determines the winner.

Functional test

Table 1. Android phone functionality test

Vivo 1906-Android 11 version		
Number of Trial = 3	YES	NO
Buttons are functional	✓	
Audio is functional	✓	
Animations are functional	✓	
Font size is readable	✓	
Right sequence of scene	✓	
OPPO F5-Android 7 version-Nougat		
Number of Trial = 3	YES	NO
Buttons are functional	✓	
Audio is functional	✓	
Animations are functional	✓	
Font size is readable	✓	
Right sequence of scene	✓	
Vivo 1606-Android 6.0 version- Marshmallow		
Number of Trial = 3	YES	NO
Buttons are functional	✓	
Audio is functional	✓	
Animations are functional	✓	
Font size is readable	✓	
Right sequence of scene	✓	

This phase examines the game's general installation issue. To test the game's operation, researchers installed it on three different types of Android phones. Researchers test the functionality listed in the table above.

Every button's functionality is excellent and functional when pressed. When playing the game, the animation is present, the audio is clear, the game instructions are clear, and the font size is readable by the user. The researchers have had no issues with the Perya 3D game's functionality while playing it.

Compatibility test

Table 2. Android phone compatibility test

Vivo 1906-Android 11 version		
Number of Trial = 3	YES	NO
Does the game lag upon launching?		✓

Does the game fit in the screen size of the phone?	✓	
Quality of the graphics is good?	✓	
Does the phone get hot and stop while playing the game?		✓
Oppo F5-Android 7 version-Nougat		
Number of Trial = 3	YES	NO
Does the game lag upon launching?		✓
Does the game fit in the screen size of the phone?	✓	
Quality of the graphics is good?	✓	
Does the phone get hot and stop while playing the game?		✓
Vivo 1606-Android 6.0 version- Marshmallow		
Number of Trial = 3	YES	NO
Does the game lag upon launching?	✓	
Does the game fit in the screen size of the phone?	✓	
Quality of the graphics is good?	✓	
Does the phone get hot and stop while playing the game?		✓

The table above shows the game's compatibility with various types of Android phones, which can have an impact on Perya 3D's success. The researchers placed three different types of phones through their tests with various Android versions.

The game's performance on higher versions of Android phones, such as Android 11, provides the best experience when playing Perya 3D without experiencing lag or controller issues. While lower versions of Android devices may encounter some lag when playing the game, the game can still be played.

The researchers evaluated the visual as well. The game fits on three different screen sizes, with no color changes and the same graphics quality across the 3 Android phones.

On the Android phone, the impact of the Perya 3D game phone is unaffected when playing the game; it does not become hot and it does not suddenly stop working.

Performance test

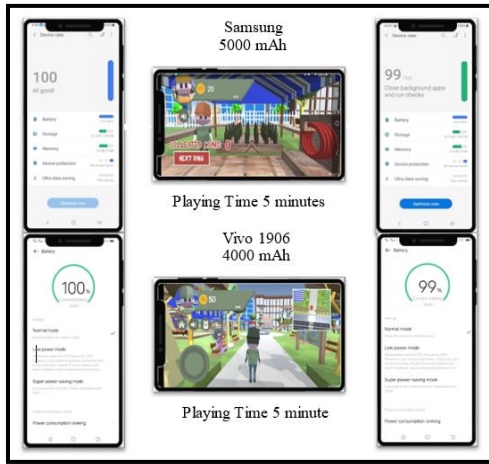


Figure 23: Performance of Perya 3D on battery life of phone.

The figure shows the Perya 3D game's performance on two different types of Android phones. The Perya 3D game was played for five minutes straight to evaluate the game's battery consumption on various Android phones with similar battery life but different battery capacities.

Researchers discovered that the phone has battery capacity of 5000mAh, and that when playing the Perya 3D game for five minutes, the battery life drops 100% to 99%. While the other phone, which has a 4000mAh battery and has a 100 % battery life, loses 1% of its battery life during the same five minutes game time. According to the data, while playing the Perya 3D, it doesn't consume a large amount of battery life.

Survey Questionnaire Results in Alpha Test

The game is tested by four I.T professionals to determine the bugs and issues of the Perya 3D before launching on Beta test.

Table 3. Results of Perya 3D Alpha Test Cases

Application	YES	NO
Is the new game's button functional??	4	0
Is the exit button functional?	3	1
Is character selection working?	4	0
Is the music mute button functional?	4	0
Does the single-player mode work?	4	0
	2	2

Is the load game functional?	4	0
Can you create and join a lobby on multiplayer?	2	2
Does the character move when the controller is moved?	3	1
Can you play all the games?	3	1
Does the game deduct the coin upon playing a game?	2	2
In every 60 seconds, you get 10 additional coins?	4	0
Does the game stop add coins when the coin balance reaches 100?	2	2
Coins are added to your current coin balance when you win them?		
Is the audio clear?		
Is the map useful?		

After the researchers have tested the Perya 3D for functionality, compatibility, and performance on various Android phones, it will be ready for alpha testing by IT professionals.

The table above illustrates the responses of the four information technology professionals who tested the game in order to identify the game's significant flaws and bugs. Respondents are given a set of evaluation questions to use as a guide for what they should test.

According to the alpha testers, the new game button, as well as the load game button, are working well, but the exit button has minor issues when pressed. The Perya 3D background music is clear, and the buttons that allow the user to mute and unmute the game's background music is functional. According to the beta test, selecting boy and girl characters is not a problem. Single-player is functional, but alpha testers are having difficulty creating and joining multiplayer lobbies. The controllers that control the characters run perfectly, but the other game in Perya 3D wasn't playable during alpha testing, according to the respondents. The main issue with the alpha test is the game's coin; the game does not deduct the coin when the player wants to play the game, and it does not add the winning coin to the current balance when the game is won. The coin counter does not add ten coins every sixty seconds and continues to add even when the coin value is 100, which is not

the developer's code. According to the respondents, the map is useless.

The game's alpha test provides the developers of what they need to fix and add to the game. The developers are now ready for Perya 3D Beta testing to finalize the game features and gameplay after evaluating and addressing all the flaws and issues found during the Alpha test.

Survey Questionnaire Results in Beta Test

This phase researcher selects twenty random respondents to test the games on Perya 3D and evaluate the games functionality, performance and quality.

Table 4. Results of Perya 3D Beta Test Cases

RANGE	SA 5	A 4	N 3	D 2	SD 1	AVERAGE	INTERPRETATION
The instruction in the game is clear??	19	1				4.95	S A
The buttons are working?	19	1				4.95	S A
Do you like the Perya park?	19	1				4.95	S A
Is the 3D quality of the game is good?	16	4				4.8	S A
Gameplay is good?	14	6				4.7	S A
The game is enjoyable	17	3				4.85	S A
The User Interface is user-friendly.	18	2				4.9	S A
The graphics are high quality.	13	7				4.65	S A
The game is easy to learn.	14	6				4.7	S A
The gameplay has no lag.	3	15	2			3.9	A
In multiplayer mode, it's capable of connecting with others.	16	3	1			4.75	S A
The controller is easy to use.	10	10				4.5	S A
The game experience is similar to reality.	20					5	S A
Is it possible to play the game without any instructions?	17	3				4.85	S A
Would you recommend the games to others?	16	3	1			4.75	S A

The beta test questions and the number of responses is listed in the table above. This step

will inform the developers of any potential flaws or issues that may arise while playing the game. It's a closed beta test, which means the researchers only pick twenty people at random to test the game. On the first question, which is whether the game instructions are clear for the player, the majority of respondents strongly agree that the game instructions are clear. The respondent's rate all of the buttons, and the average result is "strongly agree," which indicates that all of the game's buttons are working properly and without any issues. And in this step, the respondents rate the game's gameplay and whether it is fun; the average response to the evaluation is "strongly agree". The Perya Park that was created by the developers has an average strongly agreed rate with the respondents. The game has high-quality graphics and a user interface that is friendly when playing the game, which the respondents strongly agree with. The latency of Perya 3D is also evaluated by the respondents and the response rate is agreed, which means the respondents experience a little bit of lag while playing the game. The game is easy to learn and can be played without looking at the instructions, according to the respondents, and the characters and game controller are easy to use. The multiplayer connectivity is also better than in the alpha phase. The researcher's aim is to develop a Perya game similar to the reality and the response of the respondents. The game is strongly similar to the reality of Perya. The Perya 3D is recommended by the respondents to play with others to experience the fun and enjoyment of playing on the Perya.

DISCUSSIONS

This section summarizes the research work done, the conclusions reached, and the recommendations made as a result of the research. This study aims to develop a 3D Peryahan for smartphones for Filipino to experience Peryahan.

The conclusions were derived from the following test cases: Beta/Alpha test evaluation using the MEEGA+ method. The alpha test

respondents had at least some IT knowledge, whereas the beta test respondents were the mobile game's target clients.

Summary of Findings

According to the screenshot in chapter four, the eight Perya games that refer to the study's objectives were successfully developed, and the researchers met their goal of developing a Perya concept mobile game. The result also shows that other mobile game content, such as Perya Park, single and multiplayer mode, was included, which is part of the objectives and interpreted as accomplished by the researchers.

The researchers conducted the following test cases to ensure that the mobile game is functioning properly: functional test, compatibility test, and performance test. The outcome is based on the three different phones that were used in the test; in the functional test, all three phones indicate that the buttons, audio, animations, text size, and the scene sequences in the game are all working properly, and the test was evaluated as passed by the researchers. The compatibility test is performed to determine if the game can be played on various phone models without issue. The result from the three phones was also considered passed by the researchers. During a performance test, the phone's performance was assessed while the game was running. The researchers interpreted that the overall result of this study passed all the required tests because the phones used in the test had no problems running the app.

To receive feedback from the users, the researchers conduct a survey to four respondents in the alpha-test and twenty respondents in the beta-test. The respondent had experienced problems in creating and entering multiplayer lobbies during the alpha-test, the other bugs were related to coins, and the rest were regarded to be working properly. The alpha-test outcome is considered positive, but there is still work to be done to improve the game. The majority of respondents in the beta test gave positive feedback on the game, and

the researchers considered the beta test a success.

Conclusion

The researchers have developed a simulating Perya park on mobile phones that can be played by everyone; it consists of 3D features on the objects and gameplay. The Perya 3D application may be installed and played by anyone with an Android phone. It has no lag and uses very little battery power. Researchers used test cases to test the game's overall functionality and features. While playing Perya 3D in the early phase, there were some difficulties. The researchers worked out all of the flaws and built a game that was ready for the game's beta phase. The Perya 3D game worked properly during the beta phase, as evidenced by the results.

Overall, the developers of the game were able to achieve the following:

- Design and build the 3D Perya park scenery that consists of 3D objects and characters.
- Develop a proper character controller that is working properly and buttons in every game, also the game background music is working.
- Met all the mechanics per game on Perya 3D and also the prizes that can get from playing the game.

Recommendation

Based on the limitation of the study the research suggested the following recommendation:

- Enhance the graphics quality of the 3D objects and characters.
- Add more multiplayer Perya games.
- Make the Perya Park larger for the additional games.
- Add rides found in Perya to improve the scenery.

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PHILIPPINE DEFENDER 3D: Third Person Tower Defense Game Using Unreal Game Engine

John Michael Q. Colle
Eduard G. Liwanag
John Dave E. Liwanag
Jayson T. Pangilinan
Jaypee B. Patdu, MIT (Technical Adviser)

ABSTRACT

Mobile games are very popular nowadays because technology keeps on innovating. Technology such as a mobile phone is very useful for the users to make a call, send a message, browse on the Internet, etc. Due to good technological advancement, there are also bad consequences for having this. One is lack of focus especially studying because of distractions from mobiles phones. For this reason, the researchers decided to create an educational tower defense game with the concept of Philippine history to educate the user while having fun playing this game. The researchers used an Evolutionary Prototype Model to receive feedback from the testers to create the project better. The prototype research design model shown in the study was used in the development of UI designs and application development. To validate both functionalities and game design of the project, the researchers used MEEGA+ as a test case. The researchers also used stratified sampling in identifying the IT graduates who voluntarily participated to be the respondents for the test case. Based on the test case results, the researchers have proven that the project met all the objectives of the study as well as its requirements.

INTRODUCTION

Currently, the world depends on technology and everyone from it seems deeply involved. Technology has become one of the most important elements in today's society and even helped to increase efficiency and effectiveness. However, some people also say that it includes laziness and can cause people to focus more on the fun side of it instead of working.

The innovation and gaming industry is continuously improving and extending. This persistent growth may additionally be explained by the increase in the popularity of mobile phones and smartphones. In those days, discussing game advancement or professional decisions may earn questions or distrust. However, game development is no longer confined to platforms such as gaming consoles or computers. Smartphones, tablets, and other portable devices with reliable operating systems have made way for more opportunities for aspiring game developers [1].

Android is a mobile operating system specially designed for touchscreens such as smart phone devices and tablets. Android is the best-selling OS worldwide on smartphones since 2011. Because of this, the mobile game industry has been becoming popular. Android

appears to be the most used OS compared to other Operating Systems. Android platforms support a large number of applications in smartphones, tablets, and other devices including mobile games.

Mobile games are games designed for mobile devices, such as smartphones, tablets, PDA, and other devices. Today's technology, particularly smartphones, has a wide range of connectivity features including Bluetooth, Wi-Fi, and 3G. These technologies were built for wireless connectivity for multi-player games or with two or more players. Playing games gives fun and social types of amusement. Additionally, this sort of activity energizes collaboration and participation when played with others. There are very few effective ways to escape the stressful and dull reality of ordinary life. Emerging into different, almost dream-like realities, gives the user the tools to fulfill needs and wants that people lack in real life. Gamers utilize the expression "idealism", suggesting that they crave to break free from the banalities of the real world. The attraction of video games lies in the possibility for the player to be and achieve whatever he wants, without being judged just as how it often happens in reality. Pursuing that sensation of opportunity keeps

the player returning to video games, again and again [2].

Tower Defense or TD Games are some of the most popular strategy games nowadays. This strategic game where the goal is to defend the area or the player's territory by building a tower that attacks a wave of the enemy coming through to destroy the player's territory. By slaying the enemy, the player can collect gold to upgrade the tower to increase the damage to the enemy. The higher the wave level of the enemies, the higher the gold the player can collect.

Creating a tower defense game is not only for entertainment but also for educational purposes. It may, at the same time, have a good impact on academics for the game community and for the industry especially the main concept of the game is to understand the Philippine history specifically the major invaders of the country. The current situation of the world continuously gives people a hard time because of the pandemic and these people who struggle include the students. The main purpose of this study is to help create a game that will benefit the learners to acquire knowledge while playing.

Background of the study

Most Filipinos nowadays believe that just three [3] nations have invaded the Philippines; however, the truth is that the Philippines has been conquered by six [4]major nations. Because some of the Filipinos do not have enough knowledge or time to learn history, it causes major problems these days, specifically on the academic aspect in a history subject; thus, they tend to forget culture and important events in Philippine history.

Decades ago, the Philippines was one of the most wealthy when it comes to economy and natural resources. That is why other countries wanted to conquer this nation. Knowing this kind of information regarding how important the Philippines is may encourage the students and the next generation to take care of this nation and support the local resources to help the economy of the Philippines.

Furthermore, knowing history may benefit the next generation to know the importance of history especially the heroes who protected this country. Having this knowledge also gives them

the idea to take care of and protect this nation from conquerors.

The researchers came up with the idea of an educational game with the concept of Philippine history. Also, since the concept is about the invaders, the researchers combined the educational game and a sub-genre game called tower defense to apply the theme of the game. Tower defense is one of the popular games. This will help the researchers to encourage the players to enjoy the game and to achieve the purpose of this study which is to disseminate information about history.

In this case, the researchers decided to create a tower defense game with the concept of invaders of the Philippines, entitled: "Philippine Defender: TD Mobile Game Using Unreal Engine". The game application focuses on invaders of this country to provide not only entertainment but also knowledge about the invaders of the Philippines.

Objective of the study

The general objective of this study is to create a tower defense game, entitled: "Philippine Defender 3D: Third Person Tower Defense Game Using Unreal Engine".

In line with this, the study aims to achieve the following specific objectives:

- To design the application using the following features:
 - Single-player
 - Lobby
 - Multiplayer
 - Host game
 - Find Match
 - Lobby
 - Tutorial
 - Player Option
 - Settings
 - Quit Game
- To develop an educational mobile-based game with the concept of the culture and history of the Philippines.
- To construct visual scripting for the behavior of the game using blueprints code in Unreal Engine 4
- To create a game based on a specific history of the Philippines which is the 6 major invaders of the Philippines.
- To maximize the 3D graphics of the game using Blender 3D

- To use MEEGA+ as an evaluation tool to validate the results of the project.

Scope and limitation

Tower defense is a sub-genre that allows the player to think strategic plan to defend the area or territory in the game. The researchers came up with a history theme for the tower defense game which is Philippine history, specifically delving into invasion in the country. The game that the researchers develop was titled “Philippine Defender 3D: Third person tower defense game using Unreal Engine”. In this game, there are 2 different modes: the first is a single-player and the second one is multiplayer. For the single-player, the user needs to select the difficulty level and choose one [1] among four [5] different characters to start the game. Upon starting the game, there will be information that will give the player the idea to answer the bonus quiz that will appear at the end of the stage after defeating the boss. The player will have 30 seconds to build before the first wave of the enemy spawns. For each stage, there will be 4 waves in total and after the player survived each wave, the player will receive 10 golds. To build a tower to defend, the player will have a game currency which is called gold. For every stage, players will have an initial currency of 40 golds in total to build a tower. Players can choose from 4 variances of towers which are damage tower, attack speed tower, AoE-type tower, and gold tower. Towers can be upgraded up to level 3. To build a tower, the player shall spend 5 golds for level one of the damage tower, attack speed tower, and AoE-type tower and 20 golds for S class tower, which is the gold tower. To upgrade the tower, the cost will be 10 golds for level 2 and 15 golds for level 3 tower for damage tower, attack speed tower, and AoE-type tower. To upgrade the S class tower, players shall spend 35 golds for level 2 and 50 golds for level 3. For damage tower, this will have 20 base damage for level 1, 30 base damage for level 2, and 40 base damage for level 3. The attack speed will only have 10 base damage but it has a twice faster attack speed than the damage tower. This also applies to AoE-type towers, this tower has only 10 base damage but each of its hits can hit multiple enemies. The S class tower is not for attack-type towers. This tower will give the players 1 gold per 10 seconds. If the gold tower

is level 1, there will be 2 golds per 10 seconds. For level 2 S class tower, there is a total of 4 golds per 10 seconds, for level 3 gold tower. The enemy will have 3 variance which is the human enemy, tank, and boss. The human enemy and tank will have 100 hp and it will damage the base for 10 hp. The boss will have 300hp and it will damage the base for 100hp. The boss will appear at the last wave of the stage. After defeating the stage’s boss, the pop-up quiz will appear on the screen and if the player answered the question correctly, the player will have an additional 10 golds for the next stage. The main goal of the player is to defend the base that has 1000hp. For multiplayer, it has the same mechanics as per single-player and the only difference is that there will be multiple players but the same currency in the game. The advantage is that it will be easy to build and upgrade towers from different areas in the maps of the game. The difficulty level is normal and hard, the difference between these two is that the hard is composed of much faster enemies than the normal level.

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 6 major nations which invaded the Philippines to study the specific history of the Philippines and to limit the study of the researchers within this topic. This also includes the mechanic questions with multiple choices in the game. The game can only accommodate 4 players to play for multiplayer to avoid lag. When playing this type, players shall be connected via Wi-Fi with the same network connection only. MEEGA+ is an evaluation tool for games. The researchers used MEEGA+ as the evaluation tool for this study because it is an educational tower defense game that is highly applicable to this evaluation tool as a test case.

SYSTEM DEVELOPMENT METHODOLOGY

In this section, the design and the methods were explained to meet the objectives of the project using Unreal Engine 4, Blender 3D 2.91, Adobe Photoshop CS6, Audacity, and Android SDK.

Figure 6 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. This study is to create an educational tower defense and this model will be very useful for the researchers to make the game better for the user.

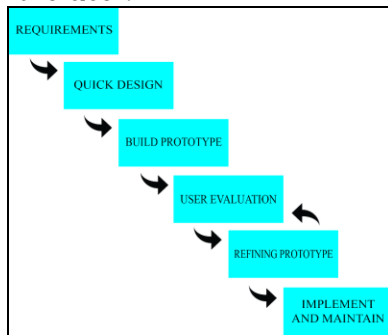


Figure 6: Prototyping Model

The study used an Evolutionary Prototyping Model. For this type of prototyping model, the researchers have let the other person consult the initial prototype. This helped the researchers to re-create or 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 reasons:

- The prototype serves as a basis for finding out missing functionalities
- Receives feedback for improvement of the system
- Possible improvements every prototype
- Customer feedback to achieve the goal of the system

Requirements gathering and analysis

A prototyping model starts with requirement analysis. In this phase, the researchers gathered data from the Internet and related games and literature from the college graduates 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 a tower defense game with a historical concept because of its educational game mechanics.

Quick design

This phase is an initial design or a quick design that allows the researchers to create a simple design of the system using Blender 3D and Photoshop CS6. The designer of this research creates multiple assets for each stage only for a basis to have more ideas for the next prototype assets and designs to be developed.

Build a Prototype

Phase three builds a prototype, after gathering data and quickly designing, the researchers were able to create a prototype based on the ideas and gathered information from quick design. After creating assets, the researchers created algorithms and animations for the game using blueprint visual scripting in Unreal Engine 4.

Initial user evaluation

In this phase, the researchers presented the initial prototype to the other person for initial evaluation of the prototype. With this method, the researchers received feedback according to the user's experience and this helped the researchers to know the missing functionalities and to have more ideas that can add up to the next prototype to make it better.

Refining prototype

In this phase, this will not be over until all the requirements and suggestions of the user were met. This phase is how the researchers refined the prototype according to the user's feedback and recommendations. The researchers continuously created and refined the prototype until the final system was developed where the user is satisfied with the approved final prototype. In this phase, the researchers continued to refine and implement the feedback received from the user. In this study, the researchers received five feedbacks 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.

Implement Product 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.

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 twenty (20) respondents specifically the IT college graduates.

Data and Requirements Gathering

The researchers used the Internet to access online research papers and some documents from the graduated students of Mabalacat City College (MCC) and also brainstormed to gather enough ideas to create the project and to achieve the main goal of the researchers which is to develop an educational multiplayer tower defense game with the concept about the history of the Philippines.

Table 1: Software Requirements

Hardware Requirements	Software Requirements	Function
Android Phone	Android OS 7.0 (Nougat)	Mobile operating system
	(Recommended)	
	3 GB RAM	Memory
	(Recommended)	
	8 GB	Internal Storage
	(Recommended)	

Design and Development Phase

The researchers used Blender 3D for developing game assets such as character, enemy, towers, building, and background assets (tree, house, rocks). The researchers created the game user interface and buttons for the game banner (Wavenuumber, victory, and game over) from Adobe Photoshop CC. The researchers used the Unreal Game Engine to create code and to run the program using

blueprint scripting and emulator of UE4. Lastly, the researchers used Android SDK to build the game application. The research development had a few problems such as connectivity for multiplayer, spawning towers and enemies inside the game, development of the mobile application user interface, and replicating and importing game assets into the software. The research mobile application user interface and replicating and importing game assets from Blender 3D into the Unreal Game Engine 4 is the first problem that the researchers encountered. The graphic designer of this researchers managed to create four (4) characters and twelve (12) enemies. However, importing these game assets into UE4 is the main problem. It kept on destroying the mesh that the researchers created from the Blender 3D. The solution the researchers made was to import the characters and enemies with rigged bones inside to keep the mesh intact and brush weights for smooth animation movements. 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. This strategic game is called a tower defense game defending the area or tower by building towers to get rid of the enemy. However, the researchers faced technical problems in visual scripting spawning enemy and towers. It took many hours and days to fix this problem and the researchers managed to fix it using a blueprint in Unreal Engine 4 visual scripting. Mobile Game Application Sample Screenshots



Figure 7: Developing a mobile application

After the researchers managed to fix the problems from the development stage, the researchers then tried to package the game

using Android SDK version 4.0 for prototype and to test the functionality.

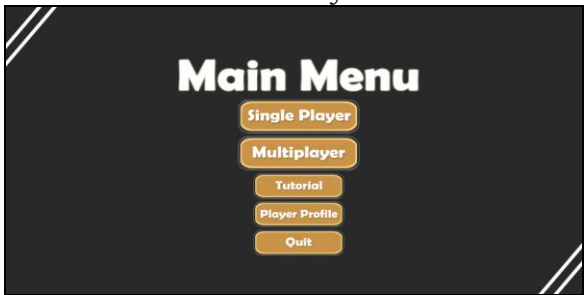


Figure 8: Main menu screenshot from the game

This is the main menu of the game that appears on the initial screen of the game. Users can choose if the game is going to be single-player or multiplayer with a maximum of four (4) players. A tutorial for information on how to play this game is also included. The player profile section gives the user to type the in-game name (IGN).

The game is already packaged and now ready to test the game for its functionality. This time, the researchers conducted a game test and tried to play the game.



Figure 9: Game settings screenshot

This is the single-player settings prototype and it seems that all functionality and game assets are good so the researchers proceeded with the multiplayer.

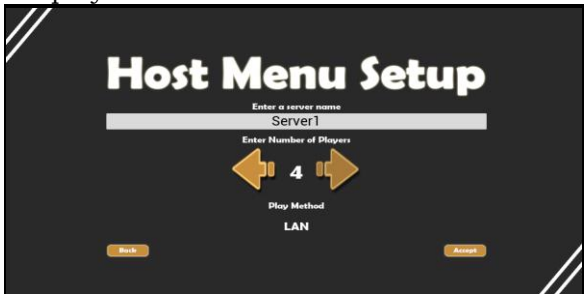


Figure 10: Host menu setup screenshot

This appears on the screen if the player chose to play multiplayer. After clicking the

multiplayer menu button, the player can now create a lobby for multiplayer and will set a server name and number of players with a maximum of four (4) players.

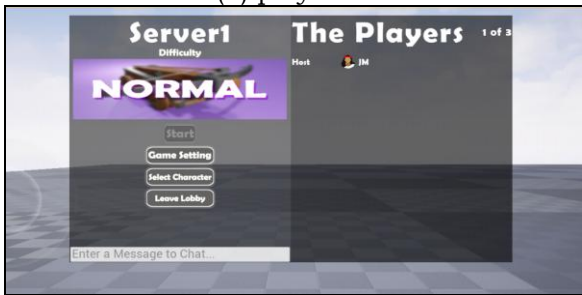


Figure 11: Host game screen

This is multiplayer. First, the host will create the lobby and the host is the only player who has access to the game setting such as the number of players, difficulty level, and if the host wants to kick a specific player out of the lobby. However, each player is required to choose a character and press-ready for the host to start the game.

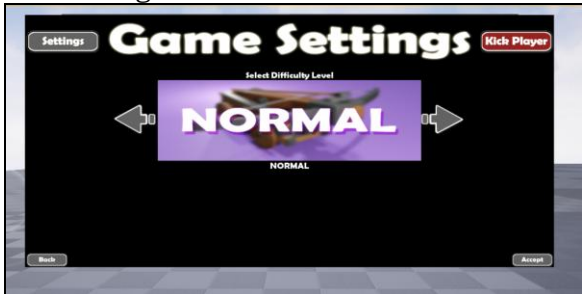


Figure 12: Difficulty settings screenshot

This screen is for the host only. The host is the one that has access to the settings of the game and chooses the difficulty level of the game. Also, the host can kick a player out of the lobby.



Figure 13: Character selection screenshot

Before the game starts, each player shall choose a character before the host could start the game. Each player can choose from four (4)

Filipino heroes. The picture above is the screenshot for selecting a character.



Figure 14: Multiplayer connectivity

The next one is on how other players can join the lobby game. To join the lobby, the main requirement is to have the same LAN connection to join and if not, there is the example screenshot below.



Figure 15: Game screen

In this game, players will have 30 seconds to prepare before the first wave of the enemy will appear. This screenshot shows the countdown before the wave of the enemy begins. This photo also shows the joystick controller on the left side to control the direction of the character and the jump, high jump, and sprint skills on the right side.



Figure 16: Tower types screenshot

Each player shall build a tower to defend the base. For this game, players can choose what type of towers they want to build. Below is the screenshot of the different variances of the tower. The 1st tower is AoE type, 2nd is attack speed type, 3rd is damage type and the gold tower type.



Figure 17: Enemy waves

Each stage shall have 4 waves in total both single-player and multiplayer and below is the screenshot sample from the game.

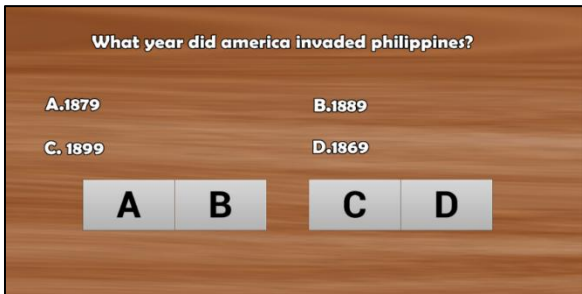


Figure 18: Game questions

After the player survived the 3 waves this pop-up quiz will appear on the screen of the players for bonus currency in-game if the players answered the question correctly.

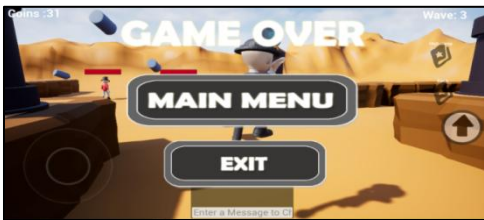


Figure 19: Game over

If the players failed to defend the base, the game is over.

The researchers used a stratified sampling method to choose the right respondents needed for the evaluation tool. As soon as the

researchers used this tool, the researchers divided the population and chose 20 IT college graduates to be the respondent on the testing tool that the researchers provided.

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 reach the satisfaction of every user and to improve the system of every prototype after the researchers received feedback from the users. 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.

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.

The researchers of this study used testing cases in terms of functionality, usability, portability, and reliability of the mobile application before deployment.

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 ten (10) 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 this to make sure that the researchers achieved one of the objectives of the study which is to develop a 3D tower defense 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 history of the Philippines 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 game also has a tower defense the main goal is to defend the base. With that, the player is expected to complete the challenging tasks given the satisfying feeling through the accomplishment.

The researchers also wanted to create a game that is educational to develop learning for players while playing mobile games and to have communication with the other users. This also promotes cooperation and friendly competition among players.

As the researchers mentioned that this game is educational, the researchers have included a pop-up quiz to have something that is considered to be 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.

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, cooperation and competition among players, content relevant to the player's interest, and efficient alternative learning method.

DISCUSSIONS

This section discusses the findings, conclusions, and recommendations based on the analysis of the result of the study entitled "Philippine Defender: TD Mobile Game Using Unreal Engine".

Summary of findings

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

The use of diagrams such as conceptual framework and methodology in developing the prototype model and the mobile application was essential to better understand the flow and the outcome in developing the game application.

The integration of the gathered idea through the Internet, documents, and prototype model helped the researchers to successfully develop the game application.

The researchers used the 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 results.

The researchers passed the test cases for player experience by knowing the history of the Philippines which is the main concept of the project. The group used Unreal Engine 4 to construct blueprint codes for this project.

The group managed to conceptualize the game using the six (6) major invaders of the Philippines as a theme of the game to limit the study of the researchers.

Conclusion

After the evaluation has been completed, the researcher drew some conclusions based on the objectives of the study.

The development of Philippine Defender followed its stated objectives wherein the researchers developed an educational 3D tower defense game with the concept of the history of the Philippines specifically the invaders of the country.

The proposed mobile game conformed to the stated objectives of the study. The researchers created the game more interesting and attractive by maximizing the graphics using Blender 3D creating animation and making the game challenging using Unreal Game Engine 4. 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 questions added into the game as new gameplay for the game was successful. To validate this result, the test case showed that

the researchers passed the criterion for sound effects.

The researchers aimed to develop an educational game that supports Philippine history to provide knowledge. For this to succeed, the researchers created a tower defense game with the concept of the invaders of the Philippines. The researchers validated this result under player experience in a 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, sensitivity, 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 history 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 as listed:

- To play this game not only for Android devices but also for IOS devices
- To add another history about the Philippines which does not only cover the invaders of the Philippines.
- To create additional types of enemies and towers.
- To implement to other target platforms aside from mobile devices
- To make the game playable over the Internet and make it not limited to local area network connectivity.

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PRO'TECH: Anti-Covid Protechtive Kit Vendo Machine

Argie Chester C. Garcia

Arji Magtoto

James Jerome G. Tomamao

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

ABSTRACT

People may now design items that will make life easier and more comfortable for everyone. People were drawn to vending machines because it is convenient to use, they can also provide quick service that can attract people to the things they offer. It can also be able to give clients good services that are both accurate and efficient. As a result, in the business world, it is ultimately feasible and profitable. The general aim of the study is to design and develop an embedded device and a mobile application entitled "PRO'TECH: Anti-Covid ProTECHtive Kit Vendo Machine with Mobile Inventory App " a vending machine that has capable to dispense basic needs in this time of pandemic; monitors stack supply; view its current revenue and sold inventory item using the Mobile application. The researchers gathered relevant information to develop the Arduino-based Vendo machine system through collaborative shared ideas, interviews, internet research, and library research. The researcher used Arduino Nano; jumper wires, coin slots, spiral motor, Wi-Fi modules, LCD screen, and push buttons. Using the Android Studio, the mobile application was designed, develop, and created. The developed functional vending machine of the researcher would be able to dispense one of three choices of item. These three items are Facemask (5pesos), Face shield (15pesos), and Alcohol (10pesos). The developed mobile application was successfully able to interact with the developed Vendo machine using Wi-Fi connection and would be able to monitor stack supply and views its current revenue and sold item.

INTRODUCTION

Nowadays, People are experiencing a pandemic, many people's lives are lost, buildings and schools are closed, businesses and other establishments are buried in debt and put almost everything on hold. But most people still have no choice but to leave their homes for work, to feed their family thus exposing themselves into the virus, whether frontline or not.

Coronavirus disease, commonly known as COVID19, is a coronavirus-related respiratory disease that can range from mild to severe (Severe acute respiratory syndrome coronavirus 2 of the genus Betacoronavirus). It is evidenced as fever, cough, and other indicators and is transferred mostly through exposure to infectious elements (such as respiratory droplets) or contaminated objects or surfaces [1]. Other major causes of COVID-19 are close contact, not wearing a face mask/face shield, not being able to wash his/her hand often, etc. A vending machine is an automated machine that distributes snacks, chocolates, or beverages such as coffee, soda, bottled water, and juices to customers after the user inputs cash coins into the machine. A variety of

countries have vending machines, and a new type of customized vending machine that offers products that aren't as popular as those present in standard vending machines has just been invented. Vending machines' ability to provide products at affordable prices around the clock, regardless of holidays, is now widely acknowledged. Machines are now extensively utilized in schools, colleges and universities, recreation centers, health care institutions, and workplaces, in addition to warehouses and industries [2].

As the new normal begins, people are slowly going out and carefully doing their usual activities. Even if the lockdown has been put at ease, the Government is still giving constant reminders to people in the strict and proper observance of minimum health and safety protocols whether you are outside, in the office, or on vacation. This study aims to provide the satisfaction of needs of one person about the mandated minimum health safety protocols by the government, especially in cases that if he/she doesn't have a facemask or face shield to wear. PRO'TECH: Anti-Covid ProTECHtive Kit Vendo Machine with Mobile Inventory App is a machine that provides alcohol, facemask,

and face shields. These protective kits can fight or lessen the chance to have any kinds of germs, bacteria, and viruses. ProTECH Kit can help us to have a facemask, alcohol, and face shield in public places like public markets or malls. There were times that other people forgot their facemask, alcohol, or face shield that can be used for their protection against any viruses. By the use of this kind of vendo machine, you can have your facemask, alcohol, and face shield by simply inserting a coin in this vendo machine. Also, this vendo machine is convenient to many people because it is easy to manage and has an inventory using a mobile application so that it can easily know if the vendo machine has still stocks of alcohol, facemask, and face shield. Using this vendo machine this study can help the pandemic because it has a purpose to help the people in the Quezon Drive Dau. During this time of the pandemic, the researchers know that there are so many people who can easily get affected by the said virus. People need to be extra careful of themselves so that they can avoid transmitting the virus, by the help of this study it can easily fight the pandemic by always wearing a facemask, face shield, and alcohol to sanitize our hands. This study aims to provide Anti-Covid ProTECHtive Kit Vendo Machine with Mobile Inventory App. It is inspired by the Vendo machine, however, the product that is selling is not snacks rather it is a facemask, face shield, and alcohol because this item is one of the necessary needs of people nowadays, especially in this time of the pandemic. The researchers intend to build a simple vendo machine that is very helpful and easy to use. The project would benefit people living in Quezon Drive Dau: Also the vendo machine has a mobile app inventory that will improve our vending machine project.

Background of the study

The Coronavirus (COVID-19) has slowed the global economy and affected normal lives. Thousands of people have been afflicted by the pandemic, and as a result of the disease's spread, they are either sick or dying. The most common symptoms of this viral infection, which can lead to pneumonia, include fever, cold, cough, bone pain, and difficulty breathing. For this novel viral disease that is infecting humans for the first time, vaccines

are not yet accessible. As a result, severe precautions such as social separation, wearing masks, and keeping a tight hygiene regimen (e.g., routinely washing hands, avoiding face-to-face confrontations, etc.) are being emphasized. There is a rapid spread of this virus all across the world [3]. To prevent the spread of this highly contagious disease, many countries are isolating their citizens and enacting rigorous quarantine measures.

During this time of pandemic the researchers wanted to make a vending machine to fight this pandemic, a Vendo machine that can provide our usual needs right now such as facemask, face shields, and also alcohol.

The said study is established to support and provide the basic needs of people who live in Quezon Drive Dau, Mabalacat City Pampanga in this time of the pandemic. It produces accuracy and fast service to those people who live in Quezon Drive, hence the researchers came up with the study to lessen and prevent the contamination of Covid-19.

Objectives of the study

The general objective of the study is to develop an Arduino-based vending machine titled "PROTECH: Anti-Covid ProTECHtive Kit Vendo Machine with Mobile Inventory App "

The specific objectives of the study are the following:

- To design a vending machine with the following features:
 - Coin slot that accepts old and new 5 peso coin, 10 peso coin, and 1 peso coin.
 - An LCD counter that shows the inserted coin amount/credits
 - A microcontroller that controls motors and buttons.
 - A motor that rotates the spiral dispenser.
 - A esp8226 wifi board that sends data through wifi.
- To design a paired mobile app with the following features:
 - Real-time product inventory and yearly and monthly sales report
 - Login security Feature
 - Notifications
- To evaluate the device and the mobile app using the following ISO 25010 criteria:

- Functional Suitability
- Portability
- Reliability
- Usability

Scope and limitation of the study

The scope of this study is focused on building an Arduino-based vending machine system titled “PROTECH: Anti-Covid ProTECHtive Kit Vendo Machine with Mobile Inventory App”. Using Arduino Nano, Coin slot Machine, stepper motor, Nodemcu, and box made of acrylic glass and jumper wires, the vending machine system will dispense some essential protective items that are timely in this time of the epidemic. The vending machine will cater to three items: A surgical facemask costs 5 pesos, each Faceshield costs 15 pesos, and an alcohol spray bottle costs 10 pesos (10ml).

The machine is designed to automatically take inventory of stock items to keep track of the stock or supplies inside the vending machine. To create the application, Android Studio will be used. The mobile application will communicate or interact with the Arduino-based vending machine system. And the application will be run by the user or supported by Wifi Module (Nodemcu Esp8266). The owner will have automatic access to the machine's inventory report by using the mobile application. By the use of the Wifi module, the mobile app can be used to remotely access the inventory report in real-time and the current coin count. It has a notification that sends a report if the available number of products in the dispenser for each category reaches below 40%. The vendo must be also connected to the Internet for the user to access this remote feature. It also includes a login feature that serves as the owner's security. A monthly sales report was also added by the researchers. The ISO 25010 was use by the researchers, to evaluate the said device and the mobile application. This will help to guide the researcher's project in terms of Suitability, Reliability, Portability and Usability.

As for the limitations of the study, the vending machine system can only dispense one item or per transaction. The remote online inventory is Wi-Fi dependent which means, it can be accessed when Wi-Fi is detected.

SYSTEM DEVELOPMENT METHODOLOGY

This section presents the methodologies used by the researchers to develop the study. The researchers have used the Agile methodology to explain the functions and the different process flows. Agile is a way to organize a project by breaking it up into several pieces, this will help the readers to easily understand the procedures in each phase. It is suitable for studies that require building and developing an actual prototype while the project progress.



Figure 3: Agile Methodology

Plan

During this phase, the researchers hold many online sessions to devise a strategy. One of the researchers' plans is to collect data from the internet, libraries, newspapers, and magazines. The researchers also developed a strategy for constructing an Arduino-based vending machine system using an Arduino Nano. It also explains how the researchers organize their time while developing the device, as well as how the researchers utilize the Android Studio App to create our mobile app.

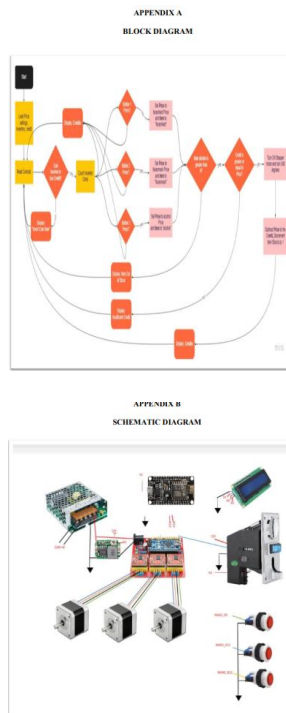
Design

The researchers define here the requirements and applications needed in building an Arduino-based vending machine, it needs hardware modules in Arduino such as Arduino nano, stepper motor, coin slot machine, etc. Researchers also use the Arduino IDE and Android Studio app, two software applications that will help to develop the Mobile application inventory and the design of the Arduino-based Vending Machine system.

Develop

At this point, the researchers want to construct an Arduino-based vending machine and put it into existence by bringing all of the necessary needs and components together. Such as Power supply for the main power source, A Wi-Fi module (nodemcu) that sends data via wifi, DC-DC Buck converter that will convert the wifi module(nodemcu) from 12v to 5v, Arduino nano a microcontroller to control motors, and buttons, A stepper motor and stepper motor driver that will help to rotate the spiral in 360

degrees and dispense an item, A Coinslot Machine that accepts different coins, A LCD that display Credits and Status Message, And lastly, Expansion board that will serve as a board interface for Arduino nano.



Test

The most important stage, once the researchers have created a functional vending machine, is to test it to check if it works and meets the researchers' objectives. The researchers checked the electronic wiring of the Vendo machines at this stage. Using a set of tests, researchers would be able to discover current and new faults, glitches, or problems.

Deploy

The researchers' output would be "PRO"TECH," a vending machine that could dispense three essential items during this time of the pandemic. Faceshield, facemask, and alcohol are dispensed by the Vendo machine prototype. It is a vending machine that is capable of avoiding pathogens or Covid-19 contamination. It also uses mobile application inventory through a wifi module to view its current sales and sold inventory items.

RESULT AND OUTCOMES

This section will show the results and outcomes based on the objectives of the study and the research output must be presented in an organized and presentable manner. These discussions and conclusions are based on the objectives of the study, completed the analysis, testing, and evaluation of the developed application and product prototype. The researchers use ISO 25010 model for the evaluation of the mobile application and the device.

The study covers primarily the design, development, and testing of the product prototype entitled "PRO"TECH: Anti-Covid ProTECHtive Kit Vendo Machine with Mobile Inventory App" a vending machine that is capable of dispensing three basic needs in this time of pandemic such as alcohol, facemask, and face shield. It monitors stock supply and view its current revenue and sold inventory item using the Mobile application.

Data and Requirements Gathering

Using the analytical tool, Conceptual Framework (See Figure 2), the researchers were able to get a comprehensive understanding of the development process. It was used to visually explain the key concepts and the relationships between entities of the study. The researcher was guided by a Prototyping model during the product and system development of the study. Using a design tool such as a Block diagram (See Appendix A) and a Schematic diagram(See Appendix B), the researcher was guided to view the detailed information of the individual parts of electronic components, modules, wirings, and how it interacts with the developed product prototype.

System Design



Figure 4: Mobile Application User Interface

The figure above shows the mobile application interface of Pro'tech. Screen 1 above shows on how to create an account, the user must input his/her full name, email, password, and phone number. If the user has completed the steps on how to register an account, the mobile app will automatically go to the login section (Screen 2). Screen 3 above shows the screen after logging in his/her account. It is the main dashboard, that user can see the price of each item, the quantity of stocks left in the vending machine, revenue that will count on how many coins has been inserted inside the vendo machine, and a line graph that represent as a yearly sales report: by the use of this graph the user can determine what item sells the most. Screen 4 shows the edit attributes section, the user will see and can edit the price, quantity, max stocks, and sold item of the vending machine. Screen 5 is the profile section, the user must verify his/her account by just clicking the "VERIFY NOW" it will automatically send the link of verification on its email account. Screen 6 represents the line graph, if the user clicks the export data the mobile app will automatically download a pdf file which contains the total earnings every month of each item and computes the total sales in a whole year. In screenshot 7 the user can change his/her profile data. And in screenshot 8 the user can reset or change his/ her password.

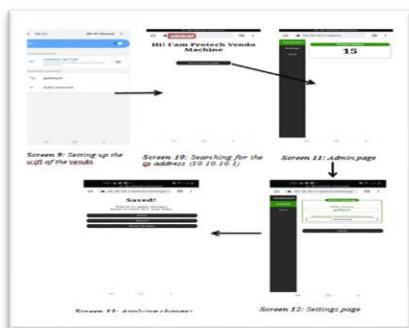


Figure 5: Mobile Application Wifi Setup

If the user wants to connect his/her vending machine to other wifi, he/she must first go to his/her settings in mobile phone and connect it to "VENDO SETUP"(See screen 9). And as it shows in Screen 10 for him/her to setup the Wi-Fi of the vending machine, the user must search on the website for the IP address of the

vending machine (10.10.10.1). Screen 11 is the admin page, in here the user will see the total sales of the vending machine. In Screen 12 on the settings page, the user can connect his/her vending machine to any Wi-Fi by just typing the Wi-Fi name and Wi-Fi password. And by just clicking the save button in the mobile app it will automatically proceed in screen 13, in here the user can reset all sales and reboot to apply changes.

Build a Prototype and Processes Screen Shots

The researchers designed a vending machine based on the panel's recommendations and the study's goals. After the group's programmer finished the system's primary functionality, the other members ran a series of tests to see if the device's features worked consistently and efficiently. The system prototype development and testing are illustrated in the figure below.

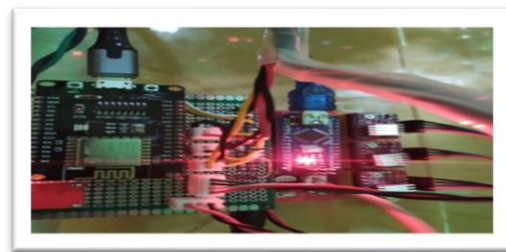


Figure 6: PRO'TECH IoT Components

Figure 5 displays the initial prototype of the study. It has a Wi-Fi module that serves as a connectivity of the mobile application and vendo machine. Arduino nano is the main heart of the components, it is a microcontroller that controls all the motors, buttons, and codes of the vending machine. Insert coin wires and button wires are one of the most important in a vending machine, to make it not confusing for the user the buttons are in colored portion, the orange button is for the alcohol, the blue button is for a facemask, and the green button is for the face shield. The researchers also added expansion board, for the components to get organized and use it as an extension of the Arduino nano. The Power of the vending machine is through the power supply that connects into outlet. Spiral motor connectors are the one who control and rotate the spiral to dispense items.



Figure 7: Testing Insert Coin Machine

Figure 6 presents the testing of the insert coin machine in terms of reliability. An insert coin machine is designed to insert different coins in the vending machine. Aside from testing the insert coin machine, all of the coins that have been entering inside the vending machine will automatically count by the “revenue” in the mobile application. The revenue will be served as a basis on how much money or coins that have been entered in the mobile application. Furthermore, the revenue can reset in the mobile app, if the user clicks the reset sales button. The researchers also notice in the testing phase that new coins like 10 pesos, are not consecutively accepted by the insert coin machine. The user must repeat inserting the coin in order to be accepted by the vending machine.

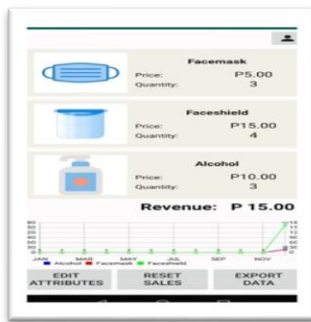


Figure 8: Testing LCD screen

liquid crystal display (LCD), electronic display device that operates by applying a varying electric voltage to a layer of liquid crystal, thereby inducing changes in its optical properties[29]. The LCD screen was use in the

vending machine for the user to have a credit indicator. The user can see how much coins that he/she put in the vending machine. The researchers notice that the LCD screen was running smoothly. If the credit has not been meet by its price, the LCD screen will automatically show the banner of “NOT ENOUGH CREDIT”. It is also connected in mobile app, when the quantity of any item is in 0, the LCD screen will show “OUT OF STOCK”.

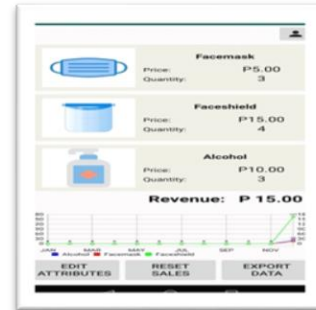


Figure 9: Testing buttons

Figure 9 shows the buttons in the vending machine, the said buttons are programmed and connected to Arduino-nano. The buttons are organized by color as stated in figure 5. Since there are only 3 buttons, the user can easily familiarize the buttons of the vending machine. The majority of the group researchers agreed to have a colored button, in order to have more design or add color in the vending machine. In the testing phase, the buttons are functioning well. The only problem that researchers encounter in the testing phase is most of the buttons are fragile so the buttons must use gently. However, the mobile app that shows in figure 8 has a connection in the quantity section, if someone buys an item in the vending machine then the button orange, blue, or green has been used, it will be automatically decremented by the mobile app in the quantity section. The button is also connected to the spiral motor of the vendo machine, it is a tool to dispense an item by rotating it to 360 degrees. Buttons, spiral motor, and the quantity section of the mobile application are connected, researchers had plenty of time to work on this three.

Evaluation with Users

The researchers demonstrated the prototype to the audience in real-time. An in-depth analysis

of the system prototype's functions was conducted, with queries such as "what does it do," "discussion of the mobile application's features," and "what else has to be added to the system prototype." Recommendations and opinions were exchanged between the researchers, capstone adviser, and capstone panelist. Deliberation was made between the capstone panelists, at the end of the presentation, the study was accepted with major revision on system prototype and documentation. The recommendation of the panelists is to have a consultation of expert in terms of inventory, 10 test cases, and to have a confirmation password when resetting a password in mobile app.

Refining Prototype



Figure 10: PROTECH Refined Prototype

The figure shows above the installation of the IoT components in the vendo machine, these components are; Power supply, Arduino nano, spiral motor, and insert coin machine. By the use of these components, the researchers can build a functional vending machine that can help the people who live in QuezonDrive, Dau Mabalacat City Pampanga to minimize the contamination of the Covid variant.

Final Product

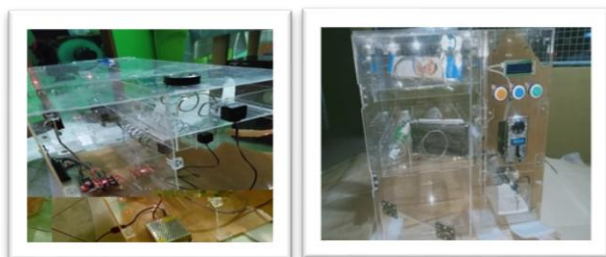


Figure 11: PROTECH Final Prototype

The illustration above illustrates the final prototype of the study. It is a vending machine that is capable of dispensing some essential items in this time of the pandemic. By the use of Arduino Nano, coin slot Machine, stepper motor, Nodemcu, and box made of acrylic glass and jumper wires the vending machine was built. It has also a mobile application that has the following features: Real-time product inventory, yearly and monthly sales reports, Login security Features, and notification. The said study evaluate through the use of ISO 25010 criteria:

Functionality test cases results of PROTECH prototype (See Appendix E). A functionality test was conducted by the researchers to assigns the testing of all the features, in order to see if it produces the expected result. The remarks of the functionality test cases revealed that all of the test cases have passed, showing that all functions are working expectedly.

Portability test cases result of Wi-Fi module (See Appendix F). Portability test case result was conducted to measure the accuracy of the said feature, also to check If Wi-Fi module can connect into different wireless fidelity connections. The remarks of the portability test case showed that all of the test cases have passed, showing that this module is working accurately.

Usability test cases result of Spiral motor (See Appendix G). Usability test case results were conducted to ensure that the task perform safely, effectively, and efficiently. The remarks of the usability test case showed that all of the test cases have passed, showing that the spiral motor is capable to rotate up to 360 degrees and dispense the selected item.

Reliability test cases result of Mobile application user interface (See Appendix H). Reliability test case result was conducted to ensure that the mobile application is performing and functioning consistently. It also ensure that the mobile app is reliable for its intended purpose. The remarks showed that all of the test cases have passed, showing that the mobile application is working as expected, can receive accurate data, and reliable to use.

DISCUSSIONS

This section shows that after careful and critical analysis of the results of the study, the

proponents were able to summarize their findings, make conclusions, and give recommendations.

Summary of Findings

Based on the given results from designing, development, and testing, all features stated in the objectives and scope of the study for “PRO’TECH: Anti-Covid ProTECHtive Kit Vendo Machine with Mobile Inventory App” are working as expected.

The researchers were able to collect all data needed and gather important hardware and software requirements that were needed in building a vending machine. Android Studio was used for making a mobile application.

The mobile application was able to pass all the test cases and scenarios in terms of functionality, usability, portability, and reliability. A vending machine has also been passed through test-cases that make the vending machine more reliable to use.

The developed vending machine of the researcher would be able to dispense one of three choices of item. These three items are alcohol, facemask, and face shield. The developed mobile application was tested and successfully would able to interact with the developed Vendo machine and would able to monitors stack supply and views its current revenue and sold item.

Conclusions

There can be no doubt that an Arduino based vending machine can dispense any desired products. The machine is working efficiently and reliably:

A. All of the functions are possible thru the use of Arduino Nano which served as the main heart of the vending machine.

B. The machine can dispense products thru the use of a stepper-motor. It pushes the selected product circularly out of the machine.

C. The machine can also informationns to the mobile app because of Wifi Module.

Therefore, PRO’TECH: An Arduino-base vending machine is useful both for the operator and the user. The machine is safe and good to be used by the people.

Recommendation

Based on the results of the findings and conclusions gathered, the proponents would like to recommend the following; for future researchers to enhance the developed Vending

machine and mobile application and provide better functionalities and usefulness:

- Future researchers/developers who will encounter this study may try to develop this for a different locale/community/city if found feasible
- Future researchers may consider developing the mobile application in a different platform like APPLE IOS
- Future researchers may add more features that are beyond the scope of this study such as developing a mobile app inventory that has total expenses.

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Quarantine Life – A Visual Novel Game

Ian Carl G. Caballero
Ghyllan Lyzzl B. Deñola
Mark Lawrence L. Feliciano
Prince Jeremie C. Malana
Kyle Andrae L. Mendiola
Ralph B. Cadalzo, MIT (Technical Adviser)

ABSTRACT

The study focused on the design and development of Quarantine Life – A Visual Novel Game. The main purpose of this study was to raise awareness regarding the circumstances the pandemic has fostered. This was done by developing a visual novel game using a variety of technologies, informing players with the IATF guidelines in the game's narrative, implementing minigames that add playability, presenting the ending summaries, and testing the game using test cases. The methodology used in this study was Rapid Application Development (RAD) which is an agile framework that focuses on rapid prototyping. It was used as it allowed the researchers of this study to divide the development of the visual novel game into smaller, separate, actionable tasks, and present the game to clients in less time. The main findings of this study were that the Quarantine Life was designed and developed successfully; and the game's functionality, usability, portability, and compatibility were tested with satisfactory results. The visual novel game is compatible with devices that have Android OS version 5 and up. Overall, the developed game met its specified objectives, but can be further improved by adding character and scene customization, medical minigames, and iOS support compatibility.

INTRODUCTION

The coronavirus disease-2019 (COVID-19) pandemic, caused by the new coronavirus SARS-CoV-2, had spread around the world, wreaking havoc on the health of millions of people. When the pandemic was still ongoing, and new events were recorded every day, the global society's resilience was constantly being tested [1]. Following a report of a cluster of instances of 'viral pneumonia' in Wuhan, People's Republic of China, the World Health Organization became aware of this novel virus on December 31, 2019. [2]. The great majority of individuals who experience symptoms (about 80%) recover without needing to be hospitalized. Approximately 15% get very unwell and require oxygen, while 5% become critically ill and require intensive care.

Acute respiratory distress syndrome (ARDS), respiratory failure, thromboembolism, multiorgan failure, and/or sepsis and septic shock, including harm to the heart, liver, or kidneys, are all possible complications that can lead to death [2]. On March 11, 2020, the World Health Organization identified COVID-19 as a pandemic [3]. Due to the COVID-19 pandemic, multiple lockdowns around the world had occurred and had changed people's

accustomed lives. Many schools have embraced online teaching methods, and most employees have been expected to work from home and attend more virtual meetings.

In regard to the COVID-19 pandemic, most individuals used the expressions quarantine, lockdown, and social distancing interchangeably, but these phrases signified various things [4]. Quarantine was a method of isolating and limiting individuals who have been exposed to a disease, such as COVID-19, in order to see if they, too, have been infected and became sick. Many people used the phrases lockdown or shutdown to denote more general and extensive limitations on movement, employment, and travel imposed on all residents in a city, region, or nation. On the other hand, social distancing was intended to assist people avoid contracting and spreading COVID-19. It simply meant avoiding as many face-to-face interactions as possible. Someone may leave their home to perform essential duties, but they must maintain at least 2 meters away from others.

When COVID-19 emerged in early 2020, Filipinos' lives had changed significantly [5]. In the event of a pandemic, public places were cleared of automobiles

and people. The amount of time children and adults spent on educational activities varied substantially in the month preceding the start of courses too. Almost every family received food assistance from the local government. Food was reported to be received by 96% of households from their local government, making it by far the most popular type of help. When asked how they were dealing with the financial consequences of the crisis, the majority of respondents said they had eliminated all non-essentials.

Borrowing was highlighted by many households, particularly from sari-sari businesses (by acquiring products on credit) and loan sharks. Several households claimed that they lowered the amount of food they ate or modified the kind of meals they ate (for example, by eating less meat or eating more cheap vegetables). Many households reported making and selling products on the street, such as masks or food, as well as selling online.

With the rest of the world contained behind walls, many people have tried finding recreational activities to do during lockdown. According to an Audley Villages study [6], the most popular activity was playing video games, followed by learning skills, then films & television. It might be predictable that playing video games was the most popular activity during the COVID-19 pandemic and the lockdowns it had facilitated. After all, they are generally played for enjoyment, but video games may also help an individual improve. Video games are a great method to learn, grow, and practice someone's problem-solving abilities [7]. Especially during a pandemic where stimulating interactions were limited, video games can greatly help in informing and making their players understand certain concepts that would be otherwise disregarded. The purpose of this study was to raise awareness regarding the circumstances the pandemic has fostered. By simulating the COVID-19 pandemic as a visual novel game, players were able to use their understanding of the issue and transform it into real-time actions. Simulations facilitate fast learning by providing immediate feedback on the outcomes of their decisions. The visual novel game assisted in equipping players with realistic

knowledge so that they can better respond to real-life situations during the COVID-19 pandemic.

Background of the study

COVID-19 pandemic measures, such as isolation and social distancing, were negatively impacting the general population's mental health [8]. Frustration, loneliness, and anxieties about the future, in particular, were typical emotions and were wellknown factors. Adding in the need for the citizens to follow COVID-19 guidelines, regulations may not be met properly. Filipinos, preoccupied with everyday survival rather than monitoring the news, struggled to keep up with the changing lockdown tiers and restrictions. The researchers had noticed the impact of video games in our general awareness and how it can help in facilitating simulations. To provide people with information about the COVID-19 guidelines in the local area, particularly, the IATF (Inter Agency Task Force) guidelines in the Philippines [9], the researchers have tried to implement a game that aims to entertain and inform.

The study was carried out to help raise awareness about the real-life difficulties that the COVID-19 pandemic had facilitated in the Philippines, as well as to aid the community with the local guidelines. This was accomplished through narrative simulations from a visual novel named Quarantine Life. A visual novel is a sort of interactive fiction video game that mixes a text-based plot with a literary narrative style with interactivity supported by static or sprite-based visuals or video game footage. The gameplay in visual novels varies from those of other game genres in that it is often limited. Most of the player interaction is usually limited to clicking to keep the graphics and narrative going, as well as making narrative choices along the way.

Novel, a visual novel on COVID-19 [10], is a comparable visual novel that educates about the COVID-19 pandemic. COVID-19 and how to prevent it are taught to young people in this game. The "choose your own adventure" game function is utilized to narrate the story and captivate young children. Educators in Singapore used it, as did parents who shared it with their children.

The game “COVID-19–Did You Know?” is another comparable study. The project achieved its stated goals of creating a serious game and making it available to young people, as well as giving accurate information about COVID-19 prevention themes [11]. This game's learning content was divided into six topics that presented specific WHO recommendations for the population, with an emphasis on issues related to teenagers' daily lives [11].

Objectives of the study

The primary objective of this study was to create “Quarantine Life – A Visual Novel Game” that centered on an individual's everyday life during the COVID-19 pandemic. The study was able to achieve this through the following objectives:

- To gather and identify related literature/studies and game development requirements.
- To design and develop an android-based single-player visual novel game that depicts daily life during the COVID-19 pandemic via branching routes.
- To develop the visual novel game using Ren'Py 7.4, Blender 2.9, VRoid Studio 0.13.1, Adobe Illustrator CC 2014, Adobe Photoshop CC 2014, Soundtrap, and Google Docs.
- To inform players with the IATF guidelines in the visual novel game's narrative.
- To implement simple minigames that add interactivity and incorporate problem-solving.
- To present the ending summaries with their corresponding chosen percentages at the end of the player's chosen route.
- To test the game using test cases in terms of functionality, usability, portability, and compatibility.

Scope and limitation of the study

The scope of this study was to primarily focus on the design, development, testing, and evaluation of Quarantine Life – A Visual Novel Game. A visual novel game is a form of interactive fiction video game which consists of a text-based plot with a narrative style similar to literature and interactivity assisted by static or sprite-based graphics or video game footage. The visual novel game is created using Ren'Py,

a visual novel engine that uses words, images, and sounds to tell interactive stories [12].

The game only supported Android operating system version 5.0 (Lollipop) and up. It was intended to be a single player game and allowed for offline usage, but also had an optional online feature that allowed the players to see what other players' choices and reached endings were in the form of percentages.

The protagonist of Quarantine Life portrayed the player as an adult living in the state of the COVID- 19 pandemic. The player's job was to read and understand the game dialog and tapping the screen after reading the character's line and repeat. At some points in the game, the player was prompted and showed two or more dialogue choices. In this situation, the player must choose a dialogue that they think was the best way to respond to the scenario or they can also choose a dialogue that they are just curious about. Their choice may change the course of the story and the final outcome (ending) of the story.

At the Main menu (The first screen to appear to the player), the player was presented with three buttons named [Play], [Preferences], and [About]. [Play] would start the game from the starting point of the story. When the player has already played the game before, the game will then load the most recent scene in the player's playthrough. [Preferences] gave the player various options to adjust certain configurations of the game such as audio volume and text speed. [About] were notes from the developer such as the current version, licenses, and credits.

In the main game (The screen where the [Play] button led to), character sprites, backgrounds, and dialogue boxes containing the characters' names and lines were displayed. At the top-right corner of the dialogue box, were three buttons named [Back], [Auto], and [Skip] represented by their appropriate icons. [Back] would return the player to the previous line of dialogue, [Auto] was a button that when toggled, automatically progresses the dialogue at regular intervals, allowing the player to progress in the game without any interaction until it reaches a point where player interaction was required, such as minigames and decision picking. [Skip] quickly 'skips' the dialogue until it reaches a point in the game where player

interaction was needed, which was useful for skipping already read text and testing out other story routes.

On the top left corner of the screen was the patient status. It indicated the protagonist's current mood or status which depended on the flow of the story. On the immediate right of the status was the date and time of the current scenario, and at a later point in the game, would have also indicated the quarantine type like GCQ or ECQ for example. On the top right of the screen, [Menu] button (represented by a gear icon), when pressed showed the same buttons on the Main Menu screen: [Preferences], and [About] except that there were three new buttons present: [History] for reviewing previous dialogue, [Main Menu] to return to the main menu, and [Return] to close the menu.

On the right-hand side was a button that when tapped, would expand, and show three buttons: [Achievements], [Dialogue Events], and [Story Routes]. [Achievements] represented by a star, contained a collection of information and prevention tips related to COVID-19 that was obtained by the player during the course of the game, which the player can review to broaden their knowledge regarding the pandemic. [Dialogue Events] represented by two chat bubbles, showed a list of choices in the game where a diverging branch will form when selected. The choices that were already picked by the player in their past playthrough will be marked with a check. [Story Routes] represented by a clock surrounded by a blue arrow, was a route map that can be dragged horizontally and contained buttons that corresponded to the different scenarios in the game. If the player tapped one of these buttons, they were sent to the corresponding scenario, abandoning their current scene. The player can only go to scenarios they have been to before. Otherwise, the button will be blocked by a lock symbol and cannot be interacted with until the player gets to the scenario corresponding to the button.

There were moments in the game where the player had encountered minigames. There were a total of 5 minigames implemented in the game: [Find the Broom], [Find an Activity], [COVID Quiz Game], [Work Preparation], and [Shopping Game]. In the [Find the Broom]

minigame, the player's objective was to find the broom in the room and tap it. They can interact with the other objects in the room as well. In the [Find an Activity] minigame, the player must look for objects in the room to spend their time with, such as the television, or the phone. The player may switch rooms using the arrows on the screen. In the [COVID Quiz Game] minigame, the player is presented with 5 questions with 3 possible answers each. The player would answer the questions to the extent of their knowledge. The number of correct answers the player has gotten will be shown after the minigame. In the [Work Preparation] minigame, the player must find the items in the list (can be accessed through the checklist icon on the bottom of the screen), the game would be completed after the player got all the needed items. In the [Shopping Game] minigame, the player would be given 200 pesos to spend in the grocery store. The player's goal was to spend all of it without overspending while also buying the required items in the list that can be accessed on the bottom right side of the screen. The player can tap any grocery item in the screen which would display a menu that allowed the player to get a certain number of that item. The basket button on the bottom right corner allowed the players to check the total cost of the player's items on hand or discard unneeded items. If the player's total cost of items on hand was already 200, they can tap the basket button and tap checkout to finish the minigame.

The visual novel game had 2 types of categories for its endings, 2 endings were categorized as "Bad End", and 6 endings were categorized as "Good End". The ending summaries for the game was shown after the player reached one of the game's endings. It first tried to fetch the online records at the beginning of the ending scene and saved the player's record at the end of the ending scene. It also displayed the game's credits.

SYSTEM DEVELOPMENT METHODOLOGY

The researchers of this study followed Rapid Application Development (RAD) as their project's methodology. RAD is an agile framework that focuses on rapid prototyping of software products, iterating periodically based on reviews, and releasing modified versions of

said products to clients on a continuous basis. It enabled the researchers of this study to divide the development of the visual novel game into smaller, separate, actionable tasks, and present it to clients in less time.

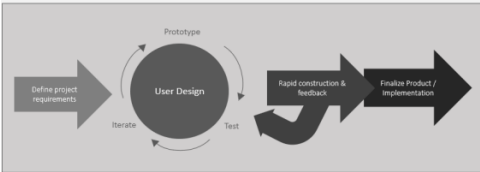


Figure 8: Rapid Application Development (RAD) Methodology

Define Project Requirements

Proponents of rapid application development began by identifying a broad range of project specifications. This planning stage was short and focusing on concept iterations as a higher priority. Goals, expectations, and schedules are examples of requirements. The clients (researchers’ adviser and panel members) gave a vision for the product, and appraising was undertaken to modify specifications with the consent of each client. The freedom to adjust conditions at any stage during the production cycle is one of the main concepts of RAD. This is also the stage at which the software and hardware requirements for the development of the game prototype were determined (see Appendix A)

Appendix A: Software and Hardware Requirements (Game Development)

Software used in Development	Minimum Hardware Requirements	Minimum Software Requirements
Adobe Illustrator CC 2014 (64-bit)	CPU: Intel Pentium 4 or AMD Athlon 64 processor RAM: 2 GB (8 GB recommended)	Operating System: Windows 7/8/10
Adobe Photoshop CC 2014 (64-bit)	CPU: Intel Pentium 4 or AMD Athlon 64 processor RAM: 2 GB (8 GB recommended)	Operating System: Windows 7/8/10
Blender 2.90	CPU: 64-bit dual core 2Ghz with SSE2 support RAM: 4 GB	Operating System: Windows 7/8/10
Google Docs	-	Browser: Chrome, Firefox, Microsoft Edge (Windows Only)
Ren'Py 7.4.4.1439	CPU: Pentium 4 1.7 GHz RAM: 128 MB	Development: Windows 10 (Operating System), Atom 1.34.0 (Code Editor) Product: Android 5.0+
Soundtrap	-	Browser: Chrome
VRoid Studio v0.13.1	CPU: Intel Core i5 4th Gen RAM: 8 GB	Operating System: Windows 8.1/10

Prototype

When the proposal was scoped, researchers started developing a basic prototype. Their aim was to quickly create a functional concept that can be shown to their client. This step was

frequently repeated as the project progressed. It is usual for proponents of RAD to cut shortcuts during the early phases of prototyping in order to generate a workable product that is acceptable to their client. This stage was when researchers worked on the visual novel’s narrative, background scenes, characters, sound effects, and the game itself. After a 1-week period, the researchers presented their progress and current prototype to their client (adviser) and revised subjects of concern accordingly.

To highlight the current and intended game prototype as well as the project requirements, certain analysis tools were employed. The following analysis tools were:

Character Modeling

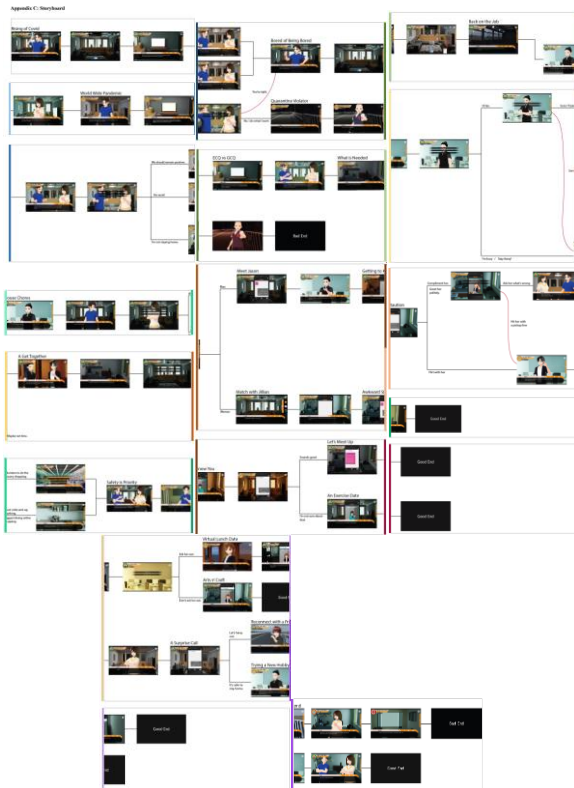
The researchers created character modeling samples (see Appendix B) representing the characters in the game prototype. The game prototype incorporated 8 character models that represented 8 characters in the game’s narrative. The models were created from VRoid Studio and were used in the game prototype as character sprites. The character models were employed in various stances to represent the various reactions that they used in the game's narrative.

Appendix B: Character Modeling Samples



Storyboard

Quarantine Life consists of diverging routes that reach different endings. Some decisions only changed the received responses while others entirely altered the game's routing. The researchers created a storyboard (see Appendix C) to represent the game's routing. It specified the chapter names as the bigger text above the pictures of the chapter. It also showed the decisions' narrative as the smaller texts near the lines which connect to their corresponding routes.



Rapid Construction & Feedback

Rapid development is the process of transforming a prototype into a functional one. This process can be replicated as needed to accommodate new components and changes. During this process, software and implementations were carefully reviewed to ensure that the final product meets the client's needs and goals. Throughout this point, clients (panel members) provided detailed feedback, recommending alterations, improvements, or new strategies to address issues as they arise. Clients have discovered

that certain ideas do not fit in practice. With this information, researchers had either restarted prototyping or, when the feedback was entirely favorable, had proceeded to the final stage.

Finalize Product/Implementation

The final stage of rapid application development is where proponents of it overcome the technological debt accumulated during early prototyping, optimizing execution to increase reliability and maintainability as they prepare the software (visual novel game) for launch. Components are transferred to a live production environment for full-scale monitoring to detect component flaws. Before comfortably giving the clients a final product, researchers had finalized the documentation and completed all the required activities. One of these activities was to use test cases to test the game prototype to check if all the pieces and functionalities worked properly (see Appendix F). The data from the testing procedure were collected by the researchers. After analyzing the collected data, refinement and modifications were implemented. Following the analysis, a conclusion was reached. Changes based on the conclusion were implemented, resulting in the best output of the game prototype.

RESULTS AND OUTCOMES

This chapter discusses and explains how the objectives of this study were met. The main objective was to develop a single-player visual novel game for Android operating system version 5.0 (Lollipop) and up named Quarantine Life. Also included in the discussion were the design and development, the functionality of the game prototype, and the testing results.

The researchers gained an understanding of the development for the game prototype and identified related literature/studies through internet research. As a result, the researchers found the requirements needed to use the prototype (see Appendix D). After obtaining the requirements, the researchers began constructing the visual novel game using a variety of technologies.

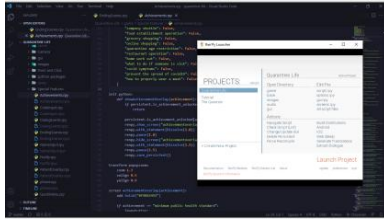


Figure 9: Ren'Py Launcher

Figure 9 shows the Ren'Py launcher that allowed the researchers to select their Ren'Py project (Quarantine Life) on the left side column. The screen on the background is a code editor (in this instance, VS Code) which is an optional software to use during the development. An emulator for the Android operating system was also used during the development. On the Ren'Py launcher, by clicking the “Android” button under the “Actions” section, the researchers were able to emulate the game prototype.

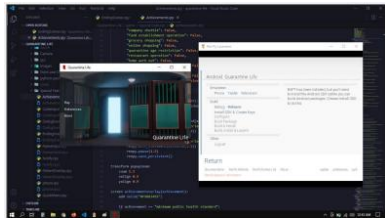


Figure 10: Ren'Py's Built-In Android Emulator

The visual novel's narrative was developed using Google Docs. The narrative included the dialogues, the scene descriptions, sound effects, minigames, and the achievements' cues and contents. Figure 11 shows some of the texts that were used in Quarantine Life's narratives.

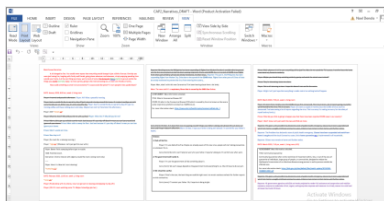


Figure 11: Quarantine Life's Narrative

The user interfaces in Quarantine Life were first developed using Adobe Illustrator. On Figure 12, these included the patient status and the date overlay on the top left corner, the buttons on the top right corner, the dialogue

box at the bottom side of the screen, and the quick menu on the right side of the screen. Any subsequent adjustments to the UI assets were done in Adobe Photoshop.



Figure 12: Layout for the Quarantine Life's Interface

The character models were created using VRoid Studio. Figure 13 shows the steps (top left, top right, bottom left, then bottom right) to create one of the characters in the game namely the Barangay Tanod.



Figure 13: Barangay Tanod's Character Model Creation

The scenes in Quarantine Life were created in Blender. Figure 14 shows the creation of the game's living room which was the commonly used scene in the game.

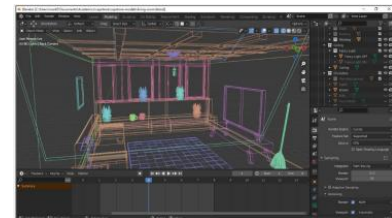


Figure 14: 3D Scene of the Living Room in Quarantine Life

The sound effects and background music in Quarantine Life were done in Soundtrap. Figure 15 shows the development of the game's main menu's background music in Soundtrap.

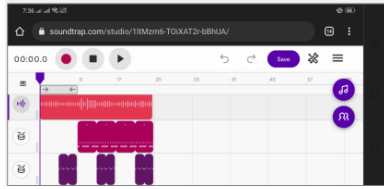


Figure 15: Creation of Main Menu's Background Music in Quarantine Life

The game's android application package (or APK) was then built using Ren'Py's built-in package builder. Figure 16 shows the steps (top left, top right, bottom left, then bottom right) that were done to create the distributed APK of Quarantine Life.

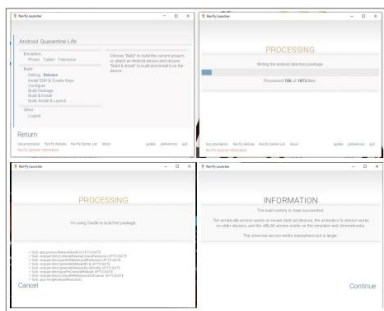


Figure 16: Ren'Py's Built-In APK Builder

IATF Guidelines in Quarantine Life

Quarantine Life added some descriptions from the IATF Guidelines [32] in the game as "Achievements". Figure 17 shows a list of achievements that were unlocked by a player. WHO recommendations [40] were also added as descriptions in the achievements screen.



Figure 17: Achievements' Screen

Quarantine Life's Minigames

The game implemented five (5) minigames in total to add interactivity and incorporate problem-solving. Most of the minigames lie in the game genre "hidden object" which mainly revolves on finding an object in a scene. One of Quarantine Life's minigames called "Find the

Broom" had an objective of finding a broom in the living room. Figure 18 shows the starting point of the minigame.



Figure 18: "Find the Broom" Minigame

Another minigame "Find an Activity" had an objective to look for objects in the rooms that players can spend their time with. One of these objects is the smartphone in the bedroom which triggers another minigame called "COVID Quiz Game". When triggered, the player would then be presented with 5 questions with 3 possible answers each. The player's objective is to answer all the questions.



Figure 19: "COVID Quiz Game" Minigame

In the "Work Preparation" minigame, the player's objective was to find the items in the list (accessed by the checklist icon on the bottom of the screen). The game would be completed after the player got all the needed items.



Figure 20: "Work Preparation" Minigame

The last minigame was called "Shopping Game". This minigame's objective was to spend exactly 200 pesos in the grocery store while also buying the required items in the list (can

be accessed on the “List” icon in the bottom right side of the screen).



Figure 21: “Shopping Game” Minigame

Quarantine Life’s Ending Summaries

After reaching the end of a route in Quarantine Life, the game would try to fetch the players’ records from an online server. Figure 22 shows the screen that would prompt when the game was trying to fetch the online record, while Figure 23 shows the screen that would prompt next if fetching was unsuccessful. Otherwise, the game would just proceed to playing the ending scenes.

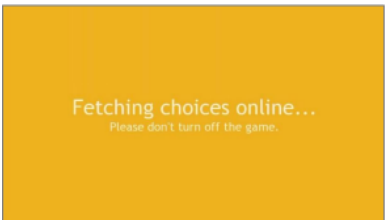


Figure 22: Screen Used When Fetching Online Records

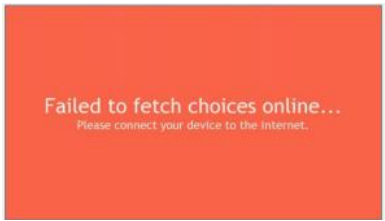


Figure 23: Screen Used When Fetching Online Records Failed

The ending scenes displayed the game’s credits as well as the ending summaries of the game. These summaries were related to the other players’ chosen decisions, and the current player’s chosen decisions. The game would display the decisions that the player chose and a corresponding percentage representing the people who chose that same decision. Figure 24

shows one of the summaries that would be displayed at the ending scenes.



Figure 24: Ending Summary

After the ending scenes were displayed, the game would try to save the player’s record on the online server. The left image on Figure 25 shows the screen that would prompt when saving was currently being done, while the right image on Figure 25 shows the screen that would prompt after, when the saving failed.



Figure 25: Screens Used When Saving Online Records

Following the completion of the game’s development, the researchers undertook a series of testing to ensure the functionality, compatibility, usability, and portability of the game prototype. Consequently, the game generally passed the functionality, compatibility, usability, and portability tests.

Functionality Test

The researchers performed a functionality test (see Appendix F) to check if all expected functionalities were functioning properly. The results of the functionality test cases revealed that all of the tests have passed, showing that the game prototype displayed properly and functioned appropriately. The functionality test includes unit testing (for features implemented in their own individual modules), integration testing (for features implemented through the integrations of multiple modules), and system testing (for the system level features implemented by the game engine). The first row (Test Case ID) in the functionality test’s table represents this distinction. Test cases with IDs starting with SFTC are system tests, test cases

with IDs starting with IFTC are integration tests, and test cases with IDs starting with UFTC are unit tests. All of the functionality test cases were tested manually by the developers.

Usability Test

A usability test was conducted to ensure that the game prototype provided a fine video gaming experience. Because video games were played in such a wide range of circumstances, it was critical that the game usability testing would take this into consideration. The researchers performed a usability test (see Appendix G) to check if the players would want to play the game. The remarks of the usability test cases revealed that all of the tests have passed, showing that the game prototype is highly engaging and playable.

Appendix G: Usability Test		
DESCRIPTION	Quarantine Life's Game Usability	
CATEGORY/CHARACTERISTIC	Usability	
DATE	06-Jan-22	
TESTER	Mark Lawrence-Feliciano	

Test Case ID	Specification	Remark
UTC1	Is the game design attractive (interface, graphics, etc.)?	Passed
UTC2	Are the text fonts and colors well identified and consistent?	Passed
UTC3	Is it necessary to learn a few things before one can play?	Passed
UTC4	Is the game able for most people to learn quickly?	Passed
UTC5	Is the game easy to play?	Passed
UTC6	Are the game rules clear and easy to understand?	Passed
UTC7	Are the fonts (size and style) used in the game easy to read?	Passed
UTC8	Are the colors used in the game meaningful?	Passed
UTC9	Does the game allow customizing, for my preferences?	Passed
UTC10	Does the game prevent me from making mistakes?	Passed
UTC11	Is it easy to recover quickly when I make a mistake?	Passed
UTC12	Did I have the impression that it would be easy for me to play when I first looked at the game?	Passed
UTC13	Is the game appropriately challenging for me?	Passed
UTC14	Does the game provide new challenges at an appropriate pace?	Passed

UTC15	Does the game not become monotonous as it progresses?	Passed
UTC16	Does completing the game tasks give me a satisfying feeling of accomplishment?	Passed
UTC17	Is it due to my personal effort that I managed to advance in the game?	Passed
UTC18	Would I recommend this game to my colleagues?	Passed
UTC19	Did I have fun with the game?	Passed
UTC20	Did something happen during the game that made me smile?	Passed
UTC21	Is there something interesting at the beginning of the game that captured my attention?	Passed
UTC22	Am I so involved in my gaming task that I lost track of time?	Passed
UTC23	Did I forget my immediate surroundings while playing this game?	Passed
UTC24	Are the game contents relevant to my interests?	Passed
UTC25	Is it clear to me how the contents of the game are related to the course?	Passed

Portability Test

A portability test was conducted to measure how easily the game prototype would be integrated into different environments. The researchers performed a portability test (see Appendix H) to check if the game can transfer properly from a different hardware to another. The remarks of the portability test cases revealed that some of the tests have passed, showing that the game prototype is not portable in other environments.

Compatibility Test

The researchers conducted a compatibility test by running the game prototype on different devices. The test checks if the game prototype can be used seamlessly across all operating systems and devices.

CTC1: Compatibility test on a mobile device that is below the game's system requirements.

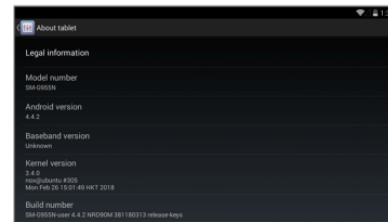


Figure 26: Mobile Device Specifications used in CTC1

Appendix H: Portability Test		
DESCRIPTION	Quarantine Life's Game Portability	
CATEGORY/CHARACTERISTIC	Portability	
DATE	06-Jan-22	
TESTER	Mark Lawrence-Feliciano	

Test Case ID	Specification	Remark
PTC1	Is the game adaptable and can be used for multiple types of devices?	Passed
PTC2	Is the game easy to install into multiple types of devices?	Passed
PTC3	Can the game be played on different types of Android mobile device (OS 5 and above)?	Passed
PTC4	Can the game handle different types of device screen sizes?	Passed
PTC5	Can the game handle different types of screen DPIs (dots per inch)?	Passed
PTC6	Can the game be used for its stated minimum RAM (512 MB)?	Passed
PTC7	Can the game be used in other operating system environments (e.g. iOS)?	Failed

The test case CTC1 tested the game prototype by installing it in a mobile device that had lower specifications than the game's requirements. Figure 26 shows the specifications of the mobile device that was used. Figure 27 and 28 show the installation of the game prototype. Figure 29 shows that the game prototype was successfully installed, but due to compatibility issues, the game prototype produced an error when opened as shown in Figure 30.



Figure 27: Installation Part 1 in CTC1

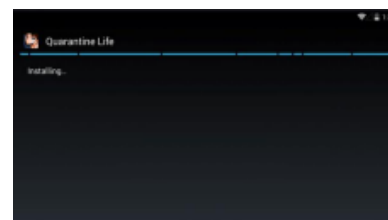


Figure 28: Installation Part 2 in CTC1

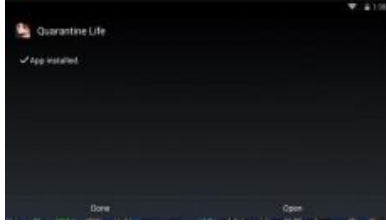


Figure 29: Installation Part 3 in CTC1

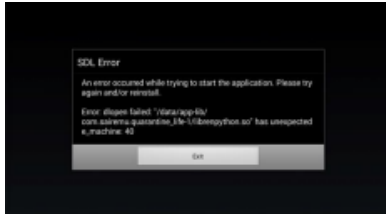


Figure 30: Installation Part 4 in CTC1

CTC2: Compatibility test on a mobile device that has an iOS operating system.

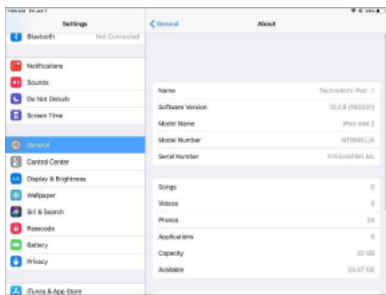


Figure 31: Mobile Device Specification in CTC2

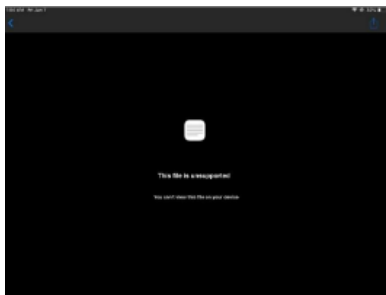


Figure 32: Installation in CTC2

The test case (CTC2) above shows that the game prototype was not able to be installed on an iOS device. The .apk file is a file format that can only be read and installed by an android operating system. Figure 32 shows that the game prototype cannot be opened on an iOS device.

CTC3: Compatibility test on a mobile device that matches the game's requirements.

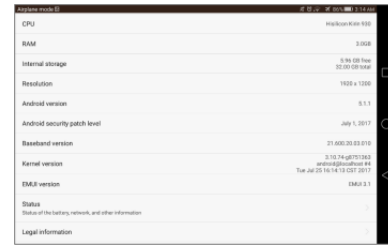


Figure 33: Mobile Device Specification in CTC3

The test case CTC3 shows a successful compatibility test to a mobile device that matched with the game's requirements. Figure 33 shows the specification of the mobile device which was an android version 5.1.1 operating system. Figure 34 shows the successful installation of the game prototype while Figure 35 shows that there are no errors when the game prototype was opened.

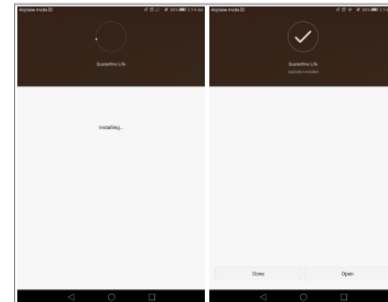


Figure 34: Installation in CTC3

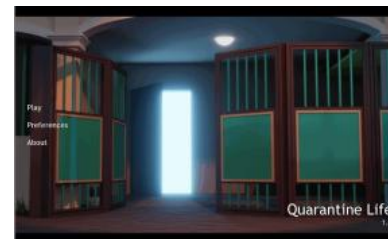


Figure 35: Opened Game Prototype in CTC3

The results from the series of testing show the successful development of Quarantine Life. In the functionality test shown (see Appendix F), the researchers proved in the results that the developed game prototype was functioning well in its desired functionalities. While in the usability test (see Appendix G), the remarks showed that the game was highly engaging and

playable. Test results in portability test (see Appendix H) and compatibility test show that the game was not able to run on all available mobile devices.

DISCUSSIONS

Following a thorough and critical examination of the study's findings, the researchers were able to summarize their findings, draw conclusions, and give recommendations about the study.

Summary of findings

Based on the test results, Quarantine Life was designed and developed successfully. The game prototype was functioning accordingly based on the specifications. To achieve the game prototype Quarantine Life, the researchers followed Rapid Application Development (RAD) as their project's methodology. Iterations were done weekly to develop the narrative, character models, scenes, background music, sound effects, and the game itself. Their clients (adviser and panel members) provided detailed feedback, recommending alterations, improvements, or new strategies. With this information, researchers had restarted prototyping several times and proceeded to the final stage when the feedback was entirely favorable.

The IATF Guidelines were used successfully to inform the players in the visual novel's narrative. These were added as unlockable information in the Achievements' screen. The integration of minigames was proven to work, and it passed the testing process. The ending scenes displayed the ending summaries successfully with their corresponding traversed percentages.

The results of the set of tests done suggest that Quarantine Life has been developed successfully. The researchers demonstrated in the results of the functionality test (see Appendix F) that the built game prototype was performing properly in its expected features. During the usability test (see Appendix G), the remarks revealed that the game was extremely interesting and enjoyable. The results of the portability and compatibility tests (see Appendix H) demonstrate that the game was able to operate on the other available mobile devices. As stated in the requirements, the game was only compatible with the Android

operating system version 5.0 (Lollipop) and up. The researchers proved that the game prototype was compatible with the said requirements.

Conclusions

The study focused on the design, the development, and the results of a visual novel game called "Quarantine Life". Based on the analysis and the testing results of the game prototype, the researchers draw the following conclusions:

Quarantine Life was successfully designed and developed based on the required specifications. The various software tools enabled the researchers to develop the prototype of the visual novel game. The integration of IATF Guidelines in the visual novel's narrative was achieved. It assisted in equipping players with realistic knowledge about the COVID-19 pandemic.

The researchers were able to develop minigames which added interactivity and incorporated problem-solving to the game prototype. The researchers were also able to present the ending summaries with their corresponding chosen percentages in the game's ending scenes.

The researchers tested the game prototype with test cases and concluded that the game prototype passed well in terms of functionality, usability, portability, and compatibility.

Recommendations

The researchers enlisted the following recommendations for the future improvement of the developed Quarantine Life prototype:

Character and Scene Customization

The researchers believed that further customizations in the game can enhance the game's playability. As the characters and scenes had fixed models, the researchers recommend adding a feature that allows players to customize the characters and scenes in the visual novel game.

Medical Minigames

The researchers recommend adding medical minigames that can give players an understanding about the basic treatment of viral infections. This is because most of the minigames that were implemented in the game revolved around the "hidden object" game genre.

iOS Support Compatibility

As the visual novel game provides realistic knowledge about the COVID-19 pandemic, the researchers recommend extending the compatibility of the game. The developed game prototype was limited only to the android operating system, and so, the researchers proposed that it will be applied to the iOS operating system as well.

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REMOTELI: Remotely Controlled Display with Raspberry Pi

Efraim M. Gabuat
Janrev Kennedy M. Galang
Jeremicah Licup
Jovillene A. Peñalosa
Arlon Luigue F. Rivera
Dennis L. Tacadena, PCpE, DIT (Technical Adviser)

ABSTRACT

There are increasing numbers of IoT devices worldwide. New inventions and innovative ideas have been created as time pass. The Remoteli project is a raspberry-pi based IOT device that is a remotely controlled display system. The goal underscores the displaying of information conveniently that advances other information disseminating means for its flexibility. Posters, local newspapers and local radio takes time and effort to release information, especially urgent news. Remoteli is an innovation to previous technology that can alter its display information anytime remotely which makes its system smart. The researchers use Prototyping Methodology to test and improve the prototype product. It allows the researchers to define the possible problems that may be encountered by the users and refine a solution until ready to implement. The researchers illustrated the system using a designing tool to overview the appearance and the layout of the website application and determine the needed features. The researcher created a test case to verify and validate the developed webbased advertisement system functionality and suitability across a set of actions or conditions to verify the expected results for more stable performance of the Remoteli and for a better user experience. With all of the tests made, the researchers concluded that the overall objective of the study and system acceptance was achieved. Better devices and a purchased domain are recommended for the system to run to its full potential.

General Terms: Raspberry Pi, Remotely, Innovations, Display, Advertisements, Announcements, Informations

Keywords: Raspberry Pi, Remote, Display, Disseminations

INTRODUCTION

The Internet of Things, or IoT, is a computing concept that refers to the concept of common physical objects being connected to the internet and capable of communicating with other devices and sending and receiving data [1]. Globally, the number of IoT devices is expanding. With the passage of time, new inventions and novel ideas have been developed. The Internet of Things is pervasive. It surrounds us from the moment we rise to the moment we return home. We're talking about an infinite number of devices, gadgets, machines, and structures that are all connected to the Web [2]. Connected devices are a component of an ecosystem in which each device communicates with other devices in the environment in order to automate household

and industrial processes. They are capable of communicating sensor data that is usable to users, corporations, and other intended parties. Consumer, enterprise, and industrial devices can all be classified into three broad categories. Smart TVs, smart speakers, toys, wearables, and smart appliances are all examples of consumer-connected devices [3]. Individuals place a high premium on information, which continues to expand in value with each passing day. Facts, figures, numbers, and images are all examples of information, as is a document, music, or a person's behavior. Information is generated when data is transformed, assessed, stored, and applied to a specific purpose. As a result of this information, people will be able to learn things they didn't know before, and it will influence what they already know. Informed decisions may be made more easily when people have access to information. Posters, local newspapers, local radio, and the previously mentioned public forums were all used to disseminate information effectively. These events were held to educate the public

about the effort. It consisted of a single newspaper issue and a few days of radio programming on community stations [4]. The internet has a number of advantages over previous modes of dissemination; information can be accessed rapidly, is easily updated, and reaches a much larger audience than printed materials do [5]. This research is focused on a Smart Display that will enable users worldwide to control the displayed display or announcement on a device (e.g. Monitor, Smart Television, LED Billboard) that contains a Raspberry Pi. The project will be built on the Raspberry Pi and have server and client capabilities. The Raspberry Pi is a small, low-cost computer that connects to a display or television through HDMI. It is capable of educating people of all ages about computing and programming. The Raspberry Pi has been used in various digital maker projects, from music machines and parent detectors to weather stations and tweeting birdhouses fitted with infrared cameras. It was created by the Raspberry Pi Foundation, a United Kingdom-based educational charity (registration number 1129409). They are committed to adult and child educational advancement, notably in computers, computer science, and related fields [6]. The goal of this project is to introduce a new way of disseminating information. Being able to control the displays and signage anywhere as long as there is the internet is one of the most important abilities of this project. Even at the time of the pandemic, our technology is upgrading and new ideas are surfacing because of the challenges that we are experiencing in our daily lives. The project will be a web-based system for it to be versatile on any device.

Background of the study

With the passage of time, the mobility of digital gadgets has become the new norm in people's daily lives. Wireless gadgets are one of the most convenient types of devices and are constantly being improved. The Internet of Things is a rapidly growing industry. There are anticipated to be 46 billion linked gadgets this year alone, and 31 billion by the end of the year [2]. According to Juniper Research's newest forecast, the Internet of Things will reach 46 billion devices in 2021. By comparison, this represents a 200 percent gain over 2016. The

entire world is currently undergoing a series of completely unexpected events. IoT, in accordance with other technology such as AI and Cloud, assists us in a variety of ways. The first solution that has occurred to most of us (and must have occurred at some point) is to track possible vectors [7]. In the time when people's mobility is important because of unexpected happenings (e.g. sudden urgency, pandemic) IoT devices may become the solution. Displaying information can attract more people into knowing what they need to know in regards to what happening around them. News, notices, and even advertisements can be able to attract the eyes of the people that are passing by. Urgent and important information can sometimes take a while to be displayed when using traditional ways. Digital signage/displays in the establishments is a way of disseminating information. Information distribution (diffusion) has always been an important social activity, however it has grown even more significant in today's information-centric cultures [9]. Many employees travel frequently or work remotely, and they may not have the opportunity to interact in person. In a fast-paced corporation trying to stay ahead of the competition, information distribution tools are vital to success [10].

Purpose and Description

The goal of this project is to introduce a new way of disseminating information. The project will be a web-based system for it to be versatile on any device. The Raspberry Pi is a small, low-cost computer that connects to a display or television through HDMI. It is capable of educating people of all ages about computing and programming.

General objectives

The general objective of this study is to introduce a new way of displaying information with multimedia with the help of "REMOTELI: Remotely Controlled Display with Raspberry Pi."

Specific objectives

In order to achieve the general objective, the following specific objectives must be met:

- To gather research data and relevant information through internet library, articles, journals and related systems.

- To identify the following requirements:
 - Hardware
 - Software
- To design website system and device using designing tools:
 - System Design Model
 - Flowchart
 - Storyboard
- To create and develop REMOTELI device's User Interface.
- To integrate IoT microprocessor.
- To test system using researchers made test case.

Scope and limitation

The study's primary focus is on the project's design, production, testing, and evaluation of the project "REMOTELI: Remotely Controlled Display with Raspberry Pi". The research data will be gathered through internet libraries, articles, journals, and related systems. With the help of the data that was gathered, hardware and software were identified. Raspberry Pi 4 microprocessor with 2GB RAM was used as the main component of the program. This model was chosen because the specification was enough to run the program. To create the website and device program a computer with Intel® Core™ i3-6006U processor, 4GB RAM, and 500GB hard disk drive storage was used. This hardware was used to initiate the project. After identifying the hardware, the researchers were able to choose which software are the most compatible for the developer to use. Visual Studio Code was used to build the front-end and back-end of the system as well as the debugging. Various browser was also used in order to test every command's executions. To run the device's user interface, Raspberry Pi OS was installed and used as an emulator. And lastly, MongoDB was used for the database of the system.

To design the website and device system, designing tools were used. System Design Model was used to visualize how the data will travel through the internet, website, and devices. The flowchart was used to picture every step to execute the general focus of the project. Lastly, the storyboard was used for the website's appearance. Each of the designing tools was created by the members to make the

system and for the developer to follow the plan in order to successfully complete the project.

To create and develop REMOTELI's user interface, the developer created a system where the user will be able to input and connect the website's identification for the REMOTELI device for the program to have a path to follow regarding fetching of the data. The integrated features on the REMOTELI device were created for it to display the information that was uploaded to the website. To display the information fetched from the website, the developer created a program for it to be able to communicate with the website using the API server. All of these commands were integrated on the backend which gives the device a unique path for the data to travel from the user to REMOTELI device. The research focused on displaying multimedia using Raspberry Pi and any display device with an HDMI port. The website acts as the channel between the Raspberry Pi and the user for them to display the information that they want to display. It has the ability to save, update, view, and alter graphics that are currently shown in public. Users can be able to make changes from afar. With the help of the panelist's recommendations, additional features were added. "Create Templates" for instance, is the ability of the website to create its own templates, and "Feed" is for the user to input information in form of text that will play at the bottom part of the display.

Test cases were created by the researchers to test the website's functionality. Numerous trials were done in order to test the system's functionality aside from the final trials which consists of three (3) trials for each feature. A team was assigned to test the quality assurance of the device itself while another team tested the ability of the system to manipulate it remotely. By going to a different location apart from the REMOTELI device, the team managed to remotely manipulate the display.

Once the project passed the acceptance testing of the board of panelists, the researchers planned to deploy the product into a marketable one. This project is generic and is available for all establishments. The researchers were unable to purchase a domain and a cloud server that would have allowed

them to fully realize the project's potential in terms of displaying multimedia data due to a lack of funds. Therefore, a free domain was used which have a one (1) gigabyte cloud storage. Only one (1) video can be played in a template because the free server cannot play heavy files. Due to the inability of the researchers to test the system on a billboard, the display became limited to indoors only. It will also only work with a display with a resolution of 1920 x 1080 pixels on a device with a screen size of 40-50 inches.

Synthesis

Technology has been improving every day, new inventions and innovations were introduced in our community. As the day goes by, people have created things that helped us with our everyday needs. A microprocessor was invented which became the main component in this study. Amidst the pandemic, the researchers were able to come up with this kind of innovation. This innovation that the researchers developed introduced a new way of displaying information that does not require regular physical contact with the device.

The traditional way of displaying and disseminating information with the help of printed advertisement (e.g. newspaper, magazine, posters) have an advantage and disadvantage. The traditional way is an accessible and credible source of information. This method is usually composed of printed materials which mean that the information is fixed, because of this, the information's lifespan is much shorter. The modern way of disseminating information also has its advantages and disadvantages. This method includes the internet and social media and most of its viewers are people who are more knowledgeable about technologies. This method provides updated information; however, information may not be credible.

Raspberry Pi is the main component of the project. The researchers gathered all the information that they may use in order to use its full potential that will bring completion to the study. Raspberry Pi is a microprocessor that is like a small computer itself making it the best option for the study. The cost of this component is not cheap yet is affordable for the researchers to purchase. The Model 4 with 2GB memory was used because the specification is

enough to run the program. The software that was used was chosen on the basis of the developer's knowledge.

With the data that the researchers found regarding the traditional and modern ways of disseminating information, they came up with an innovative way which will reach more viewers regardless of their knowledge with technologies and updates regularly. The researchers gathered data through the internet with contactless displaying information in mind. This concept was focused because people refrain from physical contact with the reason of pandemic. As they gathered related studies, they found out that there are similar researches. Digital Notice Boards were similarly studied which provides the feature of displaying information remotely. The researchers studied the logic of their study and created a program that executes the activity with more options. Notice Board is only created in the sense of only displaying information remotely while REMOTELI provides more complex features that bring the additional potential for the users to be used.

Conceptual Framework

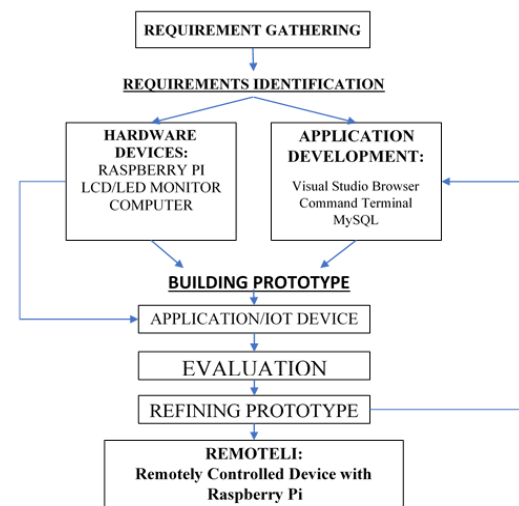


Figure 1: Conceptual Framework

The figure above is a visual representation of how the project was completed. First, the researchers gathered the needed requirements down to the process of completing the project. The requirements were gathered by analyzing how and what would be the user's needs to be able to connect to the cloud. The project uses a

website that serves as a medium that connects the user and the Raspberry Pi.

Requirements Identification

To gather all of the requirements needed, they first identified what they would use to finish the project. First, the hardware used was Raspberry Pi, LCD/LED monitor for the final output, and the researchers also be used a computer to create the codes to complete the program. For application development, the researchers used the following software; Visual Studio, Browser, Command Terminal, and MySQL for the database.

Building Prototype

Application / IOT Device

After finishing all the raw data, the researchers uploaded these data into the IoT device which is the Raspberry Pi, and the website that serves as the medium between the user and the Raspberry Pi. Upon the application, the researchers moved to the next phases to achieve the goal of the project.

Evaluation

The data obtained assisted the researchers in developing the REMOTELI's features. The system's programs and features were assessed using the test cases created by the researchers. A number of tests have been carried out to ensure the system's operation.

Refining

The users evaluated the project to refine the program to achieve a better result. In this phase, most of the debugging activities were done. After the evaluation and refining, the project was called Remoteli: Remotely Controlled Display with Raspberry Pi.

SYSTEM DEVELOPMENT METHODOLOGY

This section provides an overview of the research methods used in the review. It contains details about the participants, such as the study's eligibility requirements, who the participants were, and how they were sampled. The researchers explain why they chose the research design they did for this study and why they chose it. The instrument that was used to collect data is also mentioned, as are the procedures that were followed to conduct this analysis.

Prototyping Method

Prototyping is the method used in this project. A prototype is a working example of the

scheme. It describes the proposed system's minimal and primary functional capabilities. According to David Walker, Ph.D.; Executor Director of the Learning Technologies at McMaster University, following models are developed by refining previous iterations with the aim of achieving convergence on the target end result. Evolutionary architecture or systematic growth are two terms used to describe this design approach. In software design, device construction, and electronics engineering, different types of prototyping are used.

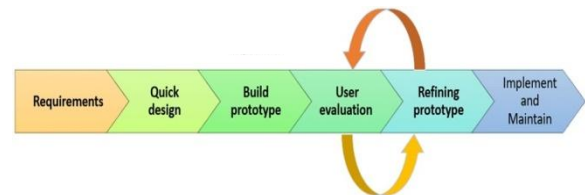


Figure 2: Prototyping Method
(Source: www.guru99.com)

The image in the figure above shows the visual representation of a prototyping model. Base on the figure, the project was first met with all of the requirements needed to be able to provide a system. There are several steps for the system to be completed. Remoteli is a digital advertising IoT project that will help the business advertise at the specific place without going directly to the location. Users can be able to remotely control it anywhere they are. Prototyping is the most applicable method that is used in this project for it represents all the needed steps to make the project complete in the better way possible.

Requirement

A requirement analysis is a critical component in developing a prototype model. The researchers were able to put their information from the linked literature and studies used. Many ideas, concepts, and strategies were developed after obtaining information about the project. The researchers focused on the big picture of the project and experimented with several languages and tools. The developer chose Angular for the back-end, which is appropriate for successful cross-platform development and more lightweight web applications. The operating system for the Raspberry Pi was Raspberry Pi OS, which is the

company's official supported operating system. The researchers were able to determine which prototype approach was appropriate for the project, thanks to the technical adviser's help and understanding. The system's software and hardware needs were eventually implemented.

Quick Design

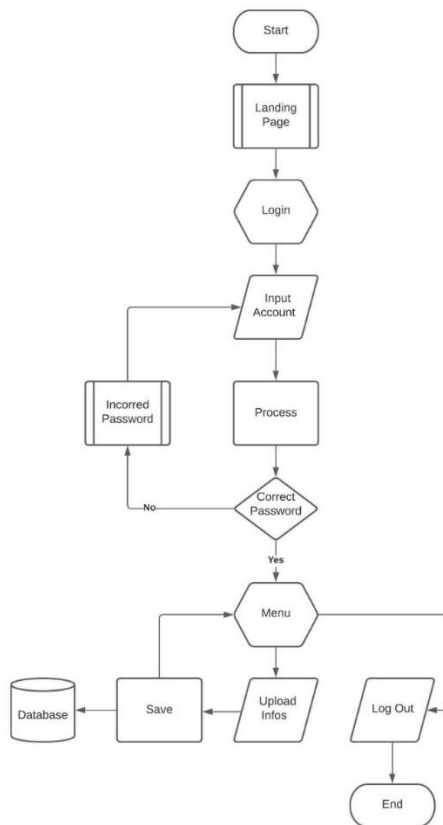


Figure 3: System Flowchart

The figure above presents the visual representation of the website and shows the initial process of how the system functions regarding the login, media files, playlist, and other features that are available in the system. It indicates that the data that are gathered are saved into the database.

Build Prototype

Building a prototype in this project required installing the Raspberry Pi OS (formerly known as Raspbian). It is similar to an emulator which shows a virtual computer inside the computer. Raspberry Pi OS shows the output that will be displayed on the finished product which makes it a good choice for prototyping and testing. The

researchers used localhost to view the output offline.



Figure 4: Raspberry Pi OS

Upon starting the device, the initial activity of the system will show the player which contains the information. The program will be executed to display the information that is scheduled. Users can manipulate the display using any device that is connected to the internet because the system is web-based for device versatility.

User Evaluation

In evaluating the system, the researchers tested the system every time a and data is added. Upon testing the website, the users found some errors when it comes to navigation. The system was honed as the user evaluates it to become user-friendly. In terms of the service itself, it is more efficient if the system has default templates than creating a new template. Creating a new template is always available. The user will only need to enter the area of each zones with the maximum resolution of 1920x1080.

Refining Prototype

In refining the prototype step, the researchers created a website that have a more user-friendly program for the clients to have a more understanding of the system. The researchers plan to test the project much frequently to avoid missing the errors. The recommendation that the panelist provided also helped the researchers to refine the project in a much better version.

Implement and Maintain

In implementing and maintaining steps, the system was uploaded to the board which is the Raspberry Pi Model 4. After uploading the system, the board was called "Remoteli". The researchers supported the group of the project that focused on watching the system for possible bugs and memory fluctuation.

RESULTS AND OUTCOMES

This section showed the results and outcomes based on the objectives of the study and the research output must be presented in an organized and presentable manner. These discussions and conclusions are also based on the study objectives, completed analysis, and testing of the developed application prototype.

The study covers primarily the design, development, and testing of the application prototype entitled “REMOTELI: Remotely Controlled Display with Raspberry Pi.”

Data and Requirements Gathering

First, the researchers successfully gathered data from the internet library research, internet research journals, and collaborations to give the researchers enough ideas, information, and a deep understanding that would help in the development of the mobile application integrated with the microprocessor prototype. The researchers used the internet to hold collaboration sessions through virtual meetings and to gather informative ideas. During the scheduled virtual meeting, researcher team members would be given a series of tasks by the project leader for them to perform. With the help of JiraSoftware, the researchers were able to keep track of each member’s activities regarding the project (See Appendix G).

Second, the researchers identified and used the required hardware (see Table 1) and software (see Table 2) in the development process of the web application. The hardware that the researchers used in the design project was a Raspberry Pi microprocessor and a 40-55-inches LCD/LED monitor for output view results. For website development, the researchers used the following software: Visual Studio, Web browser, Command Terminal, and MongoDB for the database.

Third, the researchers used the Prototyping methodology (see figure 2) to guide and track the mobile application and microprocessor-based prototype development. The researchers discussed each task and documented each development phase output, work, and make sure all task targets are achieved at the most expected output of the developed web application.

Table 1: Hardware requirements during prototyping development

Software	Description
Visual Studio Code	A reimaged and streamlined code editor for developing and debugging modern online and cloud apps.
Browser	A software program to present and explore content on the World Wide Web.
Raspbian/ Raspberry Pi OS	A Debian -based operating system for Raspberry Pi.
MongoDB	Cross-platform document-oriented database application that is open source. MongoDB is a NoSQL database application that works with JSON-like documents and optional schemas.

Table 2: Software requirements for website and microprocessor prototype development

Component	Description
Raspberry Pi 4 Microprocessor	Broadcom BCM2711, Quad core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz
Processor	Intel® Core™ i3-6006U Processor
Memory	4GB
Hard Disk Drive	500GB

4.2 Design and Development Phase

Fourth, the researchers designed and illustrated the system using designing tools to overview the appearance and the layout of the website application and microprocessor prototype.

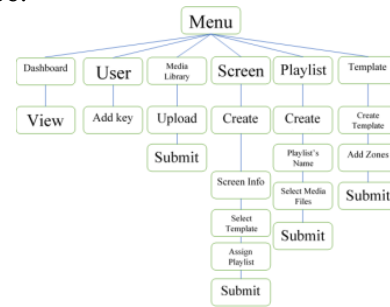


Figure 5: Visual Table of Contents

The figure above shows the main menu of the system website. The researchers came up with

the features that the user will be needing to execute the action of displaying information remotely. With the help of the panelist's recommendations, additional features were added to provide more options in terms of the main focus regarding the project.

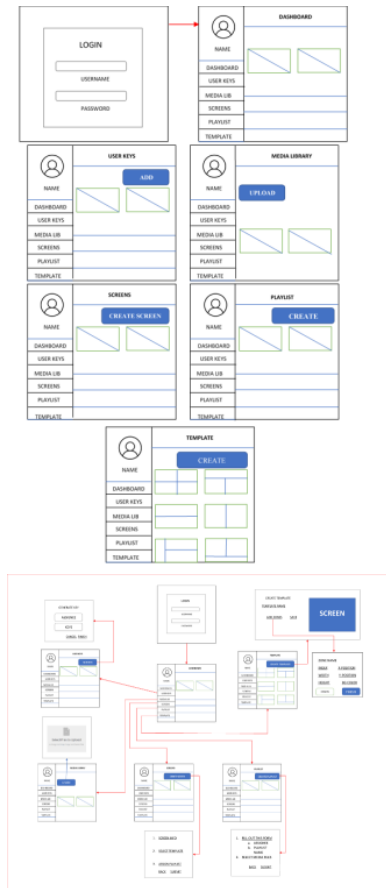


Figure 6: Website Storyboard

With the help of the volume table of contents, the researchers created a simplified storyboard that contains the main menus and their designs. This was used as a basis to complete the website design and user interface. Each section was made in a user friendly maner for the user to easily navigate the website. Every feature contains function (See Appendix D Detailed Storyboard) to complete the activity.

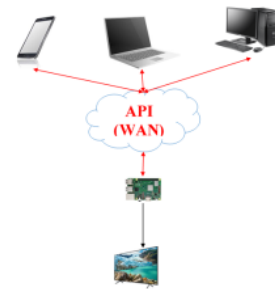


Figure 7: System Design Model

The last diagram shows the system design model of REMOTELI. The diagram contains the information on how the data travels from the user's device to the display device. In this diagram, the researchers used the red lines to indicate that the device is connected through the internet while the black line means that the device is physically connected to the other device. User's devices (e.g. smartphone, laptop, personal computer) are connected to the internet as well as REMOTELI. Giving it the ability to be manipulated remotely.

Fifth, the researcher used the software development tools (see Table 2) to translate designed diagrams into working system. The researcher successfully developed and created a system that would able to display personalized multimedia (see Appendix B User manual). Using browser, the user would able to remotely configure and interact with the Raspberry Pi microprocessor web menus; select design, upload, view, save and update images; and published it through display device connected with HDMI port of the microprocessor. The microprocessor's user interface is created in order to connect the system to the website (See Appendix F).

Remoteli's User Interface

The following are the features and details of REMOTELI website. Designing tools and panel recommendations were followed by the researchers to complete the website. Proceed to User Manual (Appendix B User Manual) for the page's appearance.

Login Page

It is the page where the user input the needed details which are the username and password to access the website and its functions. A login page was made for the user to have access to the website. Researchers built it for the privacy

of the user and for they are the only ones who have the authority to manipulate their displays.

Dashboard

This is a menu that shows a set of graphics, tables, gauges, and other visual indicators that can be tracked and interpreted. The dashboard will show the number of users, people who are logged in, and the updates within the system.

User Keys

This particular page shows the keys that are generated. This shows their status updates whether they are online or offline and the date the keys are generated. Users can also generate new keys on this page. This function was made for the user if they want to add another device.

Media Library

Here is where the users upload media files (e.g. images, videos, and texts). Once the media files were uploaded, they will be saved in the website until the user decides to delete it. This will be the main cloud storage of the system.

Feeds

This feature allows users to upload text material that will appear in a carousel format at the bottom of the screen. Carousel is a slideshow that cycles through a succession of content on this page, which will include text. This feature was suggested as an inclusion by a panelist.

Screens

This page is for the users to create a particular screen. This feature was made to organize the playlists that will play in any zone of a template. This will be what the viewers will see in the display devices. They will be entering the name on the screen, which template, and which playlist they will be playing on that screen.

Playlist

The Playlist page is where the user will be creating a playlist of the media files, the duration of each file and their order. Playlists are played in each zone. After creating a playlist, the user may customize any changes, including adding content, deleting, duration, and sequence.

Templates

This page is where the user finds the default templates. There are ten (10) default templates that are ready to use. The user can still create a new template using the feature "Create Template".

In creating a template, the user creates zones which are the parts of the screen. They will enter the preferred size of each zone and the maximum size is 1920x1080.

Testing

Sixth, the researcher created a test case (See Appendix E) to verify and validate the developed web-based advertisement system functionality and suitability across a set of actions or conditions to verify the expected result for the more stable performance of the REMOTELI and better use of the user. This table shows the trials for the project to achieve the final output. Every function was tested three (3) times to ensure there were no errors. The developer discovered flaws in the API codes during the initial trial, resulting in multimedia files being unable to be displayed at all. Guidance from a professional was sought in order to solve the error. Some logical error was also found after accidentally unplugging the monitor's power where the program was not executed, instead, it showed the operating system of Raspberry Pi.



Figure 8: Trial

The researchers allowed more time into completing the website and its features for it is the most complicated area of the project. The language that was used is typescript which is the most compatible for the developer to achieve the final project. The server that the researchers used is a free service which is Heroku, a cloud-based platform as a service (PaaS) that allows developers to create, execute, and manage applications completely in the cloud. The server needs to be maintained all the time for it to work properly. Unused files must be removed for them to have enough space. Each and every function were completed with the project's main focus in mind. After these trials, researchers found out that each and every part of the project is working properly.

Finally, the board of panelist, capstone adviser, and technical adviser in the completion of “REMOTELI: Remotely Controlled Display with Raspberry Pi” was accepted. The researchers developed the mobile application of this capstone project, and can be freely downloaded at the website domain address of <https://rcdt-dashboard.herokuapp.com/login>.

DISCUSSIONS

This section contains the summary of the findings, conclusions, and suggestions based on the findings Remoteli: Remotely Controlled Display with Raspberry Pi.

Summary of Findings

The researchers followed each step of the prototyping model in order to achieve the best outcome that they could achieve. They analyzed the whole picture of the project in which they come up with the objectives that were presented. Numbers of trials were done before moving on to the next phases. As the problem arises, the researchers were able to master the whole program itself. Recommendations that were given by the panelists were carefully analyzed and done by the developer. Each of the software used was tested whether it works the best with the program or the developer needed to use a different one. The software that was specified was the best one to use, and works well with the program. Additionally, the researchers came up with a better feature that will enable the user to create its own template.

One of the findings is that one (1) the video must only play in a template. Meaning, if there are four (4) zones in a template, only one (1) zone may play a video for the server to execute the program accurately without occurring any error.

Finally, the researchers were able to produce the main focus of the project which is a remotely controlled display where users can manipulate the displayed multimedia in a certain location even without visiting its physical location of it. Note that the displays will become clear as long as the resolution of the media file suits the size of the monitor. Out of all the monitors that were tested, the most compatible monitor size for the project is a 55-inch smart television. Nonetheless, as long as the monitor is a horizontal rectangle with 40-

55” display size and a high-resolution media file, the display will be clear/readable.

Conclusion

To verify the hardware and software functionality, the researchers developed test scenarios. Both hardware and software appeared to be in good working order based on the test case replies. There were more initial trials from the beginning while completing the project. REMOTELI is capable of executing the focus of the project which is remotely controlling the display. With the additional features, the researchers were able to add more options for the user.

The researchers were able to construct the needed diagrams to complete the project, and developers were able to develop the system website, and the REMOTELI interface with the given diagrams and model. Each diagram was followed precisely up to the last figure. Each website feature is working 100% without any error.

REMOTELI is working without any problem arising. After setting up the device, the REMOTELI executes the system program. Switching on and off the monitor will not intercept the system. The display will continue to flash the screen as long as the device is plugged. Therefore, with all of the evidence, the researchers concluded that the overall objective of the study and system acceptance was achieved.

Recommendations

The researchers examined the following suggestions for improving the created Remoteli prototype in the future.

- Make a durable case for it to be able to be used outdoor (e.g billboard).
- Additional codes and programs for it to be applicable with billboard interface.
- A server with higher storage will help the project to avoid possible server errors regarding full cloud storage. More complicated displays and templates could be displayed with high cloud storage.

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Save Them: A Mobile Game Cooperative Platform Game

Clifton Miranda
Ryan Marc Musni
Ma. Jiewel May Gutierrez
Matthew Paunel
Ralph B. Cadalzo, MIT (Technical Adviser)

ABSTRACT

The gaming industry is expanding all across the world, and smartphones are playing an important part in this expansion. The researchers came up to idea to build the game “Save Them” a mobile cooperative platform game, with a 3D (Three-dimensional graphics). The game contains a single player and multiplayer mode, and the player may pick whatever mode players wants to play. In single player mode, there is a choice of stage, which is easy, moderate, or difficult, and each stage has three levels that can only be revealed if the player completes level 1. In Multiplayer mode, three players can convene in a room where they must collaborate to complete the game, and it has the same three stages and three levels as a single player. The basic purpose of this game is to defeat all of the enemies in each level and to conquer all of the map's obstacles. Data gathered from members and online research provided the researchers with ideas, knowledge, and a better grasp of the design and development process. Blender and Photoshop were employed by the researchers as design tools. The researchers utilized a 13-5th Generation CPU with 8 GB RAM and an Intel HD Graphics 5500 running Windows 10. The game was created using the Unity IDE program by the researcher.

CCS Concepts: • Computer systems organization → Embedded systems; Mobile Game • Mobile Game Development → Android Application

General Terms: Design, Performance, Multiplayer

INTRODUCTION

A video game or also known as a game is a digital entertainment that can be played or interact electronically, where it can only be played on devices that have a video display. Video games have been greatly developed since 1952 up until now. [1] The idea of multi-program video game “Brown Box” was from Ralph Baer, the originator and known to be the father of video games, licensed his invention to Magnavox, who offered the system in 1972 to consumers as the Odyssey, the pioneer amongst home console video games. The rudimentary Odyssey console would commercially sputter and die away over the next three years. Baer’s curiosity about the TV sets in American homes was the start of the creation of the first home video game by proposing to the television company. His plan to integrate games into television sets brands in order to make them different from

competitors was denied, but Baer thought to understand fifteen years later that the idea still had potentials; one of the 28 games of Odyssey was the motivation for Atari's Pong. The success of Baer’s exploration for the brand-new use of television took place between 1966 and 1968 which became a revolutionary invention because it changed the technology for entertainment, and nowadays also became for educational purposes and also, the Atari 2600 (also called Video Computer System) was debuted in 1977 as a home system with joysticks and multi-colored game cartridges, thereby launching the second generation of video game consoles [2] Games nowadays also become a way to escape the stressful reality of those people who usually play it. People who used to play a lot of video games have been called gamer and used the term “escapism”. For some reason, video games can provide the feeling of having control of the circumstances that cannot do in real-life situations, providing with a lot and a wide range of choices. [3] Games never got out of trend and evolve in different platforms and genres and one of these is Video games which the gamer tend to do and experience some of the experience and cannot do in the real world According to Daniel Paiva, the cell phone plan in the United States

increased from 97 million in 2003 to 148 million in the next 3 years.

Because of the widespread of mobile games nowadays, the developers had observed that a lot of people are getting too used to play mobile games, that is why the developers are developing a linear mobile game application that can give or share information to the users through a game, and information that may be helpful for the users to learn something from the project game, which it will save the user get such diseases like influenza(flu), dengue, and cholera.

Even though mobile games are becoming popular and available looking back in time, playing games on a personal computer or PC made a huge difference in what people experience today, and it can also help a lot of people especially students that are now facing virtual education system, from simple dots on a screen from a living room size computer to high graphics 3D on a space-saving desktop computer or laptop made a huge of impact in lots of people.

Background of the study

Influenza, cholera, and dengue are a few of the diseases that may cause a huge problem to some countries, and a table of contents so to the whole world. Influenza is a contagious illness in the respiratory system that can infect the nose, throat, and lungs. Influenza is not the same as a common cold. In contrast to the common cold, influenza (flu) can cause serious health complications such as pneumonia, otitis media, and worst, death. Meanwhile for cholera, it is an infectious disease that can result to a severe runny diarrhea that, if it is not treated immediately, it may end to dehydration, and worst death. Cholera can be usually occurred through contaminated food or water by the infection's feces; it is caused by consuming food or water that have been contaminated by feces (poop) with the bacterium *vibrio cholerae*. The disease is most prevalent in a poor community areas, inadequate hygiene, and water. Lastly, is the dengue, female mosquitoes, *Aedes Albopictus*, or primarily known as *Aedes Aegypti* can transmit dengue virus. these mosquitoes are also the carriers of chikungunya virus, yellow fever, and zika virus.

Dengue fever is ubiquitous in tropical regions, and the local risks vary greatly due to rainfall, temperature, relative humidity, and rapid unplanned urbanization. Dengue fever causes many diseases. This can range from mild illness (people are not aware if there is someone infected) to severely similar flu symptoms in an infected person.

The term pandemic is derived from the Greek etymology “pan”, meaning “everyone”, and “demos” meaning “human”. It is a term that is used to describe the rapid spread of infectious diseases in various countries or around the world. Pandemic is defined as the global spread of a new disease. A new virus or strain that has not been activated for ages or for the first time is what caused it. This rapid spread of viruses among humans will cause a large number of deaths, and because of the uncontrollable dissemination of diseases, it often causes social damage and economic losses. Quarantine does not have to be frightening, it is an effective method of protecting the person from public contact. The period of quarantine reduces the possibility of a person's acquisition of illness that may spread to multiple people. Home quarantine is implemented by governments worldwide to prevent the spread of diseases and it is reserved for individuals who don't experience any symptoms.

There is a safety protocol for influenza, cholera, and dengue. For influenza, the only respiratory virus that can be prevented by vaccination is influenza. Hands should be frequently washed with water and anti-micro bacterial soaps, or at least with hand sanitizer. Using a tissue paper when covering your mouth from cough and sneeze is highly advised. The most widely known way for germs to enter your body is through touching your face with unclean or unsanitized hands. Your immune system can be strengthened by smiling and laughing. To support your immune system, eat well-balanced, nutritious meals. Exercise boosts your immune system and speeds up the recovery process from illness. Stay at home for 24 hours without taking any fever-reducing medication. For cholera, make sure to only drink water from unbroken sealed bottles. Boiling water is the most efficient solution to make it safe to drink. Clean properly with soap and safe water before reusing your food

preparation surfaces and kitchenware and allow to dry completely. Hands should be washed with soap and warm water on a regular basis. Use latrines or bury your waste and don't defecate in a place where the water comes. Cook food thoroughly, especially seafood, keep it covered, and consume it hot. When cooking shellfish such as crabs and crayfish, until cooked thoroughly heated to avoid eating raw foods. Keep the kitchen area clean and tidy, and places in the house where the family bathes and washes clothes. And for the dengue, long-sleeved shirts and long pants are required. Repellents such as permethrin should be applied to clothing. Use a mosquito repellent such as deet that has been approved by the environmental protection agency, if you are going to an area where there are a lot of mosquitoes, consider using mosquito netting, close the screens on windows and doors to prevent mosquitoes from entering enclosed spaces and stay away from any areas where there is standing water particularly at times of high mosquito activity, such as dawn and dusk.

The inspiration of developing the game title "Save Them" came from the idea of the Covid-19 pandemic, since the pandemic spread in almost every country and even the world, most of the affected countries were highly distressed by the disease, the government locked down some parts of the country and forced people to stay at home. Through then, the researchers gained this idea and decided to develop an informative game. Instead of focusing on the Covid-19 disease, the researchers used other more diseases to provide more information that can be shared with the users to save them from the diseases. By using the gaming platform, the researchers hoped to introduce the game to share and provide information to the users while playing it.

The game will be a 3-Dimensional action-cooperative platform game. wherein the graphics are optimized and it can run on at least android 7(Nougat) version of android operating system. The Mechanics of the game is really simple. The game has the objective to kill all the monsters in every stage of every level. To control the game, the user only needs to touch the left and right button for the

movement and the icons for the attack and jump for the action.

Objectives of the study

The objective of the study is to create a three-dimensional game extreme programming technique as a development framework. The purpose of this game is to provide in-game scenarios and trivia that will assist users learn more about diseases and their corresponding history. Along with this, it will provide information how common diseases are transmitted, the effects of the disease, and the precautionary measures and procedures to save the user from disease transmission.

The study aims to accomplish the following specific objectives:

- To develop a three-dimensional (3D) Cooperative Platform Game,
- To develop three game stages per level of difficulty which are the easy, moderate, and hard level, that will let the users play cooperatively,
- To develop three types of monsters including the boss for the user to fight, and all the monsters as the diseases that players will encounter.
- To create a multiplayer option for the game using Wi-Fi that would allow three players to play collaboratively.
- 1.2.1.5 To integrate mobile application and IoT-based automatic pet feeder system prototype.
- To develop 3 types of characters in the game, where the user will have the freedom to choose who the user wants to control in multiplayer mode.
- To develop cut scenes, scenarios, and trivia from the game to utilize the information to the players about illness transmission, impacts, and precautionary measures.
- To test all the game features and functionalities using 3 different types of test cases which is Unit Testing, Integration Testing, and System Testing

Scope and limitation of the study

Develop the abilities needed to create complex interactive gaming systems, preparing the researchers to work in a variety of industries ranging from entertainment to defense, health care to corporate, and education and government, where the usage of games and

game technology are critical. In a variety of industries, game development is a significant tool for modeling real-life training, problem solving, and research.

The first step that the researchers are familiar with is the information technology. Computers are used to process, store, and exchange all types of electronic data, within this broad definition. Information technology has progressed at a breakneck speed, with what once stationary computers evolving into personal computers, then cellphones, and so on. The researchers examined how each step of technological advancement influenced what a game development before and today, based on what video game developers had to perform in the 1970's.

The researchers needed to learn more about Android programming because the researchers needed tools to produce games. The researchers, being the game developer now, are significantly different from 40 years ago. Nowadays, the scope is much broader and the production is much larger. The researchers see that information technology has significant influence in game developers, and developers in general. The tools that the researchers managed allowed the users to connect with other users.

As a result, game development is a very valuable instrument for learning a wide range of technological advancement and abilities.

The researchers used extreme programming techniques in order to provide higher-quality software that can easily track the game's goal and progress.

Furthermore, the study aims to develop a three-dimensional (3D) cooperative platform game featuring three game stages with different levels of difficulty (easy, moderate, and hard), nine varieties of enemies, including the game's big boss, and three sorts of characters. It also has a multiplayer option that can accommodate three players. Cut-scenes, settings, and trivia were also developed by the researchers.

Its purpose is to provide the players with information and knowledge on how to prevent the diseases which are Influenza (Flu), Cholera, and Dengue. This game also provides stories and trivia about the common diseases that may greatly affect the lives of the people. Also,

discuss the precautionary measures and procedures in order to avoid the transmission of the diseases which will help and save the user if someone contracts this kind of ailment.

With the development of three-dimensional games, the game content and game mode give a more realistic view. Along with this, there will be three levels of difficulty which are the easy, moderate, and hard. Each level will have 3 stages, and in every stage, there will be fifteen enemies that the players or users will kill, and fifty percent of the enemies will drop items. Here are some of the following types of monster; red slime, dark green slime, and red germs.

Once the game started, the user will see the HP bar on the upper left part of the screen, and on the lower left part of will be the left and right arrow, which serves as the movements of the characters. The upper middle part will be the level and stage. The lower right of the screen is the attack, skill, and jump icon. When you tap one of the icons, a designated action or animation will perform. The upper right corner locates the pause icon. Once the pause icon is tapped, the pause menu screen will pop up, and the user may choose between resume or main menu button. When the character dies, a window will pop up which contains the replay and quit button.

On the multiplayer page, the user will see the connect and back button, when you tap the connect button, the user may choose either to invite or to join with other players, the users can connect and play with each other via Bluetooth. Once the user decided to play with each other, the users may choose their character. There are three characters in the multiplayer mode; they are Yoru the attacker, Breach the tank who has strong defense, and lastly Amy the healing support.

On the settings screen, is a slider for the user to adjust the volume, developers' button to see the names of the game developers, and the back button to go back to the main menu.

For multiplayer mode, the minimum number of players that can play together is two, and the maximum number of players is three. Player versus player will not be available in this game; instead, it will be Player versus environment, as the users or players need to work together to finish the game.

Meanwhile, various players will all be in the same match, server, or level, and will have the same experience in real-time. However, it must be on the same exact game area, not just the same game. In this game, researchers have decided to create a multiplayer game for those who want to play with the friends. Playing with friends makes it easier for the user to complete the game and more pleasurable to play.

On the other hand, the cooperative gameplay allows users to collaborate with one another to defeat other players or AI opponents. Players can help one another in various ways when playing concurrently, including handing weapons or goods, healing, giving cover fire in a combat, and completing cooperative actions like propelling a teammate up and over obstacles. In this game, the users must work together to defeat the monsters and progress through each level or stage of the game. Players will gain a better understanding about the value of teamwork, as the result of participating in the cooperative game.

The researchers used the UNITY game engine and BLENDER to create the 3D design of the game. The Unity engine was chosen because it enables the game to be developed for a wide range of platforms, including computers, gaming consoles, augmented and virtual reality environments, and mobile devices. It has a free and pro version for more advanced features. It is also used to test all of the game's features and functionality. Researchers, on the other hand, used Blender as it includes all of the features found in any 3D application, such as rigging, texturing, and animation, and mostly game engine. All are required for the game's development.

The study will be conducted in mobile devices powered by android system. The android version where the game can be played will be at least version 7 (Nougat). This game works via Bluetooth, and it is only available on the android operating system.

This game will be launched through t different types of test cases like functionality test cases, user interface test cases, performance test cases, integration test cases, usability test cases, database test cases, security test cases, and user acceptance test cases. The game is also linear.

Due to design constraints, this study does not cover browser, PC, or iOS playability.

SYSTEM DEVELOPMENT METHODOLOGY

This section is intended to arrange and display the research design in the proposed study, as well as to illustrate how the project is being developed in accordance to the methodical practices and methodologies.

Extreme Programming (XP) is an adaptable software development paradigm that attempts to improve the development team's quality of life as well as the quality of their software. In terms of proper engineering methods for software development, XP is the most detailed of the agile frameworks.

The researchers utilized Extreme Programming (XP) since it is the best methodology for developing a game. Extreme Programming can keep track of each work and the game's progress. Extreme programming, according to the academics, can result in a high-quality game. The researchers found that Extreme Programming is the most effective technique to produce a high-quality game while meeting the expectations of the client.

Extreme Programming (XP)

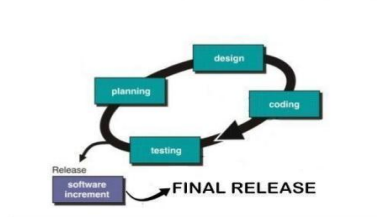


Figure 1: Extreme Programming(Source: atesting.wordpress.com)

Planning

During the iteration planning phase, the researchers gathered to conduct a brainstorming session to collect each member's idea, then the researchers conducted the study by gathering information on the internet to wrap up all the project ideas to be developed. Finally, the researchers collected all the possible ideas from the related literature and studies to add more features and improve all the conceptualized ideas. The researchers examined and studied all of the information attained before deciding to create an informational platform game and consulting

the capstone adviser to optimize the game's development and to develop a three-dimensional (3D) Cooperative Platform Game. The researchers came up with the title "Save them".

In constructing the game, the researchers were devoting nearly their entire academic semester to finish the first half of the game. The researchers divided down the assignment, focusing on each characteristic, and collaborating with the leads in each area (such as animation, programming, documenting and etc.) and intended to develop three-game stages per level which are the easy, moderate, and hard levels that let the users play cooperatively, because it may face nine types of monsters including the big boss that the users will fight, and all other monsters will be based on the diseases. The researchers estimated the starting time needed for each task and assign it to one another. The researchers were constantly informing each other on the progress through messenger. One of the researchers was tasked to enter all of the files to a project management software package, such as Microsoft Word. The researchers discussed and clarified the flaws, and backed each other up to rectify all of the possible mistakes.

Requirements

The accompanying hardware, software, and smartphone/mobile phones are the details of the specification to construct the game and test it in on each Android phone device. The researchers make use of this specific hardware and software.

The tables below indicate the hardware and software requirements that the developers used throughout the game's development.

Table 1: Minimum Hardware Requirements for Developer

Hardware	Specification
CPU	At least 13-5th Generation Ryzen 3 2200g
Ram/ Hard drive	8gb ram 500gb
Graphics Card	Intel HD Graphics 5500 Radeon Graphics

Table 2: Software Requirements for Development

Software	Description
Unity v2021.1.3 (64bit)	Is a cross-platform game engine developed by Unity Technologies.
Photoshop	Is a raster graphics editor developed and published by Adobe Inc.
Blender	Is a free and open-source 3D computer graphics software tool used for creating animated films etc.

Table 3: Smartphone Requirements for Development

Device Specification	
Android Version	Version 8 - Oreo
RAM	2GB RAM
Internal Memory	32gb

Table 4: Minimum Hardware/Smartphone Requirements for User

Device Specification	
Android Version	Android 10
RAM	4GB RAM
Internal Memory	64gb ROM

Designing

Following the completion of the planning phase, the researchers commenced the designing procedure. The researchers used Data Collection methods to show the game's functions. All of these resources helped promoters describe the game's flow to readers, academics, and users. This method also includes regular discussions among the researchers and meetings with the advisors every two weeks to outline the most significant components of the research.

The game developers utilized Blender to create a variety of objects that will be included in the game and loaded into Unity. The developers also deliberated to develop a multiplayer mode that may allow three players to play the game cooperatively, and also to develop 3 types of characters in the game, where the user will have the freedom to choose which one to control in multiplayer mode. After creating all the game's necessary components, the next

stage was to utilize Unity to build the game's mainframe and then verify the operation of the system using the C# programming language.

A Storyboard was used by the researchers to show the characters, storyline elements, tone, actions, gaming functionality, and any other components of the game in a logical order. The researchers were able to identify holes in the gameplay and storyline by storyboarding the game, and be able to design plot elements to fix any flaws or add some richness to the game. Spending time in the story boarding phase was extremely beneficial to the researchers' design process. It helped assist the researchers in putting plot point ideas into a logical flow and fine-tuning the pacing for optimal effect. This implies that researchers check to see whether anything is missing — long before the game is developed.

The researchers chose Blender and Photoshop because it enables developers to easily assess what work remains to be done. As a result, everyone was able to see what has been completed, what just recently completed, and what needs to be completed. It also assists the team in visualizing the consistency and linkages of project outcomes. Using Adobe Photoshop and Blender, the researchers create an outline and draft of the game's main object.

Coding

Following the design process, the codes must be implemented. All of the game's functionality must be implemented as a program in order for the game to function. The functioning of the items and characters must correspond to the flow of the game. Unity Software will be used as a game development platform, while the C# language will be used for coding. These are the prerequisites for finishing the game.

Testing

The researchers were meeting once or twice a week to discuss individual instances. If the criteria were met, the researchers would additionally track the game's progress. During the discussion, the researchers addressed the recommendations as well as what the other members needed to offer. Examined game documentation to check if the capstone team followed the project specifications. After gaining clearance from the course instructor, the capstone team modified the documentation.

RESULTS AND OUTCOMES

This section includes the researchers' analysis and interpretation of the test scenarios. The Test Cases are utilized by the researchers to evaluate the game. The researchers meticulously calculated the results.

To develop a three-dimensional (3D) Cooperative Platform Game. The developers utilized Unity software to construct the game, which must be a three-dimensional game with solid features that would please the user.



Figure 2: Save Them in Game

To develop three game stages per levels which are the easy, moderate, and hard level that let the users play cooperatively. The developers used unity software to create the three levels, each of which contains three stages.

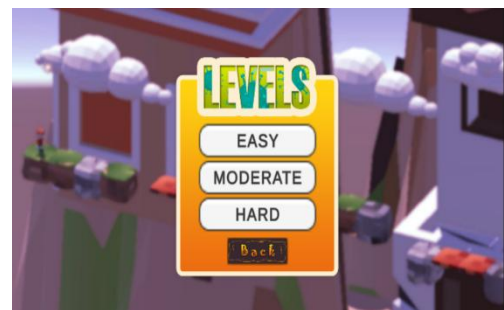


Figure 3: Save Them Levels

To develop 3 types of characters in the game, where the user will have the freedom to choose what the user wants to control in multiplayer and single player mode. The developers used a blender program to construct the three primary characters so that the user may pick between multiplayer and single player modes.



Figure 4: Save Them Monsters

To create a multiplayer option for the game using Wi-Fi that would allow three players to play collaboratively. With the support of Wi-Fi, this cooperative game will assist one another in finishing the game as soon as possible.



Figure 5: Save Them Multiplayer

To develop 3 types of characters in the game, where the user will have the freedom to choose what the user wants to control in multiplayer and single player mode. The developers used a blender program to construct the three primary characters so that the user may pick between multiplayer and single player modes.



Figure 6: Save Them Characters

To develop cut-scenes, scenarios, and trivia for the game to utilize in informing players about illness transmission, impacts, and precautionary measures. The developers create cut-scenes, situations, and trivia for the game to enlighten the player about illness transmission, impacts, and preventive methods.

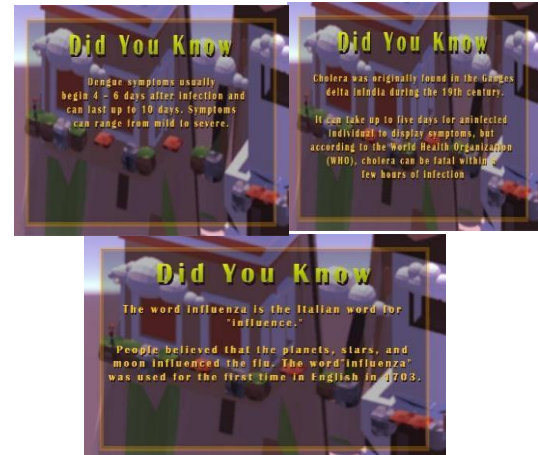


Figure 11: Save Them Trivia

DISCUSSIONS

This section explains the study's result after testing the produced game. It also includes the developers' suggestions for improving the game for future researchers.

Summary of Findings

The researchers visualized the final outcome of the 3D Cooperative Platform game. The game required minimum specifications for the android phones, Unity and Blender are the main software for the game development, and the game development followed the duration of the timetable set by the researchers. The proponents evaluated the game using test cases such as unit, integration, and system case. They find out that the average rating was 4.7 as the application is not applicable to other operating systems such as iOS and web-server. Finally, the tested game was released on the Google Play Store.

Conclusions

These conclusions were based on the study's objectives, the analysis was completed, and the testing and assessment of the game were produced. The researchers were able to meet

the general aims of the study. The program worked well on the supported Android operating system, and users were able to get the desired outcomes. The user interface of the program was well-designed and worked well on the screens of the devices used during the testing phase. Users were able to understand and use the application's components with little assistance from the developers. Extreme Programming assisted the game creators through development process. The iteration process benefited the system's proponents in envisioning its flow. During development, these iterations served as a guide in deciding the general flow of the application. The findings of the research and studies examined were used to develop it thoroughly.

The researchers created a 3D-graphics multiplayer game. On the game main menu, there are four buttons: single-player, multiplayer, settings, and exit. The game is divided into three stages, each with three levels. When the user selects single-player mode, the player is unable to select a character. When the user picks the multiplayer mode, they can select one among three characters. To advance the level, the player must avoid and destroy all viruses. The game lacks an option button, but they will be able to see the game creators on the settings button. Game designing required Blender to generate 3D characters and Unity for coding. IT specialists were asked to study the game. The experts were requested to complete the questionnaires based on the test cases. The review concluded that the game was remarkable and satisfied all the criteria for evaluation.

Recommendations

There are some suggestions to consider in order to improve the game. Add an additional level at each stage and may install the new omicron variant, because there was no omicron variant yet when the game was currently developing. The future proponents may enhance the complexity of the game by adding incredibly tough and insane levels to handle more viruses in the future. Third, the 3D objects, maps, characters, and monsters that were integrated into the game may have been upgraded for a more visually appealing experience. Finally, consider adding the new

variant in the game, increase the number of monsters or viruses in the game. The researchers made this idea in order to present other options to future researchers who may enhance and improve the game.

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SLS: An Automated Lighting System Using Android Mobile Application and Google Voice Assistance

Lance Wency W. De Vero
Jorynelle B. Mercado
Dexter John S. Tolentino
Jayvee Mark C. Dula
Mico R. Tubon
Lorenzo T. Macam (Technical Adviser)

ABSTRACT

Nowadays, the Internet is one of the technologies that is growing fast. Most houses now have access to the Internet for entertainment, social media, or communication with others. As it grows fast, many industries and departments utilize various technology such as laptops, mobile phones, and personal computers. Home automation system has increasing popularity due to their capabilities around people's houses. Different technologies have been combined with this home automation system idea to increase the features and functionality. The researchers came up with the idea to develop a device that can reduce electricity consumption by turning on and off light bulbs effortlessly and a wireless switch for the house's light with the use of the mobile phone. This study focused on building the SLS: An Automated Lighting System Using Android Mobile Application and Google Voice Assistance, developed to reduce electricity consumption and made people attain less energy consumption. Using the Android mobile application, users can control light bulb wireless with less effort. Additionally, with the Android mobile application, users can monitor and control light bulbs without taking a lot of energy to move and look for potential light bulbs consuming electricity without reason. With the features of Google Voice Assistance, even when the user is driving, one can remotely control the device at home. At the same time, the Motion Sensor features help to utilize electricity consumption economically. The overall functionality of the device prototype and Android mobile application has been tested through a series of test cases.

General Terms: Home-Automation, Wireless, Motion Sensor

Keywords: Home-Automation, Controls, Wireless, Motion Sensor, Google Voice Assistance

INTRODUCTION

The Internet of Things is a combination of two terms: The Internet which is described as a network of networks capable of connecting billions of people using standard internet protocols [1].

The Internet links many industries and departments by utilizing various technologies. Several gadgets, including mobile phones, personal computers, and commercial organizations, are related to the Internet. The second word is Thing, which refers to devices or items transforming into intelligent objects. Furthermore, it is a component of all real-world things. If we wish to describe IoT, we cannot do

it precisely and succinctly; however, Vermesan et al. characterized it as simply an interaction between the physical and digital worlds. Many sensors and actuators are used to interface between the digital and physical worlds [2].

The Internet of Things domain ushers in a new era of technology and communication in which things may communicate, compute, and change information as needed. This communication scenario has already begun, but it has gone unnoticed. Kevin Austin, the Executive Director of Auto-ID Labs at MIT, created the phrase "Internet of Things" in 1999. The Auto-ID Centre in 2003, as well as associated market analyses and publications, popularized the notion of IoT [3].

Mobile phones are becoming incredibly common in our society. Electronic connections have supplanted human relationships and mental attention. Mobile phones have become a necessity, and this industry is taking over everyone's heads. This technology brings

numerous benefits, such as convenience, simplicity of use, accessibility, which allows people to communicate with one another in an emergency, enjoy music, carry it anywhere, and many more. In 1876, Alexander Graham Bell was the first to patent the telephone.

Martin Cooper is widely regarded as the creator of the modern mobile phone. He invented the gadget and was the first person to make a phone call using a mobile phone in 1973. The notion of an electronic mobile phone has been known since 1947, but it took 26 years for that concept to become a reality. Cell phones have become the center of many people's lives. Today's children are far more knowledgeable about how to use these devices than their parents. As a result, parents frequently require their child's aid in learning how to use it. As a result, parents and children can form stronger bonds and communicate with one another more frequently than before.

Moreover, half (53%) of kids who text believe texting has improved their connection with their parents. Cell phones have grown so widespread that they have reduced face-to-face interaction, which negatively influences life.

According to a poll of 475 college students, most own a mobile phone, with some owning multiple phones. A lot of individuals have many SIM cards on their phones. Some of them have cell phones. 90% of students use the internet on their phones to talk with their pals, and the majority of them spend time sending SMS messages. Some people look over their tasks and work. Approximately 80% (percent) for listening to music and amusement, and spent the majority of evenings on these devices.

In today's recession-ravaged economy, saving money has become a national pastime. People are still opening their wallets for smartphones. According to Gartner, a research firm, sales of BlackBerrys, iPhones, and other smartphone models are climbing sharply and are expected to increase by 25% this year [4].

By the end of 2020, the number of smartphone users will have risen to 5.22 billion, accounting for 66 percent of the world's population (DataReportal, 2021). In 2020, an extra 93 million users were added, representing a 1.8 percent raise over the year-end total in 2019. Market growth in 2021 will be led by the Asia Pacific region, particularly India and China,

which will account for 2.1 billion, or 56 percent of the worldwide market share. The Asia Pacific alone had a compound annual growth rate (CAGR) of +10.6 percent over the last six years.

Increases in global smartphone penetration rates of 3% on average every year would raise smartphone penetration from 41.49 percent now to a predicted 56.28 percent by 2024. In an era where cellphones are considered a necessity, it is worth noting that the 50% penetration mark has yet to be attained.

It is critical to distinguish between smartphones and other mobile devices. Tablets, Internet of Things devices, and non-internet-capable cellular phones (usually further classified into "dumb" or "feature" phones) are examples of mobile devices. As of 2019, there are 5.11 billion different mobile devices, with smartphones accounting for 60% [5].

Smart lighting control in modern commercial studios and smart homes gives the user more control and improves the aesthetic value of the space. This is accomplished by profiling and regulating the lights based on user-defined illumination conditions. One practical and intriguing approach is to use NFC Tags, loaded with user profile data and intensity or color details and interface them with a control board that controls the intensity and color using a simple pulse width modulation and RGB led matrix panels lighting components. The PWM approach modulates the light intensity based on the width of the triggering pulse, and the desired color profile may be created by mixing three primary hues in varied proportions: red, green, and blue.

The study describes a method for profiling and controlling devices that use Near Field Communication (NFC) technology based on short-range radio communication. Because most new smartphones include an NFC chip, profiling may be made mobile and much more tailored. The paper employs an NFC reader on the base control board to read a profile from a rewritable tag. When a Tag is touched with the baseboard, the information from the NFC tag is read and passed to the microcontroller, where the specific light profile is chosen from a user-defined list of light profiles.

Background of the study

People of all ages and genders have worked during the day since the modern era. Most of

the time, people are in a rush to leave the house and realize on their way to work that they forgot to switch off the light bulbs they used before leaving the house. When no one is left in their home, forgetting to turn off light bulbs might ignite a house fire, resulting in the loss of property and life.

According to the BFP (Bureau of Fire Protection) [6], between 2013 and 2017, the BFP documented a total of 77,724 fire occurrences, or an average of 15,545 fire incidents each year, or 42 fire incidents per day. During that time, the total estimated property damage was P23.273 billion, or an average of P4.65 billion per year. During the same period, 1,257 persons were slain, for a yearly average of 251. During the five years, the number of wounded people reached 4,239, with an average of 848 people suffering from fire-related injuries that might have been averted.

The top three causes of fires, according to the BFP, are electrical connections, ignited cigarette butts, and open flames. Electrical overload, electrical arc, or short circuits can all cause fires from electrical connections. Lighted cigarette butts that started fires are typically tossed aside indiscriminately by cigarette smokers, accidentally contacting combustible objects and starting a fire. Open flame fires can be started by a torch, candle, or a gas burner that is left unattended. The top three documented fires occurred in residential areas, industrial regions, and mercantile or commercial structures.

The most dangerous hazard in a house fire is not apparent on the surface — it's hidden in the walls [7]. Arc faults are responsible for 82 percent of electrical fires, and various circumstances can cause them. The risk of arc fault fires is greatly reduced by modern smart home technology like smart plugs and smart smoke detectors, which can detect and even prevent these fires. According to Tom Kerber, Senior Director IoT Strategy at Parks Associates, home security is a market leader in the smart home concept. Given the devastation caused by fires, smart home solutions that detect, prevent, and guard against them are becoming increasingly beneficial to customers.

According to Parks Associates' study, 18 percent of internet homes in the United States with insurance believe that solutions that

detect, prevent, or mitigate electrical wire fires are the most practical usage for smart home gadgets. Parks Associates' latest complimentary whitepaper, IoT Home Safety: Fire Prevention Solutions, would be approved by Smokey the Bear. The whitepaper, sponsored by WhiskerLabs, demonstrates how consumers evaluate current fire prevention measures in the home.

According to research, approximately 40% of broadband families are interested in purchasing a smart home gadget that can detect electrical fires, which cause over 1300 injuries and 420 deaths in the United States each year. With the growing popularity of smart home technology in the United States, suppliers may anticipate consumers to make purchases directly tied to the safety of their house and family.

According to Mhadura Das [8], the world's demand for energy increased by 85 percent between 2010 and 2017. This rise is more significant than the current total power usage in India, the United States, Japan, and Australia combined. We can't slow down the power growth rate, but we can reduce the amount of electricity wasted each year by shutting off our household appliances when they're not in use. This project offers a concept and prototype of a Home Automation system that will link to other devices using the ESP8266 Wi-Fi module as a network provider. The suggested system consists of two major components. The first major component is Arduino, which controls and handles the Wi-Fi module's input. The other major component is the Wi-Fi module. A web server may be added to the module with the Wi-Fi module, allowing it to control devices through the Internet. As long as there is Wi-Fi network coverage, a single server can manage many hardware interface modules. It is compatible with a wide range of home automation equipment, including power management and security components. We wish to consolidate and artificially intelligence this automation system. We will then connect the exact residence to our database, accessible from anywhere via a specific IP address or website Collapse.

The researchers propose this study "SLS: An Automated Lighting System Using Android Mobile Application and Google Voice Assistance

" to help people with daytime jobs have fewer worries when they are leaving their houses, it can reduce energy consumption because you can remotely control if you forget to turn off the light bulbs or unplugged the electric fan, and it can prevent electric overload, which can lead to a house fire.

Objectives of the study

The study's general objective is to create and develop an automated lighting system using an Android mobile application and Google voice assistance with the features of motion sensors for each light bulb.

In line with this, the study aims to achieve the following specific objectives.

- To identify the necessary hardware and software required for developing the device.
- To create and develop a system that automates the light bulb.
- To create and develop an Android mobile application that remotely controlled the light bulb.
- To provide Google voice assistance that remotely controlled light.
- To provide a motion sensor that detects movement.
- To test the device and system using test cases and experimental tests for mobile app functionalities.

Scope and limitation of the study

The study focused on creating and developing a system that can remotely control each of five (5) light bulbs using an Android mobile application, Google voice assistance, and five (5) motion sensors.

Although the study has performed the said capability, it still has several limitations. The system can work with or without an Internet connection. However, when the Internet connection is out, it is remotely controlled using the Android mobile application of the system and only has a specific range limit. The developed Android mobile application works only for Android OS, and the Google voice assistance would not work on an Android mobile phone with a defective mouthpiece. There are also specific commands to control voice recognition, and the only language it can recognize is the English language. The device needs to complex code the Wi-Fi credential for Internet connectivity. The traveling speed of

data, which causes delay from microcontroller to firebase and firebase to microcontroller, is out of the coverage of this study. The motion sensor detects everything that has motion. It will not notice if the motion comes from a pet or a human. The implementation of the said study will be a big miniature. The system would not work without electricity. If the Internet service provider fails, the device has a probability of malfunction due to sudden out of electricity or failure of the Internet service provider.

Conceptual Framework

The direction of the study is presented using a conceptual framework that shows the various processes used by the researchers to develop the project entitled "SLS: An Automated Lighting System Using Android Mobile Application and Google Voice Assistance".

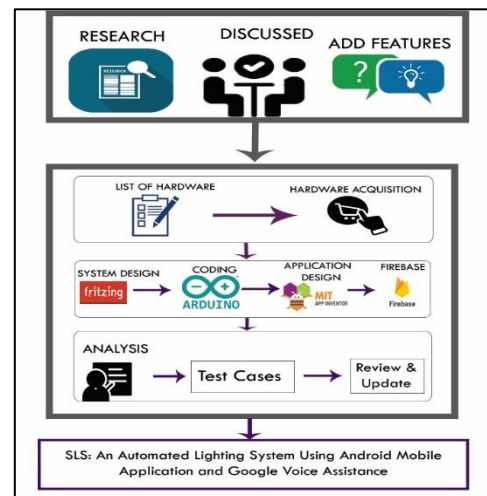


Figure 5: Conceptual Framework

Figure 5 illustrates the conceptual framework of entitled: "SLS: An Automated Lighting System Using Android Mobile Application and Google Voice Assistance"

The Input block consists of a lot of internet research about Smart Lighting systems. The researchers also gathered information about the different types of smart lighting systems or home automation, like home automation using Bluetooth or voice modules that control light bulbs similar to a smart lighting system. The researcher discovered that the best use of the lighting system is to combine the use of the Android mobile application and Google voice

assistance with the help of the Nodemcu v3 esp8266 module.

The Process Block consists of Analysis, Planning, Designing, Coding, and Testing. The Analysis happened upon the researchers had the title for the study. This process is essential because, in this process, the researchers will brainstorm about the research and share some ideas and opinions on what must be the primary goal and how the study will be done well. All the researchers discussed the Planning to develop the best plan to make the study successful. The researchers do the Designing to make the study more safety with the help of an electrician and meet the expectation of the panelist. Coding is the process to able the system works. It is also part of the study's necessary process.

The Output block is the result of the researchers' study, which is the "SLS: An Automated Lighting System Using Android Mobile Application and Google Voice Assistance".

SYSTEM DEVELOPMENT METHODOLOGY

This section presents the System Development Life Cycle method employed by the researchers in conducting the study the discussion regarding the Software Development procedures.

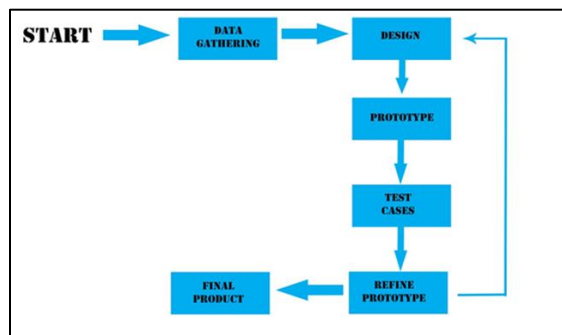


Figure 6: Prototyping Model

Data Gathering

In this phase, the researchers gathered data from different types of home automation projects to be able to sight what are the things that need to improve. After the researcher collected the data, the researchers decided to create home automation remotely controlled over the mobile phone because the smartphone

is the most common technology used by people inside the house. Then the researcher found out that there is a probability that the light bulb inside the house can be forgotten to turn off, especially when in a hurry situation. That is why the researchers also develop voice recognition using Google voice assistance. The researcher decided to use Google voice assistance like driving a car. The owner can access Google voice assistance and control the home system.

Design

After the data gathering and brainstorming of the researcher, different images for the project and its system are designed. The researchers addressed that the system design is organized and safe because it is connected to electricity. The researchers searched for an electrician to check and test if the project was safe or could cause a fire. Also, during this phase, various diagrams were developed, such as schematic diagrams that have been created using Fritzing Circuit.

Test Cases

Figure B explains the systems concept and interconnection of the project with the mobile application and the device. The mobile application is used to send data wirelessly to the Wi-Fi module that is connected to the microcontroller. The microcontroller is the main brain of the device that when data has been received, the microcontroller will immediately trigger what's owner want to turn on/off. The voice recognition is the same as the process with the mobile application, the only difference is voice recognition has to code for controlling the device like "Turn on lights one" or "Turn light one on".

Schematic Diagram

Figure D shows the home automated system circuit and how the system is built. With the Fritzing application, the researcher creates a schematic diagram that shows the relationship of a different module, the light bulb, and how the module can control the light bulb using the android mobile application and Google voice assistance. Using schematic diagram wiring and positioning of jumper wires makes it easier for future researchers to improve the project and learn how the system has to build.

The researcher used Fritzing to generate the schematic diagram shown in figure D.

Prototype

After designing the project, the researchers evaluated the overall architecture and the information gathered during the data collection process. The researchers used the information to ensure that the unit met all of the study's specifications.

The researchers used the "Arduino IDE" as a programming interface for writing and uploading programs to Arduino compatible boards and "Fritzing" for the data collection.

Hardware and Software Requirements

The following tables below shows the specification of the required hardware and software used in the development of the system.

Table 1: Hardware Specification

Components	Specification
Processor and Frequency	Inter Celeron N3460
RAM	4GB
Operating System	Windows 10

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.
Adobe Photoshop	A photo editing software.

Test Cases

Then this phase has tested the functionality of the system and then developed mobile application. The SLS was tested ten (10) times every single light and electric fan outlet to see if the device meets the effectiveness and convenience for the user. The mobile application and Google voice assistance will be at the same time. The mobile application GUI buttons were also tested if there was any bug or error shown to the mobile. The researchers created a table for the result of this phase and sought if the numbers of the tested phases are accurate on efficiency and convenience to use the device.

Refine Prototype

Refining the SLS design or development of the proposed system will be made in this phase after testing the SLS system functionality.

Recommendations and suggestions of the panelists are followed for further improvements of the device functionality. Errors, bugs, connectivity problems, wiring problems, and device functionality failed will be fixed and repaired during this phase.

Final Product

After the series of refining, testing, and redevelopment of the mobile application and device functionality, this phase will show the final product of the device. In conformity with the objectives presented by the researchers and panelists' recommendations, researchers were able to design and develop the "SLS: An Automated Lighting System Using Android Mobile Application and Google Voice Assistance".

RESULTS AND OUTCOMES

This section presents the results and discussion of the testing and evaluation of the system made by the proponents. The researchers used test cases as the testing tool to check the system's stability.

The researchers were able to identify the necessary hardware and software requirements using the aggregate information gathered by the researchers. Researchers were able to achieve the study's system prototype requirements and objectives. The electrician used 14-gauge electrical wires for the circuit breaker and 12 gauges for the electricity of the light bulb to ensure safety and less possible short circuit. The SLS prototype can now automate the light bulb with motion sensors and Google Voice Assistance that is remotely controlled through Android mobile applications. Researchers developed test cases to ensure the SLS prototype's functionalities achieve its objectives and intended outcome.



Figure 7: The SLS Android mobile application user interface

The first screen shown in Figure 7 has log-in details. When the user enters the correct username and password, the second screen will display the three following buttons: online mode, offline mode, and the Google voice assistant mode, and after that, the user can choose what method to use. When the user decides the online mode, the third screen will appear. It will show the five buttons to control the five lights. Also, it has the on and off control for the motion sensor in each light. The bottom part will show when you scroll down, and you can access the Google voice assistant. When the user chooses the offline mode, the fifth screen will appear, and the only difference with the online mode is you cannot access the motion sensors with the offline mode. The last screen that is shown is when the user wants to change their password.



Figure 8: The SLS Android mobile application and Hardware test.

In figure 8, it shows how the Android mobile application and hardware are connected. Research developed indications on and off to the Android mobile application to see the status of every light bulb. The light bulb is powered with electricity from a 20A circuit breaker for the safety electrical wiring.

Test Cases Result Prototype

Table 2: SLS Application With Internet
No. of trials for turning on light each test case =10

SLS Lights	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th
Bedroom	On	On	On	Off	On	On	On	On	On	On
Kitchen	On	On	On	On	Off	On	On	On	On	On
Garage	On	On	On	On	On	On	On	On	On	On
Bathroom	On	On	On	On	On	On	Off	On	On	On
Dinning	On	On	On	On	On	Off	On	On	On	On

Video [link](https://drive.google.com/folderview?id=1pDRzL5isa1h4eXkleO2_6WyRUoAAc_ZH)
(https://drive.google.com/folderview?id=1pDRzL5isa1h4eXkleO2_6WyRUoAAc_ZH)

The test cases shown in table 2 presents the functionalities of the prototype by turning on the light. Note that each of the function buttons of the Android mobile application was tested ten times to assure that the result of the prototype hardware and module reacts according to its function. At the initial stage of the testing prototype functionalities. It was found that it has a ten percent possibility of malfunction caused by the speed of the Wi-Fi connectivity. Speed of internet connectivity can affect how immediately the system responds.

Table 3: SLS Application Google Voice without Internet

No. of trials for turning on light each test case =10

SLS Lights	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th
Bedroom	On	On	On	Off	On	On	On	On	On	On
Kitchen	On	On	On	On	Off	On	On	On	On	On
Garage	On	On	On	On	On	On	On	On	On	On
Bathroom	On	On	On	On	On	On	Off	On	On	On
Dinning	On	On	On	On	On	On	On	On	On	On

The test cases shown in table 3 present the prototype's functionalities by turning on the light using Google Voice Assistance through the Internet. Note that each of the function buttons of the Android mobile application was tested ten times to assure that the result of the prototype hardware and module reacts according to its function. At the initial stage of the testing prototype functionalities. It was revealed that it has a ten percent possibility of malfunction due to the speed of the Wi-Fi connectivity, which shows that it affects how immediately the system responds.

Table 4: SLS Application Google voice With Internet

No. of trials for turning on light each test case =10

SLS Lights	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th
Bedroom	On	On	On	Off	On	On	On	On	On	On
Kitchen	On	On	On	On	Off	On	On	On	On	On
Garage	On	On	On	On	On	On	On	On	On	On
Bathroom	On	On	Off	On	On	On	On	On	On	On
Dinning	On	On	On	On	On	On	On	On	On	Off

Video link:

1st:

(<https://drive.google.com/folderview?id=1pYW0ROH0tBTPjW4sxRv1Le4Lai1MZ0kv>)

2nd:

(<https://drive.google.com/folderview?id=1pNVNnxGr7GGuuEWEXCiQ2Glc4ufaw10q>)

The test cases are shown in table no. 4, which presents the functionalities of the prototype by turning on the light using Google Voice Assistance without the internet. Note that each of the function buttons of the Android mobile application was tested ten times to assure that the result of the prototype hardware and module reacts according to its function. At the initial stage of the testing prototype functionalities. It was found that the speed and range of the Android mobile and hardware will affect how immediately the system responds.

The Google Voice Assistance functionality on the Android mobile application was tested while the researchers tested the functionality of the Android mobile application. Ten times each light voice command was considered for a test case to assure that the Google Voice Assistance responded accordingly. At the initial stage of testing the Google Voice Assistance functionalities, researchers found out that as long as the Google Voice Assistance recognized the voice command, it will respond accordingly to the user's voice command.

Google Voice Assistance is not based on the age of the user. It is based on the UK English default accent program through MIT App Inventor, which the developer uses to create the Android mobile application.

Table 5: SLS Application Motion Detection
No. of trials for turning on light each test case =10

SLS Lights	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th
Bedroom	On	On	On	Off	On	On	On	On	On	On
Kitchen	On	On	On	On	Off	On	On	On	On	On
Garage	On	On	On	On	On	On	On	On	On	On
Bathroom	On	On	On	On	On	On	Off	On	On	On
Dinning	On	Off	On	On	On	On	On	On	On	On

Video link

(<https://drive.google.com/folderview?id=1pRgaGWnUIXbw7f-GQPrk7L3PPcmWsn6X>)

Table no. 5 presents the functionalities of the motion sensor on turning on lights. The motion sensors detect motion and automatically turn on and off the light bulbs when the user activates the switch button from the Android mobile application. Note that each of the function buttons of the Android mobile application was tested ten times to ensure that the result of the prototype hardware and module reacts according to its function. The Motion sensor activates when the user turns on the motions sensor buttons to the Android mobile applications. Researchers set the motion sensor approximately twenty to thirty seconds delay and a cone angle range of roughly two to three meters user can turn off the motion sensor through the use of the Android mobile application at the initial stage of the testing. It was found out that it has a twenty percent possibility of malfunction caused by the speed of the Wi-Fi connectivity. Speed of internet connectivity can affect how immediately the system responds.

Table 6: SLS Application Without internet
No. of trials for turning on light each test case =10

SLS Lights	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th
Bedroom	On	On	On	Off	On	On	On	On	On	On
Kitchen	On	On	On	On	Off	On	On	On	On	On
Garage	On	On	Off	On	On	On	On	On	On	On
Bathroom	On	On	On	On	On	On	Off	On	On	On
Dinning	On	Off	On	On	On	On	On	On	On	On

Video link

(<https://drive.google.com/folderview?id=1pcFk74fP93g2ymzPTtifhXVrqLb2a6pR>)

Table no. 6 shows the test cases for the prototype and Android mobile application functionalities. Ten times trials were considered for each light bulb and UI button to assure that the hardware prototype responded according to the UI buttons. At the initial stage of the testing, researchers found out that the speed and range of the Android mobile application's connectivity and the hardware affect the functionalities of the prototype.

Table 7. Mobile Application User Interface Test Cases

User Interface (UI) Test Cases	No	Yes
1. Does the UI display indicate on and off of the light?		Yes
2. Does the Android mobile application UI buttons activate light bulbs		Yes
3. Does the Android mobile application change user password?		Yes
4. Does the Android mobile application Google Voice Assistance buttons activate light bulbs?		Yes
5. Does the Android mobile applications activates Motion Sensors		Yes
No. of trials for each test case =3		

Table no. 7 shows the test cases for the functionalities of the mobile application interface. Three trials were considered for each test case to assure that the hardware prototype responded according to the corresponding button. Note that all controls and screens responded according to the design elements and buttons of the system shown in figure no. 8.

Table 8. Electricity Circuit Functionality and Safety

Electricity Circuit Functionality	No	Yes
1. Does relay is connected to the live electricity?		Yes
2. Does the SLS prototype miniature is safe from electricity shortage?		Yes
3. Does the SLS prototype miniature have circuit breaker?		Yes
4. Does the electrical wiring have check and approve by electrician?		Yes
5. Does the SLS prototype wiring used standard wire for electricity?		Yes

Table no. 8 shows the test cases for the functionalities of the electrical wiring of the

prototype miniature. The electrician helps the researchers to build a safe electricity circuit and have a circuit breaker for more safety protocol. The researchers used the standard electrical wire suggested by the electrician connected to the live outlet, then to the circuit breaker, and then distributed to the outlet of the prototype, light bulbs, and relays. With the electrician's help, the prototype miniature of the researchers has a safe electricity circuit and is far from the shortage.

Table 9. Hardware Functionality Test Cases

Hardware	Yes	No
1. Does the hardware turn on and off the lights?	✓	
2. Does the SLS prototype miniature detect motions?	✓	
3. Does the SLS prototype miniature turn on when motions detected?	✓	
4. Does the SLS prototype miniature detects from 5 ft?	✓	
5. Does the SLS prototype miniature detects from 6 ft?	✓	

Table no. 9 shows the test cases of the SLS prototype miniature system. Remember that hardware functionality is tested ten times to ensure that the IoT components are working accordingly. At the initial stage of the testing, researchers found out that the speed and range of the Android mobile application's connectivity and the hardware affect the functionalities of the prototype, such as delays.

Table no. 10 shows the security of the device and mobile application. SLS Mobile Application has a login system that verifies username and password to gain access. Users connected to the same Wi-Fi connectivity of the device can't access the device unless users know the username and password of the SLS Mobile application. SLS Mobile application needs to log in before gaining access to the device and controlling it.

After the user logs in and is verified, the SLS Mobile Application has Auto Login System. Even if the user exits or closes the SLS Mobile application, it will automatically be logged in the user when the SLS Mobile Application is

opened again. Still, it has limitations. When the user phone restarts or shuts down, the data from Auto Login System will be lost and need to be verified again.

The offline mode of the device has SSID and Password to direct control to the device hardware. Users must log in to the SLS Mobile Application and connect the phone to the device hardware to directly control the device without the Internet. Users fill-up the SLS form to set the SSID and Password of the device. The user can't change the SSID or Password of the device. The developer needs to manually code if the user wants to change the SSID and Password of the device.

Table 10: Device and Mobile Application Security Test Cases

Device and Mobile Application Security ?	No	Yes
1. Does the SLS Mobile Application have Login Security?		Yes
2. Does the SLS Mobile Application have Username and Password verification?		Yes
3. Does the Device Access Point have SSID and Password?		Yes
4. Does SLS Mobile Application can change user password?		Yes
5. Does SLS Mobile Application have Auto log-in system?		Yes

DISCUSSIONS

This section consists of the summary of findings, conclusions, and recommendations based on the study SLS: An Automated Lighting System Using Android Mobile Application and Google Voice Assistance.

Summary of Findings

The researchers use prototyping model phases to create the prototype SLS, and mobile application integrated output product. The objectives of the study were developed based on the functionality and recommendations of the panelist. The researchers ran test cases to measure the state of the Android mobile application and the prototype to confirm the expected outcome. The panelist recommended logging in and changing the password to strengthen the security of the Android mobile application, which was accomplished. Furthermore, the researchers tried to evaluate

the Android mobile application and prototype by controlling the lights through different places. One of the Researcher' houses kept the miniature prototype, and one of the researchers controlled the prototype on different locations using the Android mobile application. The other researchers confirm the functionality of the Android mobile application and prototype by sending and receiving responses from the connected miniature prototype.

Conclusion

The proposed system adheres to its specific goals, wherein researchers created a system that helps people in electricity consumption, bills cost, and safety from the electrical circuit. The prototype used a Wi-Fi module to gain access to the internet also relays to control the light bulbs using an Android mobile application. The user can control the prototype even the user is in a different location as long as the user has access to the internet. The prototype has an offline mode that users can control the device without the internet but in a specific range.

The set goals and objectives are finally met by utilizing the prototype, and by the use of trial and error, the Android mobile application and prototype were performed the intended outcome. The researchers formulated test cases to measure and secure the functionality of the prototype and Android mobile application to verify the expected result. All phases were checked repeatedly until an acceptable, complete, and functional prototype and Android mobile application were achieved. The researchers formulated test cases to check this study's hardware and software functionality. According to the result of the test cases, there were a total of ten (10) test cases of turning on the light, turning off the lights, turning on and off motion sensor, and Google voice assistance function.

The developers created a functional login and changed password features that provide username and password to secure the Android mobile applications. The developers could control the turning on and off of the motion sensor with and without the Internet.

Recommendations

The researchers considered the following recommendations for future improvement of the developed SLS prototype.

- Improve more security by having a changed username.
- Improve wiring design by having a Nodemcu IO shield.
- Improve the Android mobile application where users can change Google voice command.
- Add more Nodemcu and relays to increase the number of light bulbs and sensors.
- Improve the Android mobile application where users can use Google voice command on turning on and off motion sensors

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Smart Sinampay: A Microcontroller-Based Clothes Hanger Manual and Automatic Mechanical Controller with Rain Sensor and Temperature Monitoring Thru Mobile

Bernie S. Bulaun
Orven Warren R. Liwanag
Sean Andrew G. Galang
Ace S. Flores
Dan Angelo M. Miran
Engr. Robbert M. Bamba, MEECE (Technical Adviser)

ABSTRACT

Clotheslines, which are still widely utilized in the community, were still a laborious method of exposing garments to sunshine and recovering clothes. Rain is another factor to consider, and it is difficult to anticipate. Furthermore, the amount of time and when the clothing is exposed to sunlight are manually assessed or determined by the garment's owner. The researchers employed the prototyping model technique to create a microcontroller-based clothesline mechanism with a mobile user interface application based on these manual methods. The prototype in this study uses bluetooth wireless technology to connect the user interface of the mobile application to the clothesline controller, which can manually extend and retract the clothesline cylinder. The prototype also offers the option to schedule the cylinder's retracting using a mobile user interface application in order to maintain the suspended clothing beneath the predetermined ceiling. When rains contact the water sensor, a buzzer put beside the controller box of the prototype will be engaged and continually buzz up for a couple of seconds to warn the homeowner and the clothesline cylinder will be retracted by the motor automatically as well. Three push buttons were also added to operate the cylinder mechanisms extend, retract, and stop functions. Test cases were chosen and validated according to the hardware and mobile user interface functions described in appendix A and B to check both hardware and mobile user interface functionalities. Additionally, the Smart Sinampay can be a general type of hanger for any products that involve sunlight exposure. The mobile application and system prototype have a series of test cases. The researchers executed 10 trials of each of the device functionalities to assure that met the objectives and system requirements. The researchers used evolutionary prototyping as a guide to complete the Smart Sinampay prototype and its mobile application.

INTRODUCTION

During the rainy season, it is always difficult to predict how the weather will adjust. Hence, working adults and students find it difficult or impossible to get laundry clothes dried on the same day. This causes to be late for activities and limits clothing options for a given day. The house tasks include cleaning since sometimes, floods enter homes. Due to moisture, windows, doors, and other materials in the house get musty. Moreover, laundry is halted for clothes which cannot get dry due to the weather although sometimes people put laundry inside homes which causes stinky dry clothes due to the lack of air to dry or in Tagalog terms, "Kulob".

Laundry can only be dried indoors for many families. Drying clothes inside, on the other

hand, may gradually raise the ambient humidity to levels 70% of the time. This creates an excellent environment for mold spores to thrive, which can trigger asthma and produce symptoms including breathing difficulties and organ inflammation, all of which are harmful to health. [1].

Washed clothes take longer to dry during the rainy season, particularly when working adults or students leave the house, leaving clothes on the line to dry, and the clothes get soaked by the rain continuously. Hot drying racks, clothes laundry dryers, irons, hydro laundry, and outdoor drying racks are all available but these current drying machines or appliances are either inefficient or costly to install and maintain, and cause significant damage to clothing.

In the United States where electric drying is most commonly used, approximately 16 billion kW is consumed each year, accounting for 5.8 percent of total resident electricity usage. In comparison to the United States where electric drying is mostly used, about 16 billion kW is consumed per year or 5.8% of the whole resident electricity consumption. With this electricity consumption rate in the Philippines, an ordinary student or working adult would find it difficult to afford. As a result, there is a need for and interest in an alternative, effective, and affordable clothes drying mechanism for residents of West Africa's tropics, where the rainy season predominates. [2]

Background of the study

In the Philippines, the weather is hot and humid. Summer afternoon rains are regular, prompting a rush to bring in the clothes that had been hanging out to dry before being soaked by the rain. According to [3], the seniors in Taiwan are burdened with the responsibility of keeping laundry dry. Many elderlies have fallen and broken bones or even experienced life-threatening injuries while rushing to carry the clothes in. In addition, an intelligent drying rack with a monitoring system and an electric motor is urgently needed to make life simpler for the elderly at home and to increase its safety.

In line with this, a smart drying rack based on the Internet of Things (IoT) is created and produced to address the inconvenience of traditional outdoor drying racks in today's culture, where the collecting of garments to dry due to changes in weather is cumbersome. It may be utilized in houses, hotels, hospitals, laundries, and other locations where a big volume of clothes is laundered often and outside drying is necessary. It is capable of completing the automated drying, recycling, drying, and disinfection of garments in a timely and efficient manner [4].

With the passage of time, digital device mobility has become the new normal in people's daily lives. Wireless devices are one of the most often used gadgets, and always being improved. The Internet of Things (IoT) is a fast-expanding industry. This year alone, 46 billion linked devices are expected, with 31 billion devices installed globally by the end of the year. [5] According to Juniper Research's most recent

study, the number of IoT devices will reach 46 billion in 2021. In comparison to 2016, this is a 200 percent rise. The entire planet is grappling with utterly unanticipated events. The pandemic outbreak has caused such a major paradigm shift that it has completely changed the perspective on life and all of its aspects. IoT, along with other technologies like AI and Cloud, helps us in a number of ways. Tracking potential vectors [6] is the first answer that has come to most individuals.

IoT devices may become the answer when people's mobility is vital due to unanticipated events (e.g., sudden urgency, epidemic). Clothes, activities, air temperature, radiation temperature, drafts, humidity, and people are all factors that impact thermal comfort. Clothes give insulation; dresses to feel comfortable. Thickness matters when it comes to keeping warm. Fewer, lighter garments are better for keeping cool. Thus, clothes are considered as a basic need of a person. Drying clothes has been easy, especially with the rise of technology. There are washing machines, dryers, and such. However, some people like to hang clothes outdoors for natural sunlight. In support of this, the Japanese have a habit of drying clothing outside. Some people use a drying machine because some are too busy, but should be utilize the sun and natural breeze to dry. Nonetheless, on a wet day, it must dry in the room as there is plenty of rain throughout the year. People dry clothes in a room, such as the living room or the bedroom, during rainy days. Moisture created by clothes drying in a room is frequently the cause of condensation in a home. [7].

With these causes, the researchers aim to integrate and employ in developing an Intelligent Laundry System that will aid in the needs of people specially during the rainy season, or in summer. The users will not be in athomes all of the time and it is difficult to predict rain in the current circumstances. If the users are accessible, the user can bring the garments to a safe location when it rains. Regardless of the users' availability at home, it takes time to recognize that rain is on the way and take the first step of putting garments in a safe location. When it rains while the user is gone from home, clothes will get wet. It would be useful if there was an automated system

that could assist people in managing laundry in daily lives. As a result, automation systems that can detect temperature and raindrops and transport the clothes to a safe location make daily tasks easier. It mainly detects temperature and thus automatically hangs clothes in protection of the expected weather.

Objectives of the study

The study aimed to develop a prototype with mobile user interface named Smart Sinampay - A Microcontroller-Based Clothes Hanger Manual and Automatic Mechanical Controller with Rain Sensor and Temperature Monitoring Thru Mobile Application. Specifically, this study seeks:

- To design a prototype of the smart-sinampay that has the following features:
 - Extend and retract mechanism to expose and keep the laundry respectively.
 - Arrays of hangers that can handle a total of 75 to 100 kilograms of laundry.
- To develop a mobile application that can manually:
 - Extend the Smart-Sinampay.
 - Retract the Smart-Sinampay.
 - Stop the smart sinampay at a certain position
- To develop a mobile application that can automatically:
 - Retract to keep the laundry based on the set schedule.
 - Retract to keep the laundry when rain is detected
 - Display the environment temperature.
- To test the functionalities of the mobile app interface by setting the test cases based on the required functionalities.
- To test prototype design based on the required parameters.

Scope and limitations of the study

The study's primary focus is on the project's design, testing and evaluation of the project. "Smart Sinampay": A Microcontroller-Based Clothes Hanger Manual and Automatic Mechanical Controller with Rain Sensor and Temperature Monitoring Thru Mobile Application.

This project is focused mainly for scheduling and monitoring using MIT App Inventor with temperature, raindrop sensor and a buzzer that alerts the user if the water sensor detects the raindrop. The researchers gathered information to create the idea of the microcontroller-based monitoring system for sun drying Time. These include internet analysis, brainstorming, and interviews with people who use manual laundry techniques. Thus, the prototype was validated by the Alpha-tester of the study who is a graduate of Civil Engineering and Nursing. It was also checked for functionality and usability and thus, the prototype has passed the test of the Alpha-tester.

The project will be limited for the person who has no time to do laundry to test the effectiveness of the system. The local for testing the project will be MIT App Inventor. For security purposes, the users must also take full responsibility for the PIN provided by the developers by not losing it or sharing it with anyone, for only the developers can change it since the PIN is hardcoded on the Arduino. The Smart Sinampay is able to hold up to 50 to 70 Kilograms of laundry as it is mainly used to demonstrate how the system works and how it would be able to help out busy people in daily life. However, due to the limitation of development materials, this prototype retracts the linear motor slowly. The clothesline array can only move sideways as far as 180 °. The raindrop sensor will trigger on any kind of liquid substance even if it's a little droplet.

SYSTEM DEVELOPMENT METHODOLOGY

The research design model used by the developers was the prototyping model. The Smart Sinampay is an integration of the mobile application user interface and structural design of the linear actuator and the sensors of the whole system. The figure given below will describe the said design model. Figure 5 Shown below will describe the steps on how to achieve the final product.

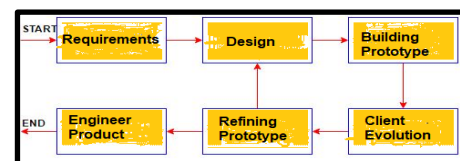


Figure 10: Prototype Model

The Prototype Model of Microcontroller-Based Clothes Hanger Manual and Automatic Mechanical Controller with Rain and Temperature Monitoring thru Mobile Application

A visual illustration of a prototype model is shown in the image above. According to Figure 10, the project must first achieve all of the requirements in order to deliver a system. The system must be finished in various phases. "Smart Sinampay" is a Microcontroller-Based Controller IoT project that will help the user to monitor and schedule the sun drying time of clothes using the MIT Application. Users can be able to remotely control the mechanism using the application. Prototyping is the most appropriate strategy for this project since it reflects all of the necessary phases to accomplish the project in the most efficient manner feasible.

A user evaluation is planned to be part of this project to give comments, recommendations, and needs which are the panelists. but because of the pandemic that is currently happening, we are to show the panelist all of the features of the system virtually.

Requirements gathering and analysis

A requirement analysis is the first step in a prototyping model. The researchers were able to collect related literature and studies as reference regarding the strengths, weaknesses, and gaps of existing literature. Similarly, the researcher came up with the notion for an extra mobile application interface for more options for the user. The researchers discovered that MIT APP creator, a mobile application developer, was suitable for user interface creation. The researchers were able to come up with it's own prototype design with the support of the study's technical consultant in terms of electronics technology and electrical understanding. Finally, the system's software and hardware requirements were adopted.

Design

Initial system design begins by using a partial design from the initial requirement. In this phase, researchers used the requirements gathered from the requirement analysis phase. The design will be based from the conceptual framework that was used as the basis for the design of the system regarding how the different modules or components of the

prototype will interact with each other to achieve the desired results.

Quick Design

The second phase is a preliminary design or a quick design. In this stage, a simple design of the system is created. However, it is not a complete design. It gives a brief idea of the system to the user. The quick design helps in developing the prototype.

Build a Prototype

In this phase, an actual prototype is designed based on the information gathered from quick design. It is a small working model of the required system. Initially, the researcher studied two different motors, a DC motor and a linear motor and found out that the mechanism of the linear motor was easy to use for the tilting capability of the prototype.

Initial user evaluation

In this stage, the proposed system was presented to a technical expert for an initial evaluation named Peter Paul B. Vinoya, a Bachelor of Science Civil Engineer and Bachelor of Science Nursing graduate. Comments and suggestions were collected to provide inputs about the strength and weakness of the working model. Additionally, the mobile applications and prototype test cases were conducted to assure the functionalities of both the prototype and mobile application user interface respectively.

Refining prototype

Prior to declaring a final product, this phase will not be over until all the requirements specified by the user are met. Once the user is satisfied with the developed prototype, a final system is developed based on the approved final prototype. The researcher, technical adviser and panelist have found out that security of using the user interface has an issue that the mobile application can be used by multiple users simultaneously. The developers were able to resolve said issue by thoroughly refining the code blocks of the integrated development environment for the mobile application.

Implementation and Product Maintenance

Once the final system is developed based on the final prototype, it is thoroughly tested and deployed to production. Each of the system's functionalities is again tested if its working according to what is defined in the objectives

based on the requirements. The intended users of the system are people in the household, particularly students and working professionals who have less time monitoring laundry. Once deployed, the researchers will provide training to the users on how to operate the system. The users will be provided information including the PIN for the Bluetooth connection as well as the developers' contact number for support should any problems arise such as losing the PIN. The users will now assume full responsibility for the system maintenance once deployed.

Final Product

The final product phase is according to the panelists' recommendations, validation and verification of the system prototype's functions. The researchers put the system prototype in an entire package to demonstrate how it works. The system was put in a box for convenient and efficient testing. When all prior steps and several initial evaluation repetitions were completed, the researchers came up with a working prototype which is the "Smart Sinampay": A Microcontroller-Based Clothes Hanger Manual and Automatic Mechanical Controller with Rain Sensor and Temperature Monitoring Thru Mobile Application. When the product implementation is done, the system was placed under the roof spot to put the clothesline in a safe place to avoid the rain. The researchers conducted a series of tests to account for various circumstances that could occur in a real-life situation. The researcher then put droplets of water in the water sensor to simulate rainfall and tested the mobile application and other functionalities of the Smart Sinampay. The researchers delivered the finished result to the capstone panelist after confirming that the objectives and suggestions were accomplished.

RESULTS AND OUTCOMES

Hardware Requirements

Table 1: Hardware Requirements of the Smart Sinampay Prototype

Hardware	Description
Arduino Micro-Controller	Open-source microcontroller board.
Temperature Sensor	To measure temperature.
Water Sensor	Detect rain drop.
Buzzer	To alert the user if it is raining.
Linear motor	To move the clothes line.
Bluetooth Module	To connect to the smartphone to access the functions of the mobile application
Real Time Clock (RTC)	To monitor time for scheduling.
Desktop Computer	Used for coding the Arduino and MIT app with a minimum specification of 4GB RAM and Windows 7 operating system.
Smartphone	Used for the mobile application of the prototype with a specification of Gingerbread or higher.

Software Requirements

Table 2: Software Requirements of the Smart Sinampay Prototype

Software	Description
MIT App Inventor	Used to develop and create GUI of a mobile application for Android phones.
Arduino IDE	Used to write codes and upload programs to Arduino compatible boards.
Canva	For individuals and groups who wish to create everything from logos to social media material to documents, prints, and more. Used to create the logo for the mobile app.

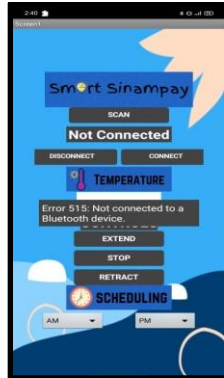


Figure 11. Scan Button

When the user press the scan button on the mobile user interface shown in figure 11 will proceed to the second screen showing all the available bluetooth devices.

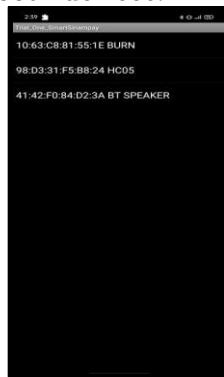


Figure 12. Available Bluetooth Devices

The system used bluetooth HC-05 module and named as HC-05 on second screen. After pressing HC-05 button the second screen, the application will proceed to the home page.



Figure 13. Connected to Prototype

Press the “Connect” button to access the functionalities of the Mobile Application User Interface. After being successfully connected to the prototype using bluetooth connectivity, the label “Not Connected” will change to “Connected”. In the Functionalities of the Mobile User Interface, the temperature status shows the temperature surrounding environment of the clothesline. The extend button will activate the motor cylinder to move the clothesline outside the roof place. The user has an option to a specific length of extension using the stop button. The retract button will move the clothesline under the set roof place.

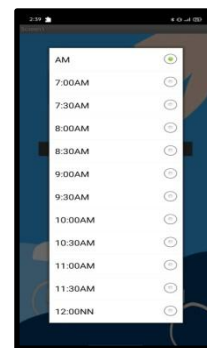


Figure 14.1. A.M Pulldown list

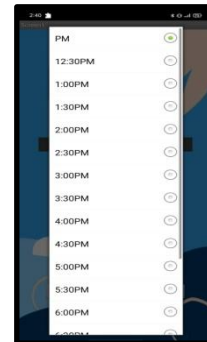


Figure 14.2. P.M Pulldown list

In the figure 13 below the scheduling these are the screen for A.M and P.M pulldown list. The A.M. pulldown schedule list separates the preferred morning setting schedule of the retract mechanism of the clothesline from the P.M pulldown lists of scheduling for the purpose managing the screen size viewing.

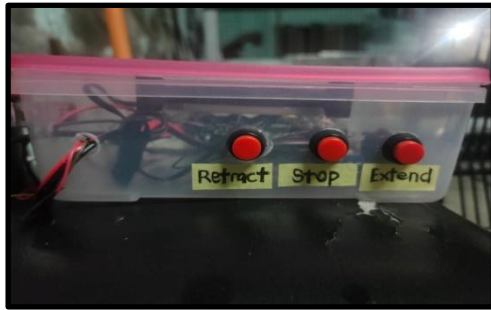


Figure12. Prototype Box Buttons

Figure 12 shown above are the manual buttons of the protype which are retract, extend and stop respectively. The user can manually retract the cylinder thru the retract button to keep the clothesline under the set roof anytime the user wants. Likewise, the extend button can be pressed to activate the cylinder mechanism to expose the clothes to sunlight. The stop button will give the user the choice of position to stop the cylinder.



Figure 13. Full Retract position of the clothesline



Figure14. Full Extend of the clothesline

The figure 13 shown above is the fully retract position of the clothesline using the manual button and automatic retracting position control thru the mobile user interface retract scheduling. While figure 14 shown above is the fully extended position of the clothesline

Prototype Test Cases Results

Table 3. Prototype Test Cases

No. of trials for each case =10

Hardware	Yes	No
Does the motor and its mechanism was able to the fully extended the position of the linear motor cylinder after pressing the manual extend button?	10	0
Does the motor and its mechanism was able to the fully retract position of the linear motor cylinder after pressing the manual extend button?	10	0
Does the motor and its cylinder stop at a certain position after the manual stop button?	10	0
Does the water sensor can detect rain drops at a minimal delay of time effectively?	10	0
Does the hanger arrays were able to carry the 75-kilogram full load capacity of the system?	10	0
Does the buzzer device was able to activate after the rain drops hit the water sensor panel?	10	0
Does the Bluetooth device was able to recognized by the mobile interface after the scan button was pressed?	10	0

Does the Bluetooth device was able to connect by the mobile interface after the connect button was pressed?	10	0
Does the Temperature Sensor display the real time temperature in the mobile application?	10	0

No. of trials for each prototype testing = 10

The test cases shown in table 3 will represent the functionalities of the prototype submodules. Each of the functionalities was tested with ten trials to ensure that each prototype submodule reacted according to its function. It was found out that the speed of the bluetooth module connectivity yields a couple of seconds time delay of mechanism response.

The three buttons, which are Extend, Retract and Stop, were tested to see if all were working properly. It was found out that there was a delay of two seconds upon pressing the button to move the mechanism. Further improvements were made such as adjusting the clothesline and the wiring of the motor in order for the mechanism to fully extend the position of the linear motor cylinder. The movement of the motor cylinder was smooth in motion due to having a bearing to allow the linear motor additional ease of moving the hanger arrays.

When the researchers tested the motor cylinder submodule, 75-kilograms of clothing including the water content was used to test the maximum capacity. The motor cylinder automatically retracts the hanger arrays when the rain droplets drop into the water sensor and the buzzer will sound to warn the user that it is raining. The temperature sensor was also able to display the temperature in real-time in the mobile application.

The results of these ten test cases show that the hardware component of the system prototype was able to meet the requirements and objectives, making it already usable.

Test Cases Results Mobile Application

Table 4. Mobile Application User Interface Test Cases

No. of trials for each case =10.

SOFTWARE	Yes	No

Does the UI Scan button can find the Bluetooth device of the prototype?	10	0
Does the UI display the real-time temperature?	10	0
Does the UI Extend Button when will fully extend cylinder mechanism?	10	0
Does the UI Retract Button will fully retract position of the linear motor cylinder?	10	0
Does the UI Stop Button will stop at a certain position?	10	0
Does the UI interface labeled "Not Connected" will change into "Connected" when the Bluetooth was successfully connected?	10	0
Does the UI interface labeled "Connected" will change into "Disconnected" when the Bluetooth was disconnected?	10	0
Does the UI Scheduling buttons will set the time when the user wants to retract the motor cylinder?	10	0

Does the UI Scheduling buttons will set the time when the user wants to	10	0

retract the motor cylinder?		

Table no. 4 shown above are the test cases for the functionalities of the mobile application interface. Ten trials were considered for each test case to assure that the hardware prototype responded according to the corresponding buttons in the mobile application. Note that all buttons and screens responded according to the design elements and buttons of the system.

The scan button was able to identify the available bluetooth devices after pressing the dedicated bluetooth module and pressing the connect button, the status changed from “Not Connected” to “Connected”.

Using a new and calibrated gun temperature, the integrity of the temperature display value of the mobile user application was obtained to be within the tolerance deviation of plus or minus one degree. See temperature data comparison of the gun temperature values and mobile application user interface displayed values in Appendix I.

The researchers were able to schedule the time to put the clothesline under the roof with ten trials. There is a button like retract, extend on the mobile application wherein the button was tested 10 times without encountering a problem on it.

The result of these ten test cases show that the software component of the system prototype interacts with the hardware component accordingly and was able to meet the requirements and objectives, making it already usable.

DISCUSSIONS

This chapter consists of the summary of findings, conclusions and recommendations based on the results and findings of the study of Smart Sinampay: A Microcontroller-Based Clothes Hanger Manual and Automatic Mechanical Controller with Rain Sensor and Temperature Monitoring Thru Mobile Application.

Summary of Findings

To achieve the prototype Smart Sinampay and mobile application integrated output product, the researchers used the steps of a prototyping

model. The researchers performed trial and error experimentation in order to check the integrity and functionality of both Prototype and Mobile Application. Panelists suggested heightening up the security levels by providing the user a serial key registration for bluetooth connectivity which was achieved by our programmers. Time scheduling and ventilation of the Arduino module were also included as further improvement of the system.

Conclusions

The researchers used test cases in order to test the prototype and the mobile app functionalities. According to the test case results, both the prototype and mobile application are working properly. Additionally, there were 10 trials for each functionality of the prototype. The developers were able to develop a security level, which is, providing a serial key for Bluetooth connectivity in order to prevent the mobile application from being infiltrated by multiple mobile devices. The objectives of the study were fulfilled based on the results of the test cases performed and which made the system usable.

Recommendations

The researchers considered the following recommendations for future improvement for the development of Smart Sinampay:

- For future developers, the researcher recommends the developed system with weather forecasting capability and extending the mode of transmission of data via internet or Wi-fi technology.
- The smart sinampay can be a general type of hanger of any product that involves sunlight exposure.
- Putting up a user login interface to increase security.
- Improving the user interface design.
- Foldable clothesline and also mount can be moved to another place.
- Camera for the security of the prototype.
- Powerbank for the prototype

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TakeItOut: A Microcontroller-Based Multiple Medicine Dispenser with Mobile Application Monitoring and Scheduling System

Raven Jean P. Limpin
Andrei Paulo M. Lulu
Arjhay Christian D. Manabat
Princess Pia G. Ocampo
Rica Mae F. Sicat
Joe Mark S. Valiao
Engr. Robbert M. Bamba, MEECE (Technical Adviser)

ABSTRACT

There may be many people out there who require constant assistance, such as the elderly, family members, or those with special needs. The timing of taking a particular drug has a greater impact on the elderly than on others. Timing is critical in preventing any dysfunction or illness. The study's general objective is to develop a Multiple medicine dispenser and scheduler application entitled "TakeItOut: A Microcontroller-based Multiple Medicine Dispenser with Mobile Application Monitoring and Scheduler System", the researchers applied the SDLC Prototyping method to improve the project's outcome. As a result, the researchers successfully gathered data through the internet literature, medicine scheduler-related applications and clearly understood the application's development. MIT app inventor, MIT app companion, and Adobe photoshop were among the technologies identified and used in the application development. The researchers used design diagrams to illustrate and monitor its progress such as storyboard, block diagram, and hardware circuit diagram. The researchers successfully created and developed an interoperable medicine dispenser and mobile scheduler application. The researchers utilized test cases to ensure that the mobile application and system prototype were both functional, each of the device's functionality were tested at least ten (10) times to fulfill the system requirements. The researchers concluded that the system prototype and mobile application TakeItOut fulfilled all of the objectives, specifications, and scope. The evidence gathered during the prototype's development and deployment shows that the study was a success. Due to time constraints, the researchers recommend to improve the design of the medicine dispenser.

INTRODUCTION

Medication adherence is a growing concern throughout the healthcare industry with doctors, healthcare systems, and other stakeholders since the elderly or senior patients' medication has a big issue of drugs misuse [1]. They would likely forget to take their tablets on time, especially if they're taking many drugs. Furthermore, kids may inadvertently take the incorrect dosage, which could result in serious repercussions such as death. [2]. The process of taking medicines given by doctors is frequently rescheduled due to a failure to remember to take the same medications at the same time. As a result, a monitoring system is required to ensure that a patient's medication is taken on time. The Medicine Dispenser System reminds users to take their medication at the appointed time. The smart medicine box is a very practical

solution for those who have a pressing need to ensure that their prescriptions are taken on time. Medication is used by a large number of elderly people and patients in severe circumstances. [3]

Home care with the assistance of a drug dispenser is a watershed moment for a company. With a medicine dispenser, the traditional medication management alters dramatically. Home care is an important aspect of the medication intake procedure in standard care. When it comes to using drug dispensers in-home care, organizational care becomes optional and only required when issues happen. The dispenser monitors the patient's medication compliance and alerts home care providers when an error occurs and it is time to intervene. When using medicine dispensers, an outside company is frequently involved. This external company delivers the medication in

the desired format that corresponds with the type of medicine dispenser. [4]

The advancement of today's technology has resulted in a significant change in our way of life, owing to its efficiency in our daily lives. In today's world, the Internet of Things (IoT) is a huge benefit. It has been embedded in our electronics, resulting in even more intelligent and progressive automation. The devices can administrate and monitor the devices at any given range at any time thanks to the Internet of Things. [5]

This study aims to build a multiple medicine dispenser that would help the medicine intake of the patient through the use of a microcontroller controlled by a mobile application user interface.

Background of the study

People in modern society have become so preoccupied with their daily lives that they have forgotten many things. Dementia affects older adults and people suffering from chronic diseases who must take their medications on time and without fail. As a result, they forget things in their daily lives. A study has been conducted in light of this condition. Recent home healthcare technologies are currently being used to remedy this problem by reminding patients of their medication schedules, providing remote monitoring, and updating patients' new medicine data, which prescribers can accomplish via the internet.[6]

Many medical blunders occur as a result of those in charge of a patient's or elder's medicine having to sort large volumes of tablets every day (Minaam, El-fattah, 2018). Patient adherence is a critical component of chronic disease treatment. To appropriately assess treatment efficacy and therapeutic obstacles, a thorough understanding of patient adherence and its modifying elements is required.

The researchers developed a medicine monitoring reminder system in which owners can set an alarm through mobile device and connect the device to the pill dispenser that would release and alert the patient to take their medications on time. The researchers came with the title "TakeItOut" because it is an application with a physical device that can set a schedule for medicine monitoring.

Objectives of the study

The general objective of the study is to develop TakeItOut: Microcontroller-Based Multiple Dispenser with Mobile Application Monitoring and Scheduling System. Specifically, this study aims to achieve the following objectives:

- To gather data through interview, survey, and observation
- To identify hardware and software technologies would be used
- To design mobile application and Microcontroller-based multiple medicine dispenser using designing tools and diagrams
- To create and develop interoperable mobile application with scheduling system and microcontroller-based multiple medicine dispenser
- To integrate mobile application that would enable to control microcontroller modules and sensors.
- To test the application system and product using researchers made test cases.

Scope and limitations

The study was focused on the development of "TakeItOut: Microcontroller-Based Multiple Dispenser with Mobile Application and Scheduling System" intended to be used for medicine intake monitoring and reminder specifically for the elders and individuals who have memory difficulties.

The information that the researchers gathered would help to built the concept of the study, the researchers found out that the prescription of the doctors must be followed at the given time. With the use of the scheduling system, the user can use the needed medicine on the right time intake of patients with comorbidities and maintenance in medicines. Therefore, the researchers came up to create a technology that can give the patients the right medicine at the right time. To fulfill the creating of the technology, the researchers used the software Arduino IDE and MIT app inventor, and for the hardware the researchers would use an Arduino Microcontroller with modules. The researchers also use designing tools (Storyboard, block diagram, hardware circuit diagram, etc.) to illustrate the design and appearance of the user interface and to connect

the connectivity of the microcontroller, modules and sensors.

The researchers would make a mobile application that controls the microcontroller that has a capability of dispensing the medicines. Based on the information that the researchers gathered from the related studies of Medicine Reminder and Monitoring System for Secure Health Using IOT, it has a feature of scheduling and monitoring system. This feature that the researchers think it would benefit the developed prototype. Finally, to ensure the quality of our prototype the researchers conduct a made test cases.

SYSTEM DEVELOPMENT METHODOLOGY

This section discusses the methodology used by the proponents to develop the prototype model, application and the diagrams used to further explain the flow and design of the study. The figure given below would describe the said design model. The proponents would be using prototype since the TakeItOut is an integration of mobile application development and experimental hardware design of the whole system.

The researchers used the Prototyping Model methodology as the software development model. The Prototyping methodology allows the rapid development of the system while the developer gets valuable feedback from the users early in the project. The TakeitOut is an integration of Arduino Micro-controller and mobile application user interface. Figure 9 Shown below would describe the process on how to achieve the final step.

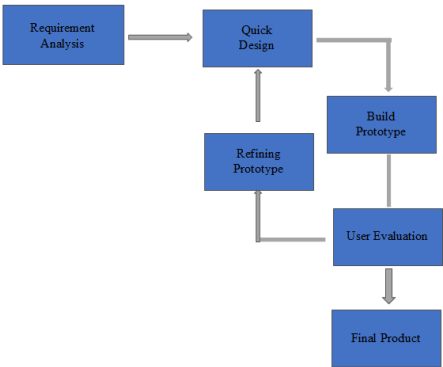


Figure 9. Prototype Model

A visual illustration of the prototype model is shown in the figure above. According to the diagram, the project must achieve the various requirements in order to make a system. The system must be finished in various phases. “TakeitOut” is a Microcontroller-Based IoT project that would help the user to schedule the medicine in take on time using the help of MIT Application.

Requirement Analysis

In this phase, the researchers collected data by brainstorming with the research team. The proponents additionally researched the related theories, projects, studies, and works of literature. Microcontrollers are already available on the market as proponents researched related projects and works. The researchers came up with the idea to combine the use of a microcontroller and medicine monitoring that can be developed to TakeItOut. Aside from the concepts and knowledge learned from the related literature and studies, the researchers consulted and adopted inputs from the technical adviser. Upon brainstorming, the researchers were able to see the need for an additional unique mobile application for the prototype and other functionalities. Software and Hardware requirements is shown in Appendix F.

Appendix F		
HARDWARE AND SOFTWARE REQUIREMENTS		
Software and Hardware Specification Used for the System Development		
Hardware	Microcontroller and Modules	Software
Intel i3 2.0ghz	Arduino Mega	IDE software
8GB RAM	Bluetooth Module	MIT App Inventor
128 SSD 500 GB HDD	Servo Motor	MIT App Companion
	GSM Module	

Quick Design

In this phase, the researchers would perform a preliminary run in the hardware to test and analyze if there were any other issues. It would assist the researchers in determining if there are any errors or flaws. To check the initial design output, a number of features trials for both the prototype and the mobile application would be examined. The developed architectural design of the prototype is shown in Appendix I.

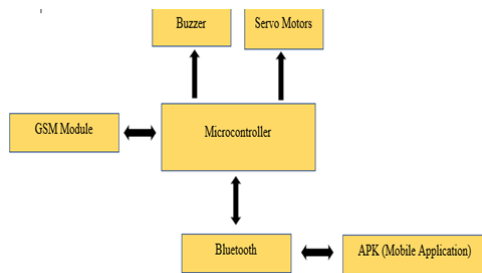
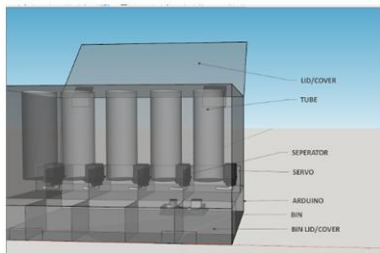


Figure 10: Block Diagram of the System

The figure above represents the graphical flow of the system prototype. The microcontroller serves as the medium for its components to function. The Bluetooth and GSM module channels through the microcontroller that triggers the buzzer and the servo motors to function.

Appendix G
Architectural Design of Prototype



Appendix I
STORYBOARD



Build Prototype

In this phase, the researchers would build the architectural design of the developed project into mobile application design and dispenser prototype design. The researchers began by inspecting each of the hardware components to identify which components are working and which are not. After that, the system prototype

began to connect all the components, including the Arduino Mega, Buzzer, GSM Module, Jumper wires, Servo Motors, HC-05 Bluetooth Module. Additionally, the researcher started coding to build a precise set of steps for the IoT devices to communicate and operate as a one system. In this phase, the architectural design of the application was constructed.

User Evaluation

The user evaluation phase begins when the initial prototype development has been completed, and the researchers have undertaken an in-depth evaluation with the capstone panelist and capstone adviser. The extended requirements for the system prototype were thoroughly discussed to improve the prototype system. The researchers would also gather initial feedbacks on design, usability, and user experience from the capstone panelist, adviser, and target users.

Refining Prototype

In the refining phase, the researchers studied what are the main caused of the errors in the prototype and code. Eventually, despite of the difficulty resolving the problems and flaws due to complicated parts of the system prototype, the study is ongoing and constant in progress. The research team made the medicine dispenser with mobile application scheduler a reality. Additionally, the refining phase of the prototype system is to be kept and utilized to build the actual application. Refining would continue until the final prototype system is built. If the prototype aims to solve a technical problem, it is refined until a solution or unsolved issue is discovered.

Final Product

In this phase, the system's implementation prototyping is completed, the final version is thoroughly tested. If the researchers believe that the prototype system is not satisfactory at the end of the testing, new improvements are implemented. After verifying that everything functioned properly, the researchers presented the final product, a microcontroller-based medicine dispenser with mobile application scheduler, to the capstone panelist and adviser.

RESULTS AND OUTCOMES

This section showed the results and outcomes based on the objectives of the study and it is

important that the research output is presented in an organized and presentable manner. Anchored on the objectives and procedures (requirement and system analysis, system design, build a prototype, evaluation with users, refine prototype, final product) These discussions and conclusions are based on the objectives of the study, completed analysis, and testing of the developed medicine dispenser and mobile application prototype. The study covers primarily the design, development and testing of the mobile application and hardware prototype entitled “TakeItOut”.

Requirements

The researchers successfully gathered data from internet library research, internet research journals and collaborations that gives the researchers enough ideas, information and a deep understanding that would help in the development of the mobile application integrated with micro-controller system. The researchers used the internet to hold collaboration sessions through virtual meeting and to gather informative ideas. During the scheduled virtual meeting, researcher team members would be given a series of tasks by project leader for them to perform.

The researcher identified to create a mobile application integrated with microcontroller and used the required hardware and software (see appendix H) in the development process of web application. The hardware that the researchers used in the design project was Arduino IDE. For mobile application development, the researchers used MIT application for the design and functionalities of the mobile application.

System Design (Software, product / Processes)

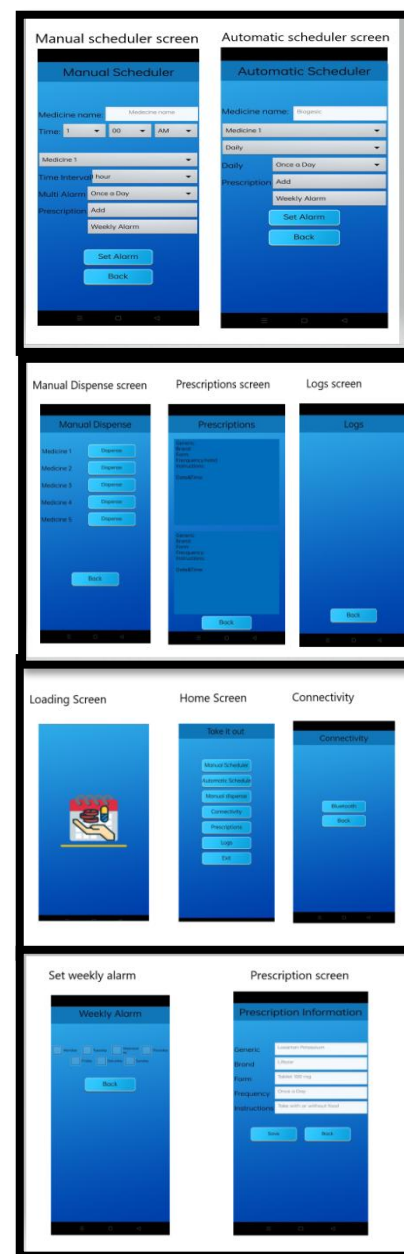
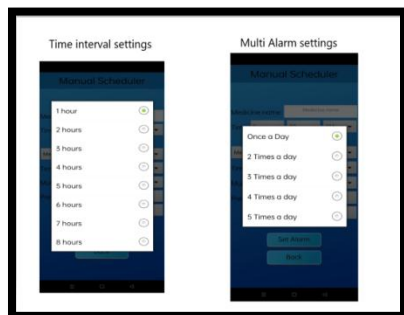


Figure 11: System Design (Screenshots of Mobile application)

Figure 11 shown above displays the first screen is prompted as the loading screen. Once the application is loaded, the home screen would be prompted. The home screen consists of seven (7) buttons which is: Manual scheduler, Automatic scheduler, Manual dispense, connectivity, prescriptions, logs, and exit. Take note that the users must always click the

“Connectivity” button in order for the user to use the functions of the applications because the application is Bluetooth connectivity dependent. On the Connectivity screen there is a “Bluetooth” button which can connect to the Bluetooth of the medicine dispenser. Once the connection between the mobile application and the dispenser, users can now use the other features of the applications. On the “Manual scheduler” button, user can set the medicine name of the pills to be taken, once the user set the name of the pills, they can now set the schedule time of the medicine to be taken. Additionally, users can set up to 5 medicine alarms with different time and names. After the user set the time and the medicine slot, users can select the time interval and how frequent the alarm would go, in the “time interval” users can choose to 1 hour up to 8 hours of time interval of the medicines based to the user’s requirement, on the other hand, “Multi alarm” can set how frequent the alarm would be. Users can choose to “once per day” up to “5 times a day”. Users can also set their prescriptions of the medicine for more detailed alarms.

The automatic scheduler button is where the user can set their alarms automatically without inputting the starting time of the alarm, the automatic schedule follows the American Standard dosing times (see Appendix “N”) where the options of the alarm have default set time of schedules.

The weekly alarm button option is where the user can set their scheduled alarms in a week, user can select days from Sunday to Saturday to repeat the same alarm on the desired day.

The manual dispense button from the home screen is where the user can manually release the medicines in the dispenser by clicking the “Dispense” button, the servo motors on the medicine dispenser would be manually controlled by the user and can release the medicine straight away even without the alarms.

Prescriptions button in the home screen is where the user can view the details of the prescriptions of the scheduled medicines that the user set from both manual and automatic scheduler.

Logs button in the home screen is where the scheduled medicines are stored, the user can

view all of the alarm logs of the already scheduled medicines.

Build a Prototype and Processes (Development and Testing Results)

The researchers designed a multiple dispenser device based on the panel’s recommendation and objectives of the study. When the researcher’s programmer completed the system’s primary functionality, the other members performed a series of tests to ensure that the device’s features worked consistently and efficiently. The system prototype development and testing are depicted in the figure below.

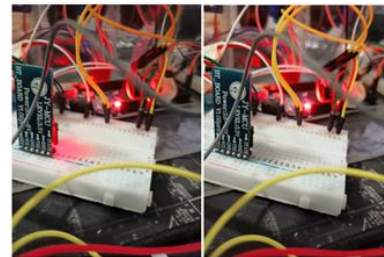


Figure 12: Testing of Bluetooth Module

In Figure 12 it represents the responsiveness of the Bluetooth Module. If the Bluetooth module’s LED blink twice after it blinks it would indicate that it was connected. But if the Bluetooth Modules’ LED is continuous to blink it indicates that the Bluetooth is not connected.

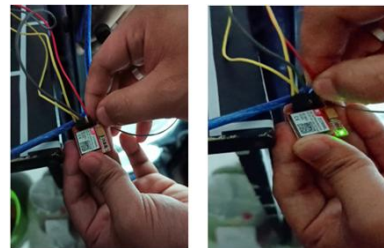


Figure 13: Testing of GSM Module

This figure presents the responsiveness of the GSM module. A GSM module can send the SMS to the user’s mobile application. As a result, the researcher found out that the GSM module can connect to the device and send notifications to the user via SMS.

Evaluation with Users (Prototype)

The features and functions of the system prototype are evaluated and discussed, including how well it responds when it comes to communication between the device and

application, other functionalities, and the attributes what the system is lacking. The recommendations were discussed between the researchers, the capstone adviser, and the capstone panelists for the systems to improve, Toward the end of the presentation, deliberation was conducted between the panelists and the adviser. The study was accepted with major revisions for both of the system and documentation. Lastly, for the improvement of the system prototype, the panelists recommend modifications on the documents (e.g. Related Literatures, diagrams, scope, format, citations, objectives, and methodology) a more compact design of the prototype, full simulation of the prototype, and the test cases of the prototype for at least ten (10) trials made.

Table 1. TakeItOut Prototype Test Case
No. of trials test cases = 10

PROTOTYPE TEST CASE	YES	NO
Does the BluetoothModule connect when connect button is clicked?	10	0
Does the first servo motor respond to the alarm of the app?	10	0
Does the second servo motor respond to the alarm of the app?	10	0
Does the third servo motorrespond to the alarm of the app?	10	0
Does the fourthservo motor respond to the alarm of the app?	10	0
Does the fifth servo motorrespond to the alarm of the app?	10	0
Does the schedule button set the time correctly for the first medicine scheduler?	10	0
Does the schedule button set the time correctly for the second medicine scheduler?	10	0
Does the schedule button set the time correctly for the third medicine scheduler?	10	0
Does the schedule button set the time correctly for the fourth medicine scheduler?	10	0
Does the schedule button set the time correctly for the fifth medicine scheduler?	10	0
Does the TakeItOutmedicine dispenser release the medicines?	10	0

The test cases shown in table 1, each of the functionalities are tested at least ten (10) times to assure that each prototype modules reacting to its functions. At the initial stage of testing the prototype functionalities, it was found out that GSM module can send SMS to the user when the servo motors release the pills in the dispenser. After finalizing the prototype wirings connection and proper orientation of mechanisms, all the modules responded according to the user interface buttons and were found out to be working properly.

Refine Prototype: Testing Results

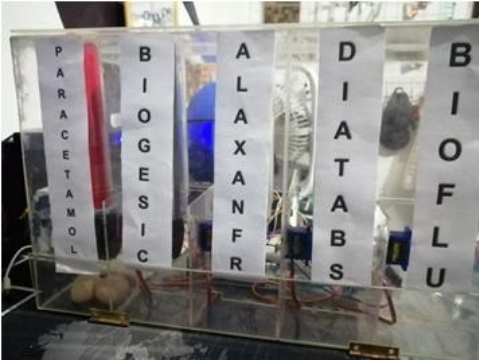


Figure 14: Refined TakeItOut Medicine Dispenser

As shown in Figure 14, the medicine dispenser has five (5) tubes that can store and release the medicines, every tube has a servo motor that would trigger if the medicines are ready to release or release by using the manual dispense using the mobile application. The dispenser has a GSM module installed that can be used to send SMS messages to the user if the medicines are release in the dispenser, the dispenser also have a buzzer installed for additional reminding system. The prototype also has a secured bins where medicines would be stored after release, it would protect the medicines from dirt and dust and also for the reach of animals and children. The researchers completely modified the device to match the panel’s recommendations and put it through a series of tests to ensure it worked properly.

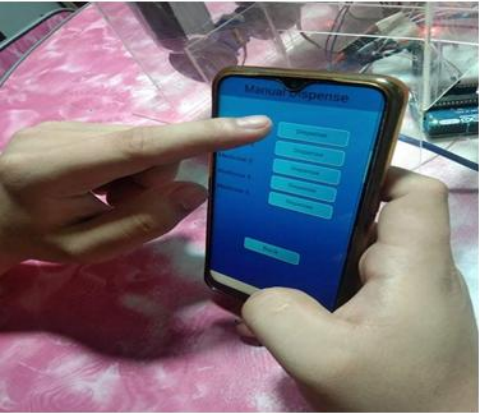


Figure 15: Testing of Manual Dispense and Servo Motors

Figure 15 shows above illustrates the testing of manual dispense function of the mobile

application and how the servo motors would respond to the user's commands if the user click the dispense button.

Feedback

The researchers were able to edit the document using Grammarly, the software that can identify wrong grammars and misspellings. The researchers also use Quill Bot to paraphrase the contents of the related literature. Additionally, the researchers successfully modified the document and the system prototype again, using the capstone panelists recommendations as a guide towards the completion of the study.

Final Product and Test Cases (Implementation Results)

Table 2 displays the test cases shown in "Appendix D" and used to validate the mobile application's functionality. For each test case scenario, ten (10) trials are performed confirm that the mobile application responds in accordance with its corresponding features. When you enter and click the manual scheduler of the mobile application it would display the time settings of the alarm and the user can set the schedules based to the user's desires. Once the scheduled medicine is ready the medicine dispenser would send a sound using the buzzer after 5 seconds when the medicines are released by the servo motors, and the GSM module would send a SMS message to the registered number of the user to notify that the medicine is ready to take. Furthermore, the manual dispense button functions work efficiently. When the user pressed the "dispense", it activates one of the servo motors and it would release the medicines. To conclude, the researchers guarantee that the program functions well and it is easy to use. Eventually, the researchers were able to validate the usefulness and capabilities of the mobile application by running consistent test cases.

Table 3, shown in "Appendix E," contains the test cases for the system prototype's usability. The researchers verified the TakeItOut mobile application is user-friendly and easy to use and that the user is not constantly confused. Aside from being simple to use, the program was also created with the user in mind. The group's mobile application developer added an appealing color palette, legible context, and

minimalist buttons to make it simple and easy to use. Even though the program is basic and easy to use, the researchers ensure it runs well.

Appendix D

Functionality Test Cases Results for Mobile Application User Interface

Test Cases Results Mobile Application User Interface

Table 2. Functionality Test Cases Results for Mobile Application User Interface

No. of trials for each prototyping testing = 10

Category/Characteristics = Functional Suitability

Mobile Application Test Case	YES	NO
Does the connect button respond and successfully connect to the Bluetooth when clicked?	10	10
Does the disconnect button respond and successfully disconnect to the Bluetooth when clicked?	10	10
Is the "Manual scheduler", "Automatic scheduler", "Manual Dispense", "Prescriptions", "Connectivity", "Logs", "Exit" buttons working?	10	10
Does the mobile application can enter and display the User's prescription to mobile application?	10	10
Is the "time interval", "multi alarm", "Add", "Weekly alarm", "Set alarm" buttons working?	10	10
Is the "dispense" button in the manual dispense working?	10	10
Does the prescriptions show the list of all prescriptions set by the user?	10	10

Appendix E

Usability Test Cases Results of TakeItOut

Table 3. Usability Test Cases Results of TakeItOut

Category/Characteristics = Usability

Mobile Application Test Case	YES	NO
Can you fill the details of the medicine in the prescription?	10	0
Are the buttons working when you command them?	10	0
Is the set alarm button working?	10	0
Can you manual dispense the medicine?	10	0
Is the real time scheduling of the app working?	10	0
Can you set the time interval of the alarm?	10	0
Is the weekly alarm button working?	10	0

DISCUSSIONS

This section consisted of the summary findings, conclusions and recommendations based on the results of the study TakeItOut: A Microcontroller-Based Multiple Medicine Dispenser with Mobile Application Monitoring and Scheduling System.

Summary of Findings

The phases of prototyping methodology were followed by the researchers to achieve the prototype TakeItOut mobile application integrated as final product. A set of objectives was developed in accordance with the functionality and design parameters. Trials were conducted in order to ensure that the release of the medicine in the dispenser is accurately provided by the data coming from the mobile application.

To achieve the prototype medicine dispenser and mobile application, the researchers use the system prototyping model phases to create the prototype TakeItOut, and mobile application integrated output product. Specific objectives were developed based on the functionalities and design elements. Experimental trials were performed to check the mobile application's functionality and the medicine dispenser device. The researchers ran set of test cases to measure and test the state of the prototype and mobile application to confirm the intended outcome. The capstone panelists recommended adding an automatic scheduler mode, prescription details of the medicine, and logs to view the recent alarms that have set, which was accomplished by creating new and improve application on a different platform. Furthermore, the researchers devised a method for evaluating the prototype and mobile application on a different location and scenarios. One of the researchers tested the prototype's functionality, which included the setting of alarms on different medicine slots, clicking dispense button on manual dispense to release the medicines, setting the time intervals and multi alarm of the medicine, viewing the logs, and checking the connectivity of the medicine dispenser and app via Bluetooth. The other research members tested the mobile application by checking the other functions and evaluating all of the prototype's components. Finally, the medicine dispenser device is functional without any issues.

Conclusions

The researchers used test cases to test the hardware and software functionalities. Based on the results of test case responses, both software and hardware were working properly. Based on the findings, the following are the conclusions of the study:

- The information needed on the efficient and exact components that were used to design and develop a user-friendly Medicine dispenser for medicine monitoring and scheduling.
- Developing a manual dispense function for the mobile application for the manual release of the medicines according to the user wants.

- Creating an IOT device that automates the release of the medicine based on the user data.
- Creating a mobile application using the following software (Arduino IDE, MIT app Inventor V.2), provides a logical combination of software tools that is very much needed in developing the mobile application.
- The tools and hardware that are used to create an IOT device are the most convenient tools that requires a suitable knowledge and skills that the researchers possess.

Recommendations

- The researchers considered the following recommendations for future improvement of the developed TakeItOut prototype.
- Improve the casing of the hardware in the medicine dispenser for security purposes.
- Improve the design of the system's mobile user interface for more reliable and well detailed reaction to the prototype system's manually controlled function.
- Adding more features and functionality to the system, such as monitoring sensors of the medicine and set a LED display in front of the medicine dispenser.

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Virus Striker: An Android-Scrolling and Shooting Game Featuring the Deadliest Viruses in the World's History

Marc Ace S. Chua

Dea G. Flores

Jimuel A. Jacinto

Jhayzie Y. Sagmit

Dessalyn J. De Castro (Technical Adviser)

ABSTRACT

The pandemic caused an unwelcome change in the world, shutting down most countries. During these stressful months, mobile games quickly grew to become one of the most flexible and accessible sources of entertainment for people who are stuck at home. The study's general objective is to develop a 3D scrolling and shooting game, entitled: "Virus Striker: An Android-based scrolling and shooting game featuring the deadliest viruses in the world's History". The researchers applied the scrum method to improve the project's outcome. As a result, the researchers successfully gathered facts through Internet literature, game-related applications and clearly understood the application's development. Blender 3D, Adobe Photoshop, Unity 3D, and Audacity were among the software technologies identified and used in the application development. The researchers used design diagrams to illustrate and monitor its progress, such as: storyboard, gameplay, character model, product backlog, and sprint backlog. The researchers successfully created and developed an educational scrolling and shooting game based on an almanac of the deadliest viruses in history. The game was tested and evaluated by twenty beta testers using the MEEGA+ questionnaire. In terms of usability and player experience, the majority of testers concluded that the application attained overall user satisfaction. The researchers concluded that the game application Virus Striker fulfilled all of the objectives, specifications, and scope. The evidence gathered during the gaming application's development and deployment shows that the project was a success. Due to time constraints, the researchers suggest adding more virus characters and making it a social interactive multiplayer gaming app.

INTRODUCTION

Ever since the species developed into its modern form, viruses have been controversial for humans. Vaccines and antiviral drugs have allowed us to prevent the spread of infections and have helped ill patients recover from several viral diseases. Smallpox, for example, has been eradicated, ridding the world of new instances. However, along the way from winning the fight against viruses, several of them have successfully transmitted from animals to humans in recent decades, causing widespread disease. Epidemics have killed thousands of people. The virus strain that caused the 2014-2016 West African Ebola epidemics killed up to 90% of those infected, making it the most dangerous member of the Ebola family. Nevertheless, other viruses are just not as deadly as the others. Some viruses, such as the new coronavirus that caused outbreaks worldwide, have lower mortality rates but represent a serious threat to public

health since they do not yet have the means to resist them. (Anne Harding, 2020) [1].

Amidst a pandemic caused by one of the viruses mentioned above, technological innovation can aid humanity during these difficult times because technology is essential to this generation. It improves people's communication and interaction with one another, and it influences an individual's learning to make it more collaborative and interactive. Furthermore, technological advancements allow people to access information anytime, making education more convenient and accessible. In line with these, the gaming industry has evolved into one of the most critical and innovative sectors and it is constantly being improved and extended. It is rapidly expanding and becoming more popular on mobile phones and smartphones. Game development is no longer limited to specific platforms like gaming consoles or computers [2].

Mobile phones are becoming more complex and graphically sophisticated, and games are a few gaming consoles. The latest phones contain an accelerometer sensor, which allows for more dynamic gameplay. In those so-called motion-based games, users can steer by tilting their phones in the appropriate direction. Games for feature phones can be downloaded in a variety of formats, including Java, BREW, Mophun, and WGE. Even though some phones support many technologies, some of them are incompatible with one another [3].

Some of the most well-known game genres are adventure games, action games, sports games, fighting games, role-playing games, platform games, scrolling games, and endless games. Choosing a genre in games is a way to classify games by having a consistent style or collection of features [4]. Endless runner games have grown in popularity in recent years. The player can proceed through the game until a barrier prevents him from achieving the highest possible score. Because of their quick play, addictive nature, and simple controls, they are an accessible genre that almost anyone can pick up and play [5].

After researching the benefits and disadvantages of procedural content generation in game development as well as the continuing advancement of mobile technology, the researchers came up with the idea of utilizing technological innovation and integrating the mobile gaming industry to provide people with alternative ways to get some relief and make the quarantine state more bearable. Mobile games can help relieve stress by providing entertainment and social connections, which are essential during this global quarantine. As a result, the researchers generated the concept of creating a mobile game entitled "Virus Striker: An Android-based scrolling-shooting game featuring the world's deadliest viruses."

Background of the study

The COVID-19 is a devastating global pandemic that hurt people's overall living, considering vast aspects of their lives. However, the impact of the pandemic and its consequences are felt differently depending on people's status. Before the coronavirus, the people have had to deal with various epidemics and pandemics across the centuries. Many claimed millions of lives, and the number of affected is constantly rising

to this moment brought upon the other viruses. The deadliest viruses that Harding (2020) listed have plagued the Philippines and worldwide. One of the reasons the cases are increasing is because people do not have enough knowledge on how the viruses started, how to prevent the them from the past and at this moment, and how to protect themselves to avoid spreading and increasing cases.

Ebola virus, Hantavirus, Spanish Flu, HIV (Human Immunodeficiency Virus), Smallpox, Dengue Virus, Rabies, Hepatitis A, and Covid-19 Virus. Ebola (EBO) (subtype Reston [EBO-R]) virus was initially discovered in the United States in 1989 in association with an outbreak of viral hemorrhagic fever among cynomolgus monkeys (*Macaca fascicularis*) exported from the Philippines. Subsequently, four other episodes of EBO-R virus infection among monkeys imported from the Philippines have occurred in the United States and Italy between 1990 and v1992. In 1989, 1990, and 1996, the virus was detected in primate facilities in the Philippines that exported monkeys all over the globe, leading to 3 cases of viral infection among humans.

The effects of the deadliest virus with the human race inspired the idea of the researchers in developing a scrolling and shooting game entitled "Virus Striker:" to provide more information about the viruses as well as equip the people with knowledge about simple ways of preventing being infected with the said viruses.

SPANISH FLU – In an estimate, it infected 500 million people or one-third of the world's population. The number of deaths is estimated to be at least 50 million worldwide, with about 675,000 which have in the United States.

EBOLA- This epidemic's impact on the world, particularly West Africa, was significant. A total of 28,616 cases of EVD and 11,310 deaths were reported in Guinea, Liberia, and Sierra Leone. An additional 36 points and 15 deaths occurred when the outbreak spread outside these three countries.

RABIES - More than 95% of human deaths from rabies occurred in Africa and Asia. About 40% of deaths occur in children under the age of 15. Rabies is present in more than 150 countries and on all continents but Antarctica.

More than 3 billion people live in regions of the world where rabies occurs.

HIV - Almost a million of people died from HIV/AIDS each year; it was the leading cause of death in some countries. HIV/AIDS is one of the world's most fatal infectious diseases, particularly across Sub-Saharan Africa. The disease has had a massive impact on health outcomes and life expectancy in recent decades, claiming almost 33 million lives.

COVID-19- The total infected worldwide is 176,693,988 and the total death is 3,830,304.

HANTA VIRUS- Although rare, Hantavirus Pulmonary Syndrome (HPS) is frequently fatal, with a case fatality rate of 36%. Total cases 1, 060 cases and 410 deaths were reported in the period.

DENGUE- Each year, an estimated 390 million dengue infections occur worldwide. Of these, around 500,000 cases develop into severe dengue, or dengue hemorrhagic fever, a more severe form of the disease, which results in up to 25,000 deaths annually worldwide. That's each year.

SMALLPOX- is estimated to have killed up to 300 million people in the 20th century and around 500 million people in the last 100 years of its existence, including six monarchs. As recently as 1967, 15 million cases occurred a year.

HEPATITIS A - There were 91 reported deaths related to hepatitis A in the U.S. in 2017. Worldwide, WHO estimates that Hepatitis. It was the cause of death for 7,134 people in 2016.

ROTAVIRUS -Each year, rotavirus causes approximately 111 million episodes of gastroenteritis requiring only home care, 25 million clinic visits, 2 million hospitalizations, and 352,000–592,000 deaths (median, 440,000 deaths) in children of less than 5 years of age.

The virus scourge roused the thought for the game "Virus Striker." Because the epidemic had spread, most of the countries have already been affected by the disease were instructed by the governments to put the countries on lockdown, mandating the citizens to remain at home.

The researchers brainstormed and decided to design a 3D game. Researchers chose to include the deadliest viruses to provide more information.

The researchers decided to use the gaming platform to create a game that allows people to enjoy the days without leaving the house.

The game's mechanics are pretty simple to understand. The game's goal is to eliminate all viruses at each level. The user controls the game by swiping left, right, and up for movement and tapping to perform a strike.

Objectives of the study

The general aim of the study is to develop a 3D scrolling and shooting game for entitled "Virus Striker: An Android-based scrolling and shooting game featuring the deadliest viruses in world's History".

In line with this, the study aims to achieve the following specific objectives:

- To gather data and relevant literature and game-related applications.
- To identify the software and technologies required for the creation of the application
 - Blender 3D
 - Adobe Photoshop
 - Unity 3D
 - Audacity
- To design the game application using designing tools
 - Storyboard
 - Gameplay
 - Game Mechanics
 - Character model
 - Product Backlog
 - Sprint Backlog
- To create and develop 3D shooting game
 - Single player
 - Map:
 - Ten (10) levels
 - Storyline
 - Global Leader Board
 - Option:
 - Character Profile
 - Shop
 - Almanac
 - Setting
 - Multiplayer
 - Enter name;
 - Host game
 - Join game

- To test and evaluate the game application using MEEGA+

Scope and limitations of the study

The study focuses on the information about the deadliest viruses that plagued the world to provide users with information and knowledge about the diseases that the featured viruses have caused. The researchers have included conditions such as Covid-19, Ebola, Hepatitis A, Smallpox, Spanish Flu, HIV, Rotavirus, MERS-CoV, Rabies, and Dengue. The gathering of data such as related literature and similar mobile applications is done thoroughly to limit the scope of the study.

The researchers have compiled the prevention technique if one is suspected of acquiring any of the featured diseases: Cholera, make sure to drink and use safe water to brush the teeth, wash and prepare food, wash their hands often with soap, and safe water. Spanish flu, avoid close contact with sick people, stay home from work, school, and errands when sick, cover the mouth and nose, clean their hands, avoid touching eyes. HIV use condoms. Male latex condoms are the most effective way to prevent HIV and other STIs when having sexual intercourse. Get tested consistently when one is sexually active with different sexual partners. Dengue, use insect repellent, wear long-sleeved shirts and long pants, and control mosquitoes inside and outside the home. Rabies regularly takes pets to veterinary clinics and ensures complete vaccination. Cats, dogs, and ferrets can be vaccinated against rabies. Covid-19, aside from being fully vaccinated, booster shots are also recommended. Sanitation and hygiene are also vital in preventing virus transmission; this includes but is not limited to washing hands with soap and water regularly and sanitizing through alcohol every time one is going out. Social distancing is also important, maintain a safe distance from anyone who is coughing or sneezing, wear a mask and face shield, avoid touching the eyes, nose, or mouth. When sneezing or coughing, it is recommended to cover the nose and mouth with a bent elbow or tissue paper. Stay at home as much as possible otherwise needed, and if one has a fever, cough, and experiencing difficulty in breathing, immediately seek medical attention [6]. In addition, the

researchers applied the scrum method to guide the project's outcome in each stage of the development process. The researchers would use design diagrams such as storyboard, gameplay, character model, product backlog, and sprint backlog to illustrate and overview its progress. Through this model, the mobile user interface and functionality are undergone thorough assessment.

Game Design

The study was developed as a mobile game that allows the users to play the game and have fun while acquiring relevant information about the viruses. The game was named Virus Striker. The game's theme focuses on presenting the deadliest virus in the world's history, particularly identification, acquisition, signs, and symptoms when a person is infected, and preventions or cures if there are any. The game's main character is named Karding, the default character that the user can play on. Other characters are available for unlocking as the user progress into the game. The characters are named Aya, Max, Maria, Alfonso, and Mark.

The game is three-dimensional (3D) with scrolling and shooting capability. It includes ten (10) game stages with varying concepts and settings, ten (10) different viruses as enemies based on and inspired from the actual viruses it represents. Each game level features a specific virus as a constant enemy throughout the game level. To complete a specific level, the user must defeat the big boss, a modified version of the virus represented in the level. The application also has a multiplayer mode that accommodates two players in the same game. The researchers have also created settings, a shop, a map, and an almanac with virus information.

The researchers created a character model based on real-life viruses and a human character that fights and shoot viruses to make the game more relatable to the gamers, especially nowadays that the world faces this pandemic. The researchers created the models in Unity, utilizing Blender for modeling and 3D creation and Photoshop for model layout. The researchers have ten different viruses based on the world's deadliest viruses in history. These viruses were designed in Photoshop and

Blender, and the viruses 3D model contains bosses and mini viruses (see appendix I). The researchers created these 3D models because 3D attracts more players and is unique and appealing to the eye. The study has been carried out as an Android-based application which limits the game to be downloaded and installed specifically for android mobile devices only. The game is playable on the Android OS version of at least KitKat 4.4 or higher. Internet connection, either via data or Wi-Fi, is also required.

Game Storyboard

Karding was the only child and a cheerful and solid child. Karding's mom passed on when he was only ten years of age because of a notable infection called "Hantavirus," contaminating his dad and mom resulting in his parent's death. As a result, Karding became an orphan, and as he grew older, he was determined to be a nurse someday.

A wealthy family adopted Karding at the age of seventeen. Karding endeavored to accomplish his objective of being a "Nurse," and his dad and mom were instrumental in his prosperity. At the age of 28, Karding became his dream of becoming a nurse to aid the sick.

Karding was walking down the corridor one day when he noticed Dr. Jeju in the lab; Dr. Jeju was one of the specialists at the hospital where Karding worked. Nobody was near him. He used to have a record for being such a troublemaker and a wrong person. And he never addressed anybody for no reason. Karding caught Dr. Jeju saying, "At last, the perfect formula that would grant me superpowers!" Karding was shocked and interested simultaneously.

He was able to obtain the formula and consume it. He acquires superhuman strength, speed, and agility, just as the capacity to strike due to the procedure. Karding was on his way to the hospital one morning when he noticed viruses floating in the air. He attempted to catch and touch the virus, which made him harm himself. He, then, at that point, endeavored to strike the infection, which killed it.

Karding begins to use his speed to run because doctor Jeju finds out that he has the formula. He then strikes all of the viruses he

encounters. Karding intended to eliminate all of the viruses to keep the spread and killing humans; nevertheless, he realized that he couldn't do it all alone, so he chose three persons at random (Aya, a 24-year-old intern nurse, Max, a 59-year-old Ebola virus survivor, Maria, a 29-year-old has a heart problem,) who are also determined to beat the diseases and deserving of superhuman powers. When Karding and his team witness how viruses spread and infect humans, they urge them to stay at home to prevent being infected, along with giving information on the viruses they have encountered (see appendix E).

Gameplay

The main screen is the starting point where the user has two options: the single and multiplayer mode. When the player selects the single-player mode, the player can find the Map, Shop, Settings, Profile, Almanac, and exit. The setting can adjust the volume of the background music, and the player can also change the quality of the game.

Virus striker is an Android-based game; it would not be compatible with iOS devices and PCs. Other gaming consoles cannot download or access the game because it is only Android-based and compatible with KitKat (4.4) or higher.

The game is recommended to be played on Android phones. It is suitable to be played in landscape orientation and is intended to be played by a single and multi-player. The game does not need an Account to play; all they need is to download and install the game.

The beginning of the game wherein the character is running because he is being chased by Dr. Jeju, the specialist who invented the formula that gives Karding and his team superhuman powers, the story would be provided then there would be a tutorial on how to play the game while the character encounter some small viruses, the character needs to avoid the obstacles and pass the level by using this swipe up, left and right to avoid obstacles and tap to attack the viruses, the character can also get power-ups and coins along the way. The character can strike the viruses whenever the player collects a flask. To use it, the player need to attack the viruses by tapping to win against the boss.

The character needs to avoid the boss's attack and strike the boss simultaneously. The larger the life deduction when green light shows in the boss's body. The red light has the smallest life-shortening effect. If the player wins, a Victory message would pop up on the screen; then the almanac would pop up with the information about the defeated boss. The character would then encounter another virus type; the player would meet a different boss at every level. One difference of "Virus Striker" in other scrolling and shooting games is that the player can reach the end of each group. In this way, the player can unlock new levels, unlock new characters and upgrade the statistics by using the collected coins and accessing new routes, which gives the players the feeling that the player is progressing and makes the game more fun.

The game has its setting where they can control the volume, and at each level, the character would encounter different viruses. The game has ten levels. The game can pause if the player remains. The game options would appear like the resume button, restart, the main menu, and quit. If the character dies, there would be a defeat message that would pop up on the screen, and it would automatically go back from the start; there would be options that would appear on the screen like the main menu and then the restart button. The front of the game has the title on the top, and when the player clicks the start, there would be two options (1) Single Player (2) Multiplayer (see appendix F).

Game Mechanics

Player:

- 100% health percentage
- Life Shield and Extra health would be rewarded when power-up is gained
- Damage dealt = the larger the life deduction when green light shows in the boss body. The red light has the smallest life-shortening effect on the boss.
- Attack speed = tap speed
- Power Ups
- Medicine = +5% health
- Flask = 1 speed (5seconds)
- Life Deduction

- hit by an obstacle = -2 point
- hit by a virus = -2 point
- hit by a boss = -8 point

Boss:

- Life is represented by HP (500 Health Point)
- 1 HP = 1 point
- Level 1 boss = 15hp
- Level 2 to level 3 = 25hp
- Level 4 to Level5 = 30hp
- Damage dealt = -1 point to the player
- Attack speed increases in every level
- HP Deduction
- Hit by player = -1 point

Levels:

- ten levels
- A level remains locked until a player successfully completes the previous level.
- Once the first level is completed, the next level would be unlocked and available for completion.
- In every level, there would be coins to be collected for scoreboard
- one coin = 5 points
- In every completed level, the player would unlock the almanac that contains the information about the virus he defeated.

Controls:

- Swipe up
- Swipe left
- Swipe Right
- Tap for attack

Shop:

Upgrade Statistics (health, speed, strength, and defense)

Unlock characters using the coins collected

Character Profile

Gameplay:

- the game can be played by Single Player or Multiplayer
- the player would start the game at level one before proceeding to the following levels
- to complete the current level, the player should:
 - Avoid obstacles.

- Avoid random viruses scattered on the player's path
- Avoid virus attacks.
- Defeat the level's boss that would appear towards the end of the level's path by attacking the boss. Attack damage is constant at 1 point. Attack damage can be enhanced by upgrading it on the shop.
- the player should collect coins on each level to determine the player's score
- the player can use coins to upgrade stats and unlock characters.

Multiplayer connectivity and gameplay

- to play the game in multiplayer mode, players can connect via local LAN
 - Two players would play in endless mode.
 - The host would be player 1. The IP address would appear at the top of the screen automatically.
 - To play, Player 2 must copy the host's IP address.
 - In multiplayer, more obstacles and random viruses would appear.
 - When one of the players dies during the game, the other player must wait for the other player to finish because the multiplayer mode is an endless and cooperative game.
 - The objective of the multiplayer game is to gather coins, which would be saved in the single-player mode, and to destroy mini viruses along the way.

In addition, after developing and creating the application, this model as well as the MEEGA+ mobile user interface, functionality, usability, and player experience are undergone thorough series of assessments. Using the mean formula, the researcher can come up with a result from the Likert scale. With that, the interpretations from the sub-criteria and criteria results are justified with valid information. Using different studies literature has a huge impact to come up with the development of a scrolling and shooting game that features the world's deadliest viruses have encountered.

CONCEPTUAL FRAMEWORK

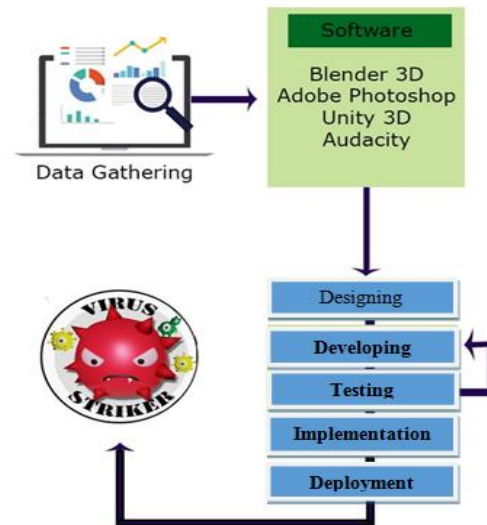


Figure 4. Conceptual Framework

SYSTEM DEVELOPMENT METHODOLOGY

This section shows the methodologies and research instruments used by the researchers. The Virus Striker is a mobile game application that displays the application's functionality under development.

Scrum is a method for addressing complex adaptive problems while achieving higher products constructively and innovatively. Scrum is a lightweight system that assists individuals, teams, and organizations create value by providing adaptive [25].

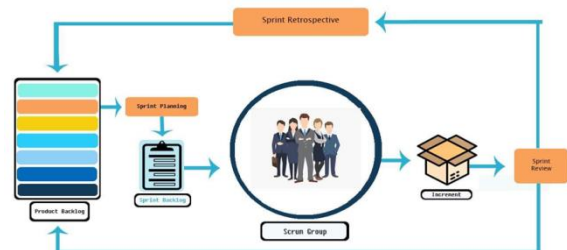


Figure 5. Scrum Methodology

This methodology is appropriate for the study's growth. Furthermore, unpredictability and risk are inevitable during the creation of the research; therefore, using this methodology would help meet the study's needs. The list below shows the event scrum designed to guarantee to development of the application.

Scrum Team

Ms. Dessa Lyn De Castro is the Capstone Adviser for the development team, and the Scrum team consists of the Capstone Members. Jimuel Jacinto as Programmer, Dea Flores and Jhayzie Sagmit for Graphic design and Marc Ace Chua, Dea Flores, and Jhayzie Sagmit for documentation and research (see Appendix A).

Appendix A



Scrum Roles

Ms. Dessa Lyn De Castro is the scrum master who assists the team in achieving its objectives and coordinating operations with other teams that gives guidance towards the completion of this study. Product Owners refers to the panelist of the study advising the researchers on technical problems in the project documents and prototypes including its recommendations. The development teams, who develop the design and logical analysis of the application (see appendix B).

Appendix B



Project Initiation

The researchers brainstormed and designed the titles proposed at the title defense. Among the titles presented, the panelist accepted one of the titles shown—the team researched by playing several games similar to the title to understand how the game works. As the team explained the title to the Panelists, Panelist instructed the development team to create a game inspired by the viruses. The panelist also gives a Capstone sample for the guide, entitled "Geomonstrum." [26]. The panelists recommended that the researcher make the original characters' backgrounds and research the viruses and microscopic images used in the game. The researchers chose a technical adviser to assist with the technical side of the project.

Product Backlog

To gather data and information the researchers searched from different literature, studies, and different viruses' description, and preventions, this process allowed the researchers to brainstorm and merge the ideas to develop a better concept. Using the product backlog as the basis for the Game analysis, Main Menu, Gameplay, 3D models, Sounds and Background effects, Evaluation, and Documentation help the researchers to develop and design the game application (see Appendix C).

Appendix C



Sprint Planning

To identify the development and design of the application, the researchers used open-source and license software to develop the application using Unity3D, Photoshop, Blender, and

Audacity. This hardware is used for the development and designing of the application. In the development of the design of the mobile game application, the researcher used different license software's namely Unity3D, Photoshop, Blender, and Audacity. Unity3D needs a Windows 7 (SP1+) and Windows 10, 64-bit versions only, Processor with X64 architecture with SSE2 instruction set support, and Graphics of DX10, DX11, and DX12-capable GPUs. Photoshop needs a CPU: Intel or AMD processor with 64-bit support, 2 GHz or faster processor, RAM: 8 GB, HDD: 4 GB of storage space, GPU: DirectX 12 support and 2 GB of memory, Operating System: Windows 10 (64-bit) version 1809 or later, Screen Resolution: 1280 x 800, the Internet connection is needed to activate the software. Blender needs a Windows 8.1+, macOS 10.13+, or Linux, Storage space: ~500 MB, Display: 1280×720, 24 bit, CPU: 64-bit dual-core with SSE2 support, 2 GHz, RAM: 8 GB, Graphics card: Any GPU card operating on OpenGL 3.3 GPU with 2 GB RAM, Mouse: Standard mouse, trackpad, or pen and tablet. Audacity needs Windows 10 / 11 (32- or 64-bit), Recommended RAM/ Processor speed RAM 4 GB / 2 GHz, Minimum RAM/ Processor speed 2 GB / 1 GHz. The mobile game installation in android mobile phones requires an Android version of KitKat and above.

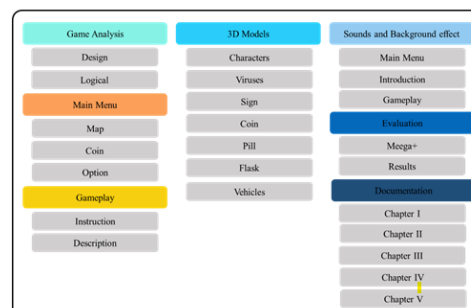
Sprint Backlog

To design the application, the researcher used storyboard, gameplay, and character modeling to keep the designing process of the mobile game better. With these tools, the researcher can keep the flow of the development smooth. The storyboard shows the full game summary, wherein, the launching screen up to the exit page can be viewed. This serves as the guide to what can users do in game as well as the developer can view the development process. The gameplay displays every screen the user can be seen throughout the game. At the first screen, users are allowed to choose whether to play a single-player or multiple players. Any android Smartphone can run the game with at least a KitKat version of android and above. Game Play gives the developer the flow to keep the process on track. Character Modeling displays the enemies based on the real viruses

that the world has encountered and a human character that fights viruses.

Appendix D

Sprint Backlog



Weekly Scrum

To create the application, the researchers arranged face-to-face meetings and virtual meetings to get a better understanding of the process of developing and designing the game application. The researchers also set a to-do list and a checklist for all the pending work as a group. That would serve as a basis to talk about the tasks assigned to each member of the capstone project.



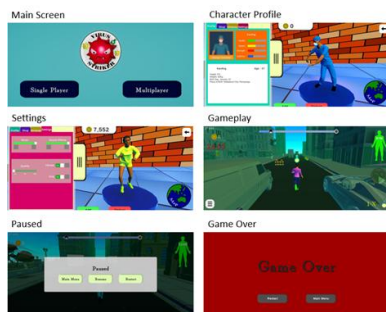


Increment

To design the game application, the researchers achieved all the required processes of developing and designing the application wherein the design and logical analysis are considered. The application provides single-player and multiplayer where there are different characters and each has a different special ability. The multiplayer option can only accommodate two players. With the coin, the player can upgrade the character's health, speed, strength, and defense. The game consists of 10 levels, and the player can encounter different viruses on every level. The Virus Striker game application is working and can be installed on mobile phones.

Appendix E

Storyboard



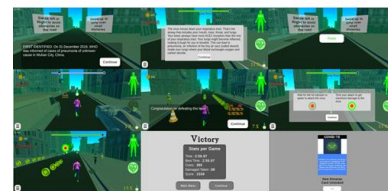
Sprint Review

The researcher conducted a developer test for the application feature to ensure that the application's features are functional and that it is working properly. The application features include a leaderboard where players can submit their names to see where they rank, as well as a single-player mode where players can choose characters with different special abilities, as well as a multiplayer mode that can accommodate two players. The game application gestures in the user interface are smooth. This control includes swiping left and right to avoid any obstacles and virus attacks, and swiping up to jump. For the point system of the game, the player needs to collect coins. The coins can be used to purchase new

characters with special skills or to improve the stats of existing characters. The game has a power-up, which is the flask that the player can use to attack the viruses along the way. The researcher conducts a developer test for the application feature to ensure that the application's features are functional and that it is working properly. The application features include a leaderboard where players can submit their names to see the rank, as well as a single-player mode where players can choose characters with different special abilities, as well as a multiplayer mode that can accommodate two players. The game application gestures in the user interface are smooth. This control includes swiping left and right to avoid any obstacles and virus attacks, and swiping up to jump. For the point system of the game, the player needs to collect coins. The coins can be used to purchase new characters with special skills or to improve the stats of existing characters. The game has a power-up, which is the flask that the player can use to attack the viruses along the way.

Appendix F

Gameplay



Testing phase

The researchers evaluated and tested the application to test its functions by the developers and respondents. The researchers used different mobile phones as developer testers to ensure and know the errors needed to improve the application. MEEGA+ was used as a game development evaluation tool by the researchers. MEEGA+ questionnaires consist of criteria and sub-criteria, the criteria are User experience and Usability while the sub-criteria are Aesthetic, Learnability, Accessibility, Challenge, Satisfaction, Social Interaction, Fun, Focused Attention, and Relevance. To evaluate respondents using the choices ranging to strongly agree and strongly disagree (see appendix H). The evaluation consists of 20 respondents randomly using the Google form and apk app of the application. To translate the results of the evaluation, the researchers use

the Likert-scale and statistical statement to identify the overall results.

Table 1: Likert Scale

Scale	Mean Range	Description	Interpretation
-2	-2 to -1.2	Strongly Disagree	Very Poor
-1	-1.3 to -0.4	Disagree	Poor
0	0 to 0.4	Neutral	Fair
1	0.5 to 1.2	Agree	Good
2	1.3 to 2	Strongly Agree	Very Good

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 = Arithmetic Mean

N = Number of set values

Ai = Data set values

$$A = \frac{1}{n} \sum_{i=1}^n a_i$$

Hardware and Software Requirements

The researchers' hardware and software requirements for testing the game application are listed below.

Table 2. Hardware and Software requirements

Hardware Requirements	Software Requirements	Functions
Android Phone	Android OS 5.0 (Lollipop) (Recommended)	Mobile Operating System
-	3 GB RAM (Recommended)	Memory
-	8 GB RAM (Recommended)	Internal Storage

The researchers identified and used the required hardware and software (as shown in the table above). The researchers used an Android phone for the test project, with the following software: Android OS 5.0 (Lollipop) for

the mobile operating system, 3 GB RAM (recommended) for memory of the device, 4 GB (recommended) for memory, and 8 GB for internal storage.

Sprint Retrospective

In this process, if the game passed all the criteria in MEEGA+ and the board of panels and technical advisers tested and accepted the game, the game application would be ready to deployed and uploaded to Play Store.

Appendix J

User's Manual



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.

The study primarily presents the design, development, and testing of the game application entitled "Virus Striker: An Android-based scrolling-shooting game featuring the world's deadliest viruses." "As a result, the researchers conducted a related literature review to gain concepts and ideas from previous studies and existing game application before brainstorming and proceeding to the planning stage. In this chapter, the researchers also used the MEEGA+ as an evaluation tool to use for twenty (20) respondents.

Data and Requirements Gathering

The researchers used online data collection to gather information from Internet searches and clearly understand the application's development. The researchers used the Internet to hold virtual meetings to collaborate and gather information during this phase. Researchers also discussed the game's gameplay, character customization, 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 software tool used in the developed application is unity used in developing 3D mobiles games, Photoshop used in editing images, and models. Audacity was used in recording sounds and background effects and blender was used in creating 3D models.

Mobile Application Sample



Figure 6. Main Menu

Figure 6 above shows the main screen of the Virus Striker Mobile Game when it is successfully installed on an Android mobile device.



Figure 7. Character

In figure 7 they can see the back button where the player can go back to the main menu, and on the left side, they can see the shop, and on the lower right, the player can see the map.



Figure 8. Character Profile

Figure 8 shows the profile of the character. The other option shows the shop with four power upgrades: health upgrade, speed upgrade, strength upgrade, and defense upgrade—Almanac, where cards are stored and the option of the quality levels which are high, medium, and low. Music and sound effects vibrate on, off, and save and reset buttons.



Figure 9. Map, Storyboard and leader board.

Figure 9 shows the level selection with ten levels. Top right has the Storyline: This contains the full story of the game and below is the Global Leaderboard: the player need to insert the name in the username box and click "upload score and update leaderboards" to record the score.



Figure 10: Actual Gameplay

Figure 10, shows the continue button when the player starts in the first level, click continues and the ready button would appear after clicking the "ready" button, the game would start. After defeating the boss, the continue button would show up and congratulate the player on defeating the boss. When the player clicks "continue," a new almanac card is unlocked and, upon clicking "confirm," the almanac would be stored in the almanac section and its information after the player click the confirm button in the almanac, the victory message would show up. It contains stats per game, the time, best time, coins, and damage is taken.



Figure 11: Multiplayer Connectivity.

Figure 11 shows the names of both multiplayer participants. A name must be entered by both Players 1 and 2. The host would start the game and then wait for player 2 to join. Enter the IP Address to join; the Join Player or Player 2 must enter Player 1's IP address. The start button would appear after both players have clicked the ready button.

Design and Development phase

The researchers used a variety of tools to design the application, including game mechanics, gameplay, character models, product backlog, and sprint backlog. The researchers developed Virus Striker, an android-based game that provides viruses by playing the game and killing the boss of each level, each of which has a distinct virus that displays its Almanac. It provides images, 3D models such as characters, viruses, obstacles, buildings, sound effects, background music, 3D power-ups, health description of the player, and instructions for the user's better interactions and experience.

Development and testing results

The researchers picked twenty random respondents to test and evaluate the application. This method is used to get feedback from the user's satisfaction to improve the systems after getting feedback from the users. This study used criteria usability and user experience and sub-criteria in terms of Aesthetic, Accessibility, Challenge, Satisfaction, Social Interaction, Fun, and Focused Attention. MEEGA+ is divided into usability and player experience (see Appendix H).

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

Table 3. Developer testing

Device Brand	Operating System	Feedback
Techno Pop 5 LTE	Android 11, HIOS 7.6	The images and character are clear and slightly log.
Realme 8 5g	Android 11	The game

Techno Spark6 Go	Android 10, HIOS 6.2	played with no logs The game is realistic and easy to navigate.
Techno Camon16	Android 10, HIOS 6.0	The game was played with no logs.
Oppo a79	Android 7.1	The game was played with no logs.

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 log when navigating the jump and swipe gesture. Realme 8 5g 9Android 11 also played with no logs. 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 logs. In Oppo a79 (Android 7.1) the game was smooth and the player doesn't encounter any logs during the gameplay.

Evaluation

The researchers have utilized MEEGA+ as the method of evaluation. This method is divided into two criteria: Usability and Player Experience.

The researchers have constructed the MEEGA+ questionnaire by including the appropriate questions/statements that were based on the MEEGA+ criteria of evaluation. The questionnaires were via Google form to the respondents generate feedback. The testing was conducted on 20 respondents to ensure that the application had passed the assessment based on the set criteria. The collated feedback of the respondents was tallied, and the evaluation of the outcomes are the following:

Appendix H
MEEGA+ Statement Criteria Allocation

Quality Factor	Dimension	Item No.	Description	Average	Equivalent
Usability	Aesthetics	1	The game design is attractive (interface, graphics, cards, boards, etc.)	1.40	A
		2	The text font and colors are well blended and consistent.	1.30	A
	Learnability	3	When I first looked at the game, I had the impression that it would be easy for me.	0.85	A
		4	Learning to play this game was easy for me.	0.95	A
		5	I think that most people would learn to play this game very quickly.	0.80	A
	Operability	6	I think that the game is easy to play.	0.75	A
		7	The game rules are clear and easy to understand.	1.45	NA
	Accessibility	8	The fonts (size and style) used in the game are easy to read.	1.35	A
		9	Does the app provide Almanac?	1.80	NA
		10	The game provides images?	1.55	NA
		11	This game is appropriately challenging for me.	1.55	NA
Player Experience	Challenge	12	The game provides new challenges (often new obstacles, situations, or variations) at an appropriate pace.	1.20	A
		13	The game does not become monotonous as it progresses (repetitive or boring tasks).	0.50	A
		14	Completing the game tasks gave me a satisfying feeling of accomplishment.	1.40	A
	Satisfaction	15	It is due to my personal effort that I managed to advance in the game.	1.05	A
		16	I would recommend this game to my colleagues.	1.15	A
	Social Interaction	17	I was able to interact with other players during the game.	0.90	A
		18	The game promotes cooperation and/or competition among the players.	0.85	A
	Fun	19	I felt good interacting with other players during the game.	0.85	A
		20	I had fun with the game.	1.75	NA
	Focused Attention	21	Something happened during the game (game elements, competition, etc.) which made me smile.	0.85	A
		22	There was something interesting at the beginning of the game that captured my attention.	0.85	A
	Relevance	23	I forgot about my immediate surroundings while playing this game.	0.45	N
		24	The game contents are relevant to my interests.	0.95	A
		25	It is clear to me how the contents of the game are related to the course.	0.75	A

Aesthetics

This criterion represents the game design of the game such as interface and graphics. The test case showed that the researchers passed the test case when it comes to attractiveness and blending color and text fonts in the game (see Appendix H). The researcher garnered a positive test result. Overall, the average weighted mean result of “1.35” and interpreted as “Very Good”. The researchers achieved one of the objectives of this study which is to maximize the graphics according to this result.

Learnability

This result showed that the game is very easy to play that the player would easily understand

the game mechanics and learn in the actual game (see Appendix H). The researcher garnered a positive test result. Overall, the average weighted mean result of “0.86” and interpreted as “Good”. It was agreed by the majority of beta testers that the game's application was easy to learn.

Operability

This criterion determined if the game is easy to understand the game rules and mechanic of the game. Users may have difficulties and issues when using the program to ensure that the game application navigates correctly. The researcher garnered a positive test result. Overall, the average weighted mean result of 1.1 and interpreted as “Good”. The results of the operability test reveal that the game is easy to play and that the player can easily learn and understand the game rules.

Accessibility

The researchers performed an accessibility test to determine if the game fonts are good enough for the players. This test also for the information that the player would learn from the image and almanac provided by the researchers. The researcher garnered a positive test result. Overall, the average weighted mean result of 1.56 and interpreted as “Very Good”. The majority of beta testers agreed that the game's application has an almanac, which received the highest accessibility result out of all the accessibility questions, and that the game's images and text are clear and easy to read (see Appendix H).

Challenge

The researchers included a challenge test for this study. This study is a game so the researchers create the game challenging for the player to make the game more exciting. The researchers include obstacles for realistic situation and while doing the task in the game to be more challenging. The researcher garnered a positive test result. Overall, the average weighted mean result of 1.1 and interpreted as “Good”. As per the majority of beta testers, both the application and the gameplay of the game are challenging and enjoyable to play. (See Appendix H).

Satisfaction

After the challenge criteria, the researchers included satisfaction to validate if the player is satisfied after playing and completing the task

of the game. The researchers also include to the test case if this game is highly recommended. The researcher garnered a positive test result. Overall, the average weighted mean result of 1.2 and interpreted as “Good”. The test results show that the researchers met the satisfaction criterion of the game being user-friendly and recommendable to others, as well as giving the player a satisfying feeling of accomplishment (see Appendix H).

Social Interaction

Since this study is a multiplayer game, the researchers included social interaction to validate if the game is good for player interaction. The researchers garnered a positive test result. Overall, the average weighted mean result of 0.86 and interpreted as “Good”. The test results show that this study passed the criteria for allowing the player to interact and cooperate to the other players (see Appendix H)

Fun

The researchers performed a fun test (see appendix H). This sub-criterion refers to the user's enjoyment while playing the game. Considering the user's feedback after using the application can be the basis of improvement that might add to the application. To assure the application has enjoyment. The researcher garnered a positive test result. Overall, the average weighted mean result of 1.3 and interpreted as “Very Good”. The result of the fun test shows that the fun test has passed, indicating that the game application has different animations and scenes that can give the users excitement while playing and having a gaming scrolling shooting—evaluating the players' feeling of pleasure, happiness, relaxation, and distraction. Fun is subjective and something that emerges from the player experience. Combining the different elements that make up the player experience can set up a fun time.

Focused Attention

The researcher performed a Focused Attention test (see Appendix H) to evaluate the player's attention, focused concentration, absorption, and temporal dissociation. These sub-criteria are the basis of the application if the user can concentrate on a specific task for an extended time. The researcher garnered a positive test result. Overall, the average weighted mean

result of 0.65 and interpreted as “Good”. The findings of the test reveal that the game's focused attention criterion was met by the researchers. The majority of the beta testers agreed that the game was engaging and could keep players' attention.

Relevance

The researchers performed a relevance test (see appendix H) to evaluate if the mobile application provides relevance from the users. This criterion also for the player if the content of the game is related to the course. These criteria are the basis of the application, whether the game contents are relevant to the player's interests, and whether the game's content is very clear and related to the course. The researcher garnered a positive test result. Overall, the average weighted mean result of 0.82 and interpreted as “Good”. The results of the test reveal that the game's relevance criterion was met by the researchers. The majority of the beta testers agreed that the game's content is both entertaining and understandable.

Table 4: MEEGA+ Evaluation Results
Respondents: 20

Qual ity Fact or	Dimensi on	Item No	Question	S A 2	A 1	N 0	D - 1	S D -2	Aver age	Equival ent
Usability	Aestheti c	1	The Game Design is attractive (interface, graphics, etc.)	8	12	0	0	0	1.40	A
		2	The text font and colors are well blended and consistent.	6	14				1.30	A
	Learnabi lity	3	When I first looked at the game, I had the impression that it would be easy for me.	2	14	3	1		0.85	A
		4	Learning to play this game is easy for me.	4	11	5			0.95	A
		5	I think that most people would learn to play this game very quickly.	2	12	6			0.80	A
	Operabil ity	6	I think that the game is easy to play.	3	10	6			0.75	A
		7	The game rules are clear and easy to understand.	11	8	1			1.45	SA

Player Experience	Accessibility	8	The fonts (size and style) used in the game are easy to read.	7	1	3				1.35	A
		9	Does the app provide Almanac	1	6	4				1.80	SA
		10	The game provides images.	1	1	9				1.55	SA
	Challenge	11	This game is appropriately challenging for me.	1	1	9				1.55	SA
		12	The game provides new challenges (Offers new obstacles, situations or variations) at an appropriate pace.	6	1	2				1.20	A
		13	The game does not become monotonous as it progresses (repetitive or boring tasks).		1	1	8	1		0.50	A
	Satisfaction	14	Completing the game tasks gave me a satisfying feeling of accomplishment.	8	1	2				1.40	A
		15	It is due to my personal effort that I managed to advance in the game.	3	1	5	2			1.05	A
		16	I would recommend this game to my colleagues.	8	7	5				1.15	A
		17	I was able to interact with other players during the game.		1	8	2			0.90	A
	Social Interaction	18	The game promotes cooperation and/or competition among the players.		1	7	3			0.85	A
		19	I felt good interacting with other players during the game.		1	7	3			0.85	A
		20	I had fun with the game.	1	5	5				1.75	SA
	Fun	21	Something happened during the game (game elements, competition, etc.) which made me smile.		1	7	2			0.85	A
		22	There was something interesting at the beginning of the game that captured my	1	1	6	3			0.85	A

			attention								
		23	I forgot about my immediate surroundings while playing this game.	2	6	1	1			0.45	N
		24	The game contents are relevant to my interests.	2	1	2	6			0.80	A
	Relevance	25	It is clear to me how the contents of the game are related to the course.	2	1	3	5			0.85	A

Table 5: Criteria, Summary of Beta Test Results

Criteria	Average mean	Interpretation
Usability	1.2	Good
Player Experience	0.98	Good
Total	1.09	Good

The table shows that the game passed the evaluation with the "Good" interpretation with an average mean of 1.09. 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.

Table 6: Sub-criteria, Summary of Beta Test Results

Sub-Criteria	Average Mean	Interpretation
Aesthetic	1.35	Very Good
Learnability	0.86	Good
Operability	1.1	Good
Accessibility	1.56	Very Good
Challenge	1.1	Good
Satisfaction	1.2	Good
Social Interaction	0.86	Good
Fun	1.3	Very Good
Focused Attention	0.65	Good
Relevance	0.82	Good
Total	0.96	Good

In these results, the table shows that the game passed the evaluation with the average mean of 0.96 with the “Good” interpretation. The table shows that the game is excellent when it comes Aesthetic, Accessibility and Fun. The overall result for beta testing passed and ready for deployment.

DISCUSSIONS

This section consists of the summary of findings, conclusions, and recommendations based on the results of the study “Virus Striker: An Android-based scrolling-shooting game featuring the deadliest viruses in the world’s history.”

Summary of Findings

Based on the previous related literature that the researchers considered, the researchers easily determined all the specific requirements needed to complete the study.

The use of diagrams such as conceptual framework and methodology in developing the prototype and the mobile application was essential to better understand the flow and the outcome in developing the game application.

The integration of the gathered data through the Internet, documents and articles helped the researchers to successfully develop the game application.

The researchers used the 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 shown in the test case results.

The researchers passed the test cases for player experience by having knowledge about the deadliest virus which is the main concept of the project. The researchers used Unity Game Engine 4 to construct JavaScript codes for this project.

The group managed to conceptualize the game using the ten (10) deadliest viruses in the world as a theme of the game to limit the study of the researchers.

The study's objectives are met, as evidenced are in the results of the application evaluation. This research aims to design and develop the Virus Striker. The researchers provided different features for a better user interface. The researchers tested the application

prototype with MEEGA+ concluded that the Virus Striker developed well in Aesthetic, Learnability, Operability, Accessibility, Challenge, Satisfaction, Social Interaction, Fun, Focused attention, and Relevance. The application's user interface was well-designed and operated well on the devices' screens (see Appendix E and F). The Users were able to understand and use the application. Blender and Unity are the primary game development software used by the researchers to visualize the outcome of the mobile application

The researchers developed a Virus Striker game application with 3D games and graphics that includes Characters, Game Mode, Main menu, Obstacle, Swiping gestures, Multiplayer, Scoreboard, Almanac, Power-ups, Shop, Map, and Leaderboard. The following features are explained below:

The application provides different characters, girl and boy characters. Every character has a specific ability. The users can get the characters by using the coin collected while playing the game. The characters have Health, Speed, Strength, and defense statistic. The game provides one primary character, available at the first level of the game; this character is free. The application offers a game mode that offers different stages wherein each level surface encounters other viruses according to the virus strength. The next level could unlike after finishing the current level. The researchers have created the main menu where users may view the game map, money earned by character statistics, shop, Almanac, and settings. The application provides different obstacles in 3D objects such as Cars, buses, trucks, vans, taxis, Cone, and signs. The barriers encountered during the gameplay. The application function provides swiping gestures. The movement includes left, right, and jumping to avoid the obstacles and get the Flask and Pill. The program offers multiplayer two people can play at the same time.

Multiplayer functions by connecting to the same IP Address came from player 1. The game keeps track of the monies earned on a scoreboard automatically recorded. Coins can be used to purchase and update characters. The Almanac provides viruses' information and prevention. Almanac can unlock after killing the boss of the game. The power-ups have two

characteristics that might help the character in the game, Flask that kills viruses and a Pill to increase the character's health. The game has a shop to buy characters, upgrade stats, almanac information, and settings. The map provides the overall levels of the application. Lastly, Leaderboard provides data or records about the player. It also shows and puts the player's name.

The researchers developed a game application using the following tools and technologies Unity 3D, Adobe Photoshop, Blender 3D, and Audacity these are explained below:

The Virus Striker was developed using Unity 3D, a game development platform for building 2D and 3D applications. Adobe Photoshop is used to edit images, chart design, and game layout. Blender is a 3D modeling software used to create obstacles, power-ups, and virus models. Audacity is used to record the music and sound effects of the application.

The researchers have evaluated the application by having twenty (20) respondents by using MEEGA+ (see appendix H). The result of the evaluations has met the Usability and Player experience of the application. The majority of the respondents Agree on the usability and player experience of the application. Some say strongly disagree, and the lowest feedback is neither agree nor disagree.

The researchers developed enemies based on different viruses that the player would encounter at each level. These viruses are turned into three-dimensional representations to kill the player character. The game's enemies are Ebola, Rotavirus, Covid-19, Smallpox, Dengue, MERS-CoV, Hepatitis A, HIV, rabies, and Spanish flu.

Conclusions

After the evaluation has been completed, the researcher drew some conclusions based on the objectives of the study.

The researchers evaluated and tested the application "Virus Striker: An Android-based scrolling-shooting game featuring the world's deadliest viruses".

The development of Virus Striker followed its stated objectives wherein the researchers developed an educational 3D scrolling and shooting game with the concept of the deadliest viruses that human encountered.

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

The researchers managed to create sounds effect using Audacity to make the game more realistic and exciting to play. To validate this result, the test case showed that the researchers successfully passed the criterion for sounds effect.

The researchers aimed to develop and educational scrolling and shooting game with the concept of the deadliest viruses in the world that human encountered to provide knowledge about these viruses. To support this, the researchers validate this under user player experience in testing tool which has shown that the game is challenging and it makes the player that can actually learn and have fun with 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 quality of the game graphics, vibration and fps. The researchers created a multiplayer game for the players to interact and communicate with each other to have fun and also to learn while playing mobile games.

Recommendations

The researchers considered the following suggestions for future improvement of the developed game. The respondents would like to recommend the following for future researchers to enhance the developed application.

Additional Viruses. Future researchers may add additional viruses that may arise. Viruses have different variants based on medical studies, especially coronaviruses, which are still rampaging nowadays, such as delta, beta, omicron, and other undercover variants.

Additional Categories (Theme). Future researchers may add additional themes in the future. The game consists of a city that has buildings around it. Future researchers may add different pieces, such as horror, forest, beach, snow, hills, etc.

To play this game not only for Android devices but also for IOS devices

To implement to other target platforms aside from mobile devices

To make the game playable over the Internet and make it not limited to local area network connectivity.

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WHEELBOT: A Microcontroller-Based Wheelchair with Manual and Mobile Maneuvering Controlled System thru Mobile User Interface Application

John Albert Lago
Aldrin Polo
Randel Ronquillo
Paul Jefferson Yumul
Jonathan David Tulabut
Engr. Robbert M. Bamba, MEECE (Technical Adviser)

ABSTRACT

In recent years, the wheelchair has become a representation of individuals with incapacities. An appropriate wheelchair allows the user to meet his or her mobility needs. The role of wheelbot is to be one of the modes of transportation for the elderly and disabled. The study aims to develop an efficient WHEELBOT: A Microcontroller-Based Wheelchair with Manual and Mobile Maneuvering Controlled System thru Mobile User Interface Application that would benefit nurses and people with mobility disabilities. The researchers used the Prototyping Methodology as the software development model. The prototyping methodology allows the rapid development of the system while the developer gets valuable feedback from the users early in the project. The researchers successfully gathered all information needed to make the wheelbot working properly. The researcher to combine the modules and program the Arduino using the Arduino IDE. The researchers successfully built a fully functional mobile application that could control the wheelbot with 3 types of options. The researchers concluded that the WHEELBOT: A Microcontroller-Based Wheelchair with manual and mobile maneuvering controlled System thru mobile user interface application met all the requirements set forth in the study's objectives and scope. With the evidences made by the researchers, the research project was successfully achieved. With this, the research met all its objectives, requirements, and scope for its intended purpose and user. Certain recommendation includes the improvement of the features of the prototype and using a more advanced method such as Bluetooth or Wi-Fi for a better wheelchair.

INTRODUCTION

An estimated 20 million people worldwide in 2003 needed a wheelchair for mobility and lacked one (World Health Organization [WHO], 2008). In less-resourced settings, access to appropriate wheelchairs is limited. An appropriate wheelchair allows the user to meet his or her mobility needs in the local environment, providing postural support with proper fit and is durable, safe, available, affordable, and maintainable by the user (WHO, 2008). Globally, charitable, governmental, and service organizations provide wheelchairs. However, users in less-resourced settings often receive inappropriate wheelchairs or wheelchairs with inadequate services. Awareness is increasing wheelchair provision by trained personnel increases the chance that wheelchair users receive appropriate wheelchairs. [1]
Versatility gadgets are proper for individuals who experience a broad scope of portability

troubles because of an expansive range of ailments and disabilities, including removal, joint pain, cerebral paralysis, poliomyelitis, strong dystrophy, spinal-rope injury, spina bifida, stroke, and are additionally pertinent for more established individuals who experience versatility challenges. Assistive advancements, for example, wheelchairs, have been shown that, when proper to the client and the client's current circumstance, they fundamentally affect the degree of autonomy and investment that individuals with inabilities could accomplish. [2]

A wheelchair could help a person's well-being in a variety of ways. Increased physical activity levels could be achieved with a wheelchair that is usable, comfortable, and quickly propelled, thereby enhancing both physical and mental health. Pressure sores, the progression of deformities or contractures, and other secondary disorders associated with weak postures may all be reduced with a well-fitting

wheelchair with a cushion and proper user training. [3]

There has been expanding interest in the Wheelchair among innovators, plan engineers, and the overall population in recent years because the Wheelchair has come to represent the individual with incapacities. For instance, the public image for crippled admittance is a theoretical picture of an individual in a wheelchair. It is a definite and reasonable article and, as of late, has become the focal point of a large number of thoughts and ideas for development. Conversely, the significant makers of wheelchairs have been somewhat moderate in presenting novel thoughts and have instead been content with minor item upgrades, especially as to fueled wheelchairs. [4]

The special case has been the creation of the games type Wheelchair, which was first imagined and created in light of rivalries in hustling, b-ball, and different games for competitors with inabilities. Sports-type wheelchairs for general use were first presented by new organizations like Quadra and Motion Designs, however, they are currently offered by every significant producer. The unrest in lightweight wheelchair plan and styling is a good representative for the soul and essentialness of individuals behind this development, many of whom have disabilities. [5]

Now and again, the issue is that the handicap makes somebody lose the capacity to walk; subsequently, for this situation, the method of controlling a wheelchair should be possible utilizing voice orders, manual control, and android control utilizing an android application. In any case, an electric wheelchair is costly and has a restricted control choice. Researchers concocted a plan to construct a wheelchair with many control choices in this task.

Background of the study

Many different kinds of disabilities require wheelchairs for mobility, which are referred to as mobility impairments. Disabilities may be orthopedic (relating to the bone and muscles), or they may be neuromuscular (relating to the nerves and muscles) [6] on the other hand, after a certain age, or as researchers refer the senior citizens, physical problems can prevent

people from performing daily activities. Getting around becomes increasingly complex, even when indoors.[7] WHEELBOT: A Microcontroller-based Wheelchair with Manual and Mobile-maneuvering Controlled System through Mobile User Interface Application is intended to give a solution to people who have mobility disabilities where it is not just an ordinary wheelchair. Wheelbot is a motorized wheelchair controlled in three ways: Joystick, Voice Control, and Mobile control. The researchers aim to add a feature that can track the Wheelbot. Through this project, mobility, disabled people would no longer need extra effort to control their wheelchairs.

Objectives of the study

The study aimed to develop an efficient WHEELBOT: A Microcontroller-based Wheelchair with Manual and Mobile-maneuvering Controlled System through Mobile User Interface Application that would benefit nurses and people with mobility disabilities by developing a mobility and independence product. The study also intended to create a wheelchair that would be a useful mode of transportation for the elderly and disabled.

- To identify the hardware and software specification and requirements.
- To design microcontroller-based wheelchair using designing tools such as Schematic Diagram and Story Board.
- To integrate microcontroller, modules and sensors.
- To create and develop a mobile application that interconnect and controls hardware products.
- To test the mobile application and product system functionality and operability using researchers made test case.
- Scope and delimitation

The study would be covering the development of the WHEELBOT: A Microcontroller-based Wheelchair with Manual and Mobile-maneuvering Controlled System through Mobile User Interface Application. The researchers research what tools or specifications of the software require building an automatic wheelchair and needing to use Arduino, a microcontroller and modules connected to Arduino and a sensor, and the

software the researchers use to build codes Arduino is Arduino IDE. Based on the wheelchair, the researchers checked a design of a regular wheelchair that can make it an automatic wheelchair. The researchers also used a schematic diagram to see the connection of the module's wirings and a storyboard for mobile application design. The researcher also develops a mobile application in MIT app Inventor. In this app, the user would allow controlling the wheelchair using the mobile application, and it can also be managed via a mobile application designed for the caretaker's convenience in controlling the WHEELBOT's wireless maneuvering. The wheelchair has an ultrasonic sensor that stops when the ultrasonic detects a blockage. The mobile application is accessible through Bluetooth, allowing users to use it at their leisure. It has login features, whereas only authorized users can control the wheelbot.

Due to design limitations, the voice control would not detect any other languages besides English. The researchers use test case questioners to ensure that each functionality of the hardware and software is working correctly, and Appendices L and M provide a list of references.

The WHEELBOT has three speed options in mobile application (Low Speed, Medium Speed, and High Speed).

Low speed 75rpwm is equal to 2.4m/h.

Medium speed 90rpwm is equal to 2.8m/h.

High speed 175rpwm is equal to 3.4m/h.

It also has 175rpwm for joystick speed, which is 3.2m/h as users could see in appendix I.

The researchers have seen that the wheelchair has a limitation that the system cannot do, and these are, The WHEELBOT cannot be controlled through Wi-Fi, and the mobile app controller is only available for Android users. The WHEELBOT has a maximum weight and minimum weight that could carry a person.

Minimum Weight: 40lbs

Maximum Weight: 60lbs

Wheelchairs could only drive on flat surfaces and cannot drive on high slopes. Because of the wheelchair design requirements and the need for robust wheels that could drive on high slope surfaces, the researcher cannot make the wheelchair drive on high slopes.

The researchers created a test case questionnaire to test the wheelbot's functionalities. The researcher has ten test trials in each module indicated for the wheelbot, as shown in appendix B and appendix C.

CONCEPTUAL FRAMEWORK

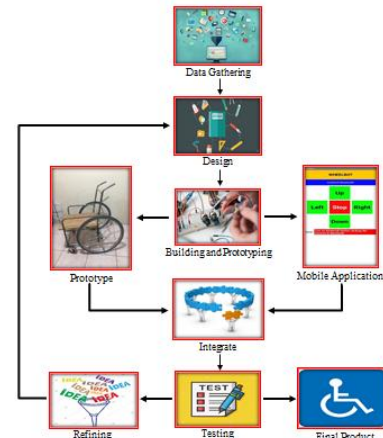


Figure 6. Conceptual Framework

SYSTEM DEVELOPMENT METHODOLOGY

This chapter is used to coordinate and demonstrate the analysis plan of the planned thesis and presents how the implementation of the project is being done following the methodical practices and techniques.

The researchers used the Prototyping Methodology as the software development model. The prototyping methodology allows the rapid development of the system while the developer gets valuable feedback from the users early in the project. From the user feedback, changes to the prototype would be applied to re-align the requirements given by the user. This cycle repeats until the customer approves the final requirement specification. It would then be used to develop the final version of the software.

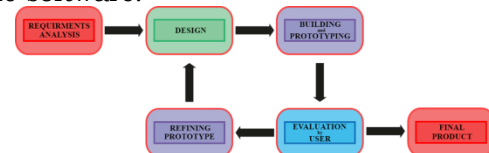


Figure 7: Prototype Model

The prototype model for Wheelbot: A Microcontroller-Based Wheelchair with Manual and Mobile Maneuvering Controlled System Thru Mobile User Interface Application.

(Source:

<https://www.freetutes.com/systemanalysis/sa2-prototyping-model.html>)

Figure 7 shows that the Prototype Model for Wheelbot has six development phases. These are the: Requirements Analysis, Design, Building or Prototyping, Evaluation by User, Refining Prototype, and the Final Product. Figure 7 shows that each phase overlaps another and repeats until the system is built.

Requirements Analysis

In this phase requirement analysis, the researchers discussed what the system should do in this project. The method of collecting information on the original collection of specifications, which included a literature analysis, discussions with future users, and reviews of similar programs, all contributed to a better understanding of what the system needed to do.

Design

In this phase, designing the project's system, the researchers gathered the information through the internet for the requirements used to build the project. The researchers also gathered the user's information to give an idea of what they want, the project to include the final product. Given below is the storyboard plan for the user interface design plan.

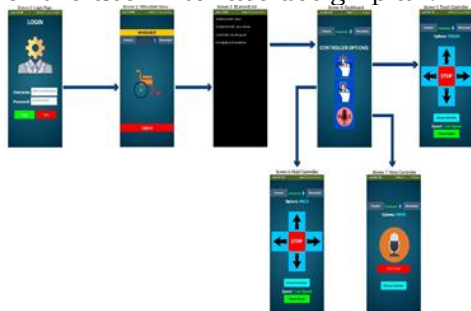


Figure 8: Mobile Application Design

Figure 8, as shown above, is the design plan for the mobile application user interface. The first screen, or home screen, consists of the following: The Login button indicates in the mobile app and the username and password table that an admin could log in to their account. The wheelbot title, the Bluetooth

connect button, and the wheelbot image in the middle for a nice-looking representation of the wheelbot prototype or theme representation. The second screen would appear when the connect button has successfully connected to the Bluetooth module. After connecting to Bluetooth, there is a button for the touch, hold, and voice controller options. Minimal basic buttons would be considered to simplify the only needed functionalities. Maneuvering buttons would control the mechanism and the motor's motion. The stop button would be placed in the middle of the maneuvering buttons for ease of clicking. Finally, a disconnect button would let the user return to the main screen.

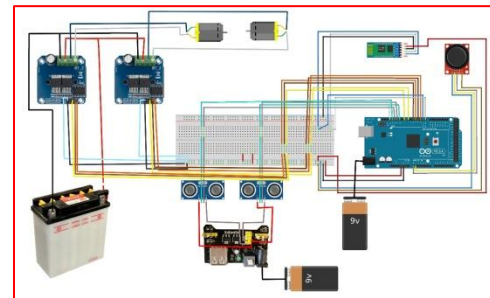


Figure 9: Schematic Diagram

This diagram shows all the modules and hardware needed and how the connectivity would connect to the microcontroller. The researcher uses two BTs7960 modules that control the motor of the wheelchair, and the modules are connected to a 12-volt battery. The researcher also uses a joystick to maneuver the wheelchair manual and Bluetooth HC-05 to control the wheelchair using a mobile application, and all of the modules are connected to the Arduino mega.

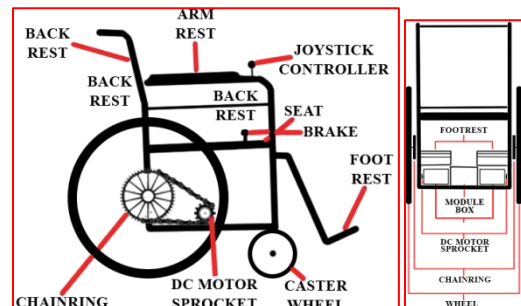


Figure 10: Design of the Wheelbot

Figure 9 shows the design of the wheelbot, which could be changed depending on the recommendation. The researchers' tools to build the wheelchair galvanized pipe to build the main chair and two wheels connected to two DC motors, a caster wheel attached to the bottom of a wheelchair to enable it to move the object, and a sprocket connected to a DC motor. The researcher also inserted a footrest in front for users' comfort.

Building and Prototyping

In this phase, the researchers would begin designing a prototype or an updated prototype after new specifications have been settled upon and the original design or a revision in the design of a new requirement has been completed. The version has been tweaked to meet current specifications in response to the original concept.

Table 1 shows the software application used to build the mobile application and code the microcontroller and other modules of the Wheelbot prototype.

Table 1: Software Requirements for Wheelbot Prototype.

Software	Description
Arduino IDE	Open-source compiler used to code through computer and would be saved to Arduino Mega or any microcontroller.
MIT App Inventor	Website compiler for android application drag and drop coding, code blocks.

The researchers used MIT app Inventor is website compiler researchers use to build and design the mobile application through the code blocks. For the microcontroller and other modules, researchers use the Arduino IDE to code the requirements or control needed of the Wheelbot.

Table 2 presents all the modules and hardware requirements needed for building the Wheelbot prototype.

Table 2: Hardware Requirements for Wheelbot Prototype.

Hardware	Description
MY1025Z2 DC Motor	12 volts Scooter motor 350 watts that would provide the movements of the wheelchair.
Motor Driver BTS7960 43A	To allow DC motors to run forwards or backwards.
Arduino Mega	Open source microcontroller board
HC-05 Bluetooth Module	To control the wheelchair through mobile application
12volts Battery	To supply battery for DC motor, Arduino UNO, and all modules.
Arduino Joystick	To control the wheelchair manually (x axis, y axis).
Breadboard	Extension to Arduino UNO and other modules.
Jump wires	An extension wire that connects to Arduino UNO, breadboard and other modules.
Ultrasonic	A Sensor that used to detect and determine the distance of the object.

The researchers used Arduino Mega for the microcontroller, 12 volts battery, and DC motor for the movements of the Wheelbot. They use a motor driver, a Bluetooth module and joystick controller, and a breadboard for the wiring connectivity for the maneuvering.

Table 3 lists the requirements needed for the mobile application.

Table 3: Smartphone Requirements of the Wheelbot Prototype

Smartphone	Description
Android 6	6th major version of the Android mobile operating system.
2GB RAM	2000MB android RAM storage.
8 GB Internal Storage	8000MB android Internal Storage

Evaluation by User

In this phase, the final prototype goes through a series of testing. Furthermore, if the user is not satisfied with the outcome, new requirements and modifications are needed, but the project is complete if the user is satisfied with the outcome. Table 1 and Table shown below would check the final product functionalities by answering the individual test

cases of the mobile application and the **prototype, respectively.**

Refining Prototype

If the users are not satisfied with the current prototype, the researchers need to refine the prototype according to the user's feedback and suggestions. This process would not be completed until all of the user's conditions have been met. A final system is designed based on the approved final prototype until the users are pleased with the developed prototype.

Final Product

When all the previous steps and several initial evaluation repetitions were completed, the researchers developed a working prototype. Product implementation is finally achieved. Please see Appendix F and Q for the final mobile application interface and wheelbot prototype products, respectively.

RESULTS AND OUTCOMES

This section showed the results and outcomes based on the study's objectives, and the research output must be presented in an organized and presentable manner. These discussions and conclusions are based on the study's objectives, completed analysis, and testing of the developed application prototype. The study covers the design, development primarily, and testing of the application prototype entitled **WHEELBOT: A Microcontroller-based Wheelchair with Manual and Mobile-maneuvering Controlled System Through Mobile User Interface Application.** Researchers identified all the software and hardware used to build the wheelchair. Researchers make sure that all the modules and compilers used are known. With the software and hardware indicated in our software requirements (see Appendix D) and hardware requirements (see Appendix C), researchers were able to build a wheelbot with the requirements provided.

The researchers followed the designated design that the schematic provided us. For a better design, the researchers ensured that researchers followed the schematic. The schematic gives complete information on connecting the modules to the Arduino and ensuring they work properly. The researchers also storyboarded the results for the mobile application. The mobile application can control

the wheelchair with three options and a speed chooser that allows the user to choose what he wants.

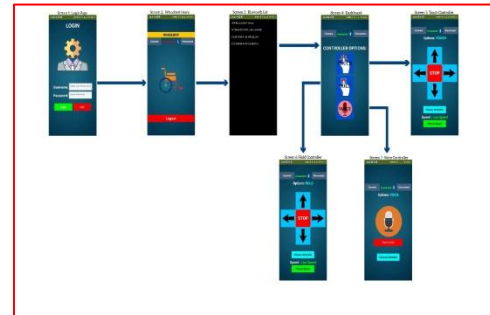


Figure 11: Wheelbot Mobile Application User Interface

Wheelbot Mobile Application User Interface

The researchers made a mobile application using the MIT app. First, researchers identified each functionality that the mobile application could have. Then, they build the mobile application using a storyboard on how researchers build its pattern. They come up with a mobile application with the first login screen, and then, once the user logs in, the wheelbot dashboard would show. It has two buttons: the Bluetooth connection and the logout. Once the button connects, it would bring up a new screen with all of the Bluetooth options accessible in the location, from which users could select the wheelbot Bluetooth. When the button is connected, it would display a new screen with all of the available Bluetooth devices in the region. Users can use the wheelbot Bluetooth. Once the user successfully connected the Bluetooth, it would show the controller of the wheelbot. It also contains an option that allows the user to choose how to control the wheelchair. The buttons contain a Hold button, Press button, and Voice button. If the user chooses to hold the controller, the wheelchair would automatically start. When the user is not holding the control button, the wheelchair would stop while the push button is pressed. It would not stop until the user pressed the stop and voice buttons on the controller. It would not stop until the user pressed the stop and voice buttons on the controller. The user would then control the wheelchair-using voice commands like "move

forward." The researcher makes sure that the storyboard design is followed.

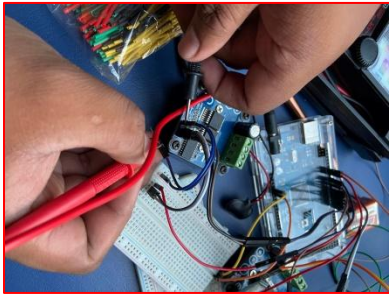


Figure 12: Checking Jump wires each module.

Checking Wiring for each Modules

As seen in Figure 12, the researchers check each wire that is connected to the modules; some of them are functionally working, but some of them are not, so they make sure that all of the wires included in the modules are properly working, and there is no sign of broken wires.



Figure 13: Building the wheelchair

Wheelchair Designing and Building

Researchers made a financial plan to fabricate a wheelchair with steel spears to guarantee it is durable and add footrests that permit the client to rest, as shown in Figure 13. Researchers likewise paint the wheelchair dark color to give it an engaging appearance.



Figure 14: Motor driver speed test

Testing speed of the motors.

As illustrated in Figure 14, researchers tested the speed of motors by including a speed option in the mobile application and measuring the meters per hour of the motor. The low motor speed was 2.4 mph, medium speed was 2.8 mph, high motor speed was 3.2 mph, and the embedded joystick speed was 3.2 mph because it depends on how fully the user presses the joystick fully press the joystick, it would reach 3.2 mph.

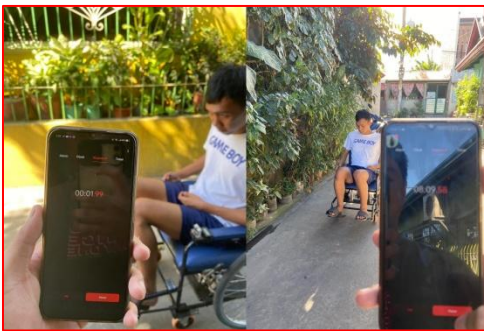


Figure 15: Wheelbot estimated distance and battery life.

Checking the estimated distance and battery life of a wheelchair.

As shown in Figure 15, the battery life has a charge of 55%. The researchers checked the maximum distance of the wheelchair using the speed meter that was used to get the speed of the wheelbot. The speed meter already has a record of 25.09 miles. Researchers tested it using a stopwatch until the battery decreased to 45%, resulting in 8 minutes and 9 seconds (see the reference in appendix N), and multiplied it by 10. Researchers also tested the distance until the battery decreases to 45% and then minus the total distance to the recorded 25.09 miles, resulting in 25.53 (see the reference in appendix O) and multiplying it by 10. Researchers have 1.358333 hours, or 1 hour, 21 minutes, and 29.9 seconds before the battery runs out of juice. The predicted distance researchers could travel before the battery dies 4.4 miles. The computation and reference can be found in Appendix P.

Table 4: Mobile Application Test Cases

No. of trials for each test case = 10	YES	NO
1. Does the Bluetooth button response to connectivity?	10	0
2. Does the left button activate the left maneuvering motor and Mechanism?	10	0
3. Does the right button activate the right maneuvering motor and mechanism?	10	0
4. Does the forward button activate the forward maneuvering motor and mechanism?	10	0
5. Does the backward button activate the back maneuvering motor and mechanism?	10	0
6. Does the forward maneuver system react to the left control Voice command?	10	0
7. Does the right maneuver system react to the right control voice command?	10	0
8. Does the forward maneuver system react to the forward control voice command?	10	0
9. Does the backward maneuver system react to the backward control voice command?	10	0
10. Does the stop maneuver system react to the stop control voice command?	10	0

Table 5: Wheelbot prototype Test Cases

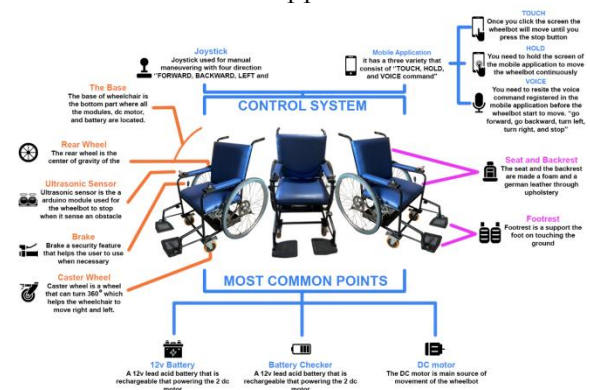
No. of trials for each test case = 10	YES	NO
1. Does the left maneuver system react to the manual left control of the joystick?	10	0
2. Does the right maneuver system react to the manual left control of the joystick?	10	0
3. Does the forward maneuver system react to the manual left control of the joystick?	10	0
4. Does the backward maneuver system react to the manual left control of the joystick?	10	0
5. Does the wheelchair stop when the ultrasonic detects an obstacle?	10	0

The experiments for the WHEELBOT mobile application are given in table 4, and they relate to the usefulness of each button highlighted in the WHEELBOT application. The researchers tested every function first, and researchers got ten preliminaries to the Bluetooth button and ten ideal preliminaries in Bluetooth availability. From that point forward, researchers check the five buttons because they are so receptive to the microcontroller, and researchers get 100% on all controls on each button. Allude to the experiment in Appendix L to guarantee that the mobile application reacts to the microcontroller and buttons.

As shown in Table 5, these are the test cases for the joystick and ultrasonic of the wheelbot. After testing the mobile application, researchers tested the joystick and ultrasonic using the test cases. The researchers scored

10/10 on each joystick movement and 10/10 on ultrasonic. The microcontroller was responsive to ultrasonic and joystick signals as researchers tested the joystick position and ultrasonic sensor. Refer to the test case in appendix M.

Finally, adding options for mobile applications that allow the user to choose what control they might use, researchers also add a speed indicator and allow the user to choose what speed they use (low speed, medium speed, high speed). The researchers also added security features to the app. Researchers added a login page for security. Appendix F shows the user interface for a mobile application.

**Figure 16:** Infographic of the Wheelbot

The graphic visual representation of the wheelbot, showing basic knowledge or information intended for the wheelbot.

DISCUSSIONS

This section consists of the summary of findings, conclusions and recommendations based on the results of the study WHEELBOT: A Microcontroller-based Wheelchair with Manual and Mobile-maneuvering Controlled System Through Mobile User Interface Application.

Summary of Findings

In order to achieve the prototype of the wheelbot and the mobile application-integrated output product, researchers used the steps of the prototype model. The specific objective corresponds to the functionality and design parameters that were formulated.

The first objective, researchers, was to gather all information needed to make the wheelbot work properly. To achieve that, researchers

looked for all information on how to build a wheelchair step-by-step, make the wheelchair automotive, and build the mobile application that would be connected to the wheelchair researchers built. According to the researchers, all of the information gathered is compatible with the project.

The second goal is for researchers to construct a prototype wheelchair based on the schematic diagram. This allows us to have an idea of how the whole system would run using the schematic diagram. Appendix A has the reference. The researchers also followed the storyboard on how they built the mobile application. Appendix F has the reference.

The third goal is to combine the modules and program the Arduino using the Arduino IDE. The researchers ensure that all the modules are connected to Arduino and working properly. Each module is tested before researchers build it and combine it with the Arduino microcontroller.

In the fourth objective, the researchers successfully built a fully functional mobile application that could control the wheelbot with three types of options, allowing users to choose. The three options include "HOLD," "TOUCH," and "VOICE." The hold allows the user to control the wheelbot continuously while holding the button, and the automatic stop when unholding the button, touch options, if users press the forward button, it would not stop unless the users press the stop button, and the voice options, which allow the users to control the wheelchair using basic commands. The researchers build this mobile application using the storyboard, and researchers code it on the MIT App Inventor.

Lastly, the researchers tested and checked the product's functional features using the test questionnaire. The researchers say each function is tested up to ten times. The researchers got a perfect mark for each test question and realized that both the prototype and mobile applications worked properly.

Conclusion

The researchers concluded that the WHEELBOT: A Microcontroller-based Wheelchair with Manual and Mobile-maneuvering Controlled System Through Mobile User Interface Application 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, both hardware and software were working properly. Additionally, there are ten times trials on each module, for a total of forty trials for the joystick controller and fifty trials on each mobile application controller option, for a total of one hundred and fifty trials, including the HOLD, TOUCH, and VOICE option.

The developers created a working mobile application, which included a username and password to prevent the app from being used on numerous devices. The owner of the mobile application can change the password.

The developers were also able to double-check each jump wire used in various modules to ensure proper wiring. Researchers guarantee that all jump wires users utilize are in perfect functioning order. Researchers put them through a testing process. The tester could determine whether the jump wires are in good working order.

The developers were also able to examine the speed of the wheelbot using a speedometer, which revealed that the wheelchair could go at a top speed of 3.4 m/h, a medium speed of 2.8 m/h, and a low speed 2.4 m/h.

For a better appearance, the researcher made the wheelchair look ergonomic. The researchers also added a manual break so that the user could break the wheelchair and a seatbelt.

Recommendations

The researchers considered the following recommendations for future improvement of the developed Wheelbot prototype. Adding an incline chair for features researchers would give the chair better look and ergonomic style, also adding a solar panel power for electricity power and make the wheelbot use even do not use battery, changing the Bluetooth module to Wi-Fi module it has better latency to the Bluetooth. It has a good signal that makes the user use the wheelbot longer, unlike Bluetooth. Adding also a battery checker in mobile application help to see the user if the wheelchair has enough battery to run the wheelchair and also break system in mobile application this helps a lot for the patient safety secure this recommendation should

adopt the future proponents for better enhancing the wheelbot.

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