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FOREWORD

Welcome to the Tech-Insight Volume 3, Issue 1 for Academic Year 2022-2023!

This issue showcases a diverse range of research projects, all united by their innovative approach to addressing challenges and opportunities in the digital age. From harnessing renewable energy to exploring the impact of AI in education, these studies offer valuable insights and practical solutions.

Here's a glimpse into what you'll find:

- **Carabao Milk Quality:** Uncover the science behind this valuable source of nutrition with predictive modeling using machine learning techniques.
- **E-Commerce Insights:** Delve into customer sentiment analysis, unlocking valuable information for businesses to refine their strategies.
- **Adaptive Learning:** Discover the potential of Universal Design for Learning to create inclusive and effective educational experiences for all.
- **Technology for Public Services:** Witness the development of information management systems for fire protection, community affairs, and student guidance, streamlining processes and enhancing transparency.
- **Gamification and Education:** Get ready to be entertained and informed with innovative educational games exploring agriculture, Philippine history, and even spider battles!
- **Smart Solutions:** Explore alternative networking technologies, anti-theft detection devices, and cloud-based file management platforms, fostering efficiency and security.

We invite you to delve deeper into these research projects and discover their potential to inspire progress in various fields. We believe their findings will benefit researchers, practitioners, and policymakers alike.

Happy reading!

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Predictive Modeling for Carabao Milk Quality: Unraveling Key Influencers using Machine Learning Techniques

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***Abstract*— This research presents a comprehensive study on Carabao milk quality using predictive modeling techniques, specifically tailored for the dairy industry in the early stages of development in Marinduque. Key influencers are analyzed using advanced machine learning algorithms such as Support Vector Machines (SVM), Random Forests, and Gradient Boosting. The results showcase promising accuracy for classification tasks and mean squared error evaluations for regression tasks, providing valuable insights for optimizing Carabao milk production and enhancing milk quality as the dairy industry in Marinduque is about to embark. The visualization of classification confusion matrices and regression plots demonstrates the model's performance, enabling stakeholders to make informed decisions for sustainable farming practices tailored to the unique conditions of Marinduque, while also meeting the demand for high-quality milk products.**

Keywords—Carabao Milk Production, Support Vector Machine , Random Forests, Gradient Boosting

I. INTRODUCTION

Carabao milk boasts elevated levels of fat, lactose, protein, ash, calcium, and vitamins A and C, while simultaneously exhibiting lower cholesterol and biliverdin levels compared to cow milk. Furthermore, it contains distinctive elements like bioactive pentasaccharides and gangliosides that are absent in cow milk. The exceptional quality of carabao milk has generated global interest in carabao breeding, leading to an increasing demand for genetically superior dairy buffaloes within the production framework [1,2]. Given its nutritional richness and diverse applications, ensuring and optimizing the quality of Carabao milk becomes pivotal, especially within the unique agricultural context of Marinduque.

To ensure healthy and productive carabaos for milking, careful attention is needed. A feeding plan, around 10% of their body weight in selected feed, is crucial for their well-being and milk quality. This plan includes balanced forage and nutrient-rich concentrates. Diet impacts milk quality directly. Hydration, vet check-ups, and a comfortable milking environment matter. Gentle milking techniques in a clean space prevent stress and encourage milk production. Sanitation is vital to avoid milk contamination. Overall, a holistic approach involving diet, health management, milking practices, and environment maintains carabaos' health and milk quality.[3]

In this research paper, researcher embarks on an extensive exploration of Carabao milk quality specifically within the Province of Marinduque. Employing advanced machine learning techniques, to discern the influential factors that shape its overall quality [9] in this distinct region. The study delves into critical elements such as pH, temperature, taste, odor, fat, turbidity, and colour, seeking to gain profound insights into the defining characteristics of this milk in the context of Marinduque.

Through the application of advanced machine learning methodologies – specifically, Support Vector Machines (SVM), Random Forests, and Gradient Boosting – researcher strive to unveil the pivotal influencers affecting Carabao milk quality [4] within the unique conditions of Marinduque. By harnessing these powerful tools, the goal is to pinpoint the key contributors that foster the production of high-quality milk specifically tailored to the province's requirements [5,6]. The visualization of classification confusion matrices and regression plots serves as a tangible demonstration of the effectiveness of the predictive models, enabling stakeholders to make informed decisions that are finely tuned to Marinduque's agricultural landscape.

II. METHODOLOGY

A. Data Collection and Preprocessing

A collection of 1059 data points has been compiled, encompassing pertinent characteristics. It's important to note that this dataset was compiled from trusted sources that may not be specific to the Province of Marinduque; therefore, the exact location of data collection is unknown.

TABLE I. DATASET INFORMATION

Characteristics	Description
pH	Range : 3 to 9.5
Temperature	Range: 34°C to 90°C
Taste	Values: 1 - good, 0 - bad
Odor	Values: 1 - good, 0 - bad
fat	Values: 1 - good, 0 - bad
Turbidity	Values: 1 - good, 0 - bad
Colour	Range : 240 -255
Grade *	Grade Quality : low, medium, high

*Target and takes the Grade quality value

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Table I shows the dataset information for features and target variable. The dataset grade quality value contains 429 instances of low quality, 374 instances of medium quality, and 256 instances of high quality. The data is carefully curated to ensure accuracy and consistency. Any missing or erroneous data points are addressed through suitable preprocessing techniques, such as imputation or removal. This preprocessing step aims to ensure the reliability of the dataset and the subsequent analysis [7].

B. *Feature Selection*

To enhance the effectiveness of the predictive models, a feature selection process is conducted. This involves identifying the most relevant attributes that significantly contribute to Carabao milk quality. Feature selection techniques like correlation analysis and mutual information are employed to determine the optimal subset of features [8].

C. *Model Training*

The collected and preprocessed data is split into training (80%) and testing sets (20%). Support Vector Machines (SVM), Random Forests, and Gradient Boosting, selected for their capabilities in handling classification and regression tasks, are trained on the training data similar to [9]. These algorithms learn relationships between input features and Carabao milk quality attributes.

D. *Model Evaluation*

The trained models are evaluated using appropriate evaluation metrics. For classification tasks, metrics such as accuracy, precision, recall, and F1-score are computed to assess the models' performance in predicting quality categories [10]. For regression tasks, mean squared error (MSE) and other relevant regression metrics are employed to measure the models' accuracy in predicting quantitative quality attributes[11-13] .

E. *Vizualization and Interpretation*

To offer insights into model performance and its impact on Carabao milk quality, classification confusion matrices and regression plots are generated. These visualizations effectively depict model proficiency in classifying quality categories and predicting attributes. Interpretability techniques, including feature importance scores from Random Forests and Gradient Boosting, are employed to understand individual feature contributions to overall predictions.

III. Results and Discussion

The predictive modelling techniques, namely Support Vector Machines (SVM), Random Forests, and Gradient Boosting, were applied to analyze the quality of Carabao milk based on key influencers. The obtained results as shown in Table II highlight the effectiveness of these models.

TABLE II. Accuracy Table

Methods	Accuracy	Precision	Recall	F1
SVM	83.02%	84.41%	83.02%	83.08%
Random Forest	99.53%	99.54%	99.53%	99.53%
Gradient Boosting	99.06%	99.06%	99.06%	99.06%

A. *SVM Classification Results*

The Support Vector Machine (SVM) model demonstrated a classification accuracy of 83.02%. The classification report showcases precision, recall, and F1-score metrics for each quality category: high, low, and medium. Notably, the model exhibited a commendable recall for the 'low' quality category, contributing to the overall accuracy. The weighted average F1-score was 0.83, reflecting the model's ability to balance precision and recall across categories.

B. *Random Forest Classification Results*

The Random Forest model exhibited exceptional classification accuracy, achieving 99.53%. The classification report further reinforces the model's robust performance, with high precision, recall, and F1-scores across all quality categories. The weighted average F1-score of 1.00 signifies the model's accuracy and balanced performance, indicating its suitability for predicting Carabao milk quality.

C. *Gradient Boosting Classification Results*

The Gradient Boosting model also showcased strong classification accuracy, at 99.06%. The classification report highlights precision, recall, and F1-score metrics, emphasizing the model's consistent performance across quality categories. The high recall for the 'medium' quality category demonstrates the model's ability to correctly classify instances within this category.

D. *Regression Results*

For regression tasks, the Mean Squared Error (MSE) was employed to evaluate the predictive models' performance.The Random Forest model exhibited an MSE of 0.0332, while the Gradient Boosting model had an MSE of 0.0532. The SVM Regression model achieved an MSE of 0.2240. These MSE values reflect the models' ability to predict quantitative quality attributes, with lower values indicating more accurate predictions.

E. *Visualization*

To provide a visual representation of the achieved results, the following plots demonstrate the classification confusion matrices and regression plots:

a. Classification Confusion Matrices:

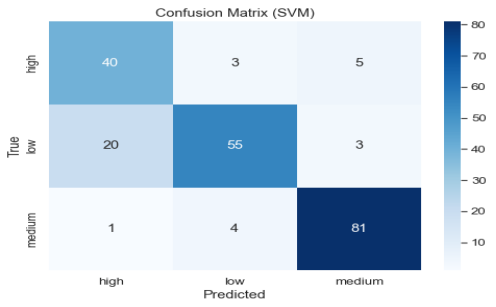

Fig. 1. SVM Classification Confusion Matrix

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Figure 1 displays the classification confusion matrix for the SVM model. It accurately identified 40 instances as "high" class, 55 as "low" class, and 81 as "medium" class. However, misclassifications occurred: 3 instances of "high" class were misclassified as "low," 5 as "medium"; 20 instances of "low" class were misclassified as "high," 3 as "medium"; and 1 instance of "medium" class was inaccurately labeled as "high," 4 as "low."

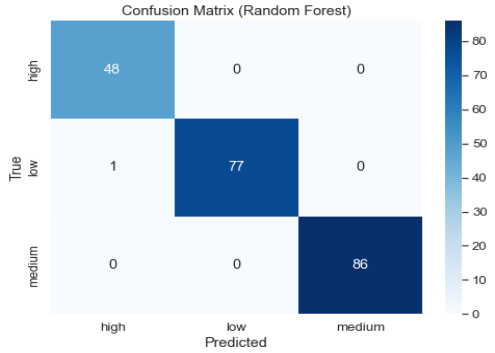

Fig. 2. Random Forest Clasification Matrix

Figure 2 demonstrates the Random Forest's accurate identification of 48 instances truly belonging to the 'high' class, as well as its correct recognition of all 86 instances categorized as the 'medium' class. For the 'low' class, the classifier achieved high precision, accurately predicting all 77 instances. Notably, one instance, inherently part of the 'low' class, was misclassified as 'high'.

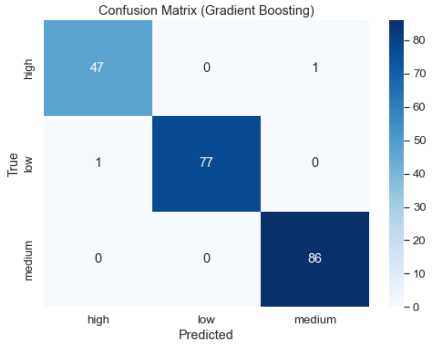

Fig. 3. Gradient Boosting Clasification Matrix

Figure 3 displayed Gradient Boosting classifier robust performance, effectively predicting instances across "high," "low," and "medium" classes with high precision. It accurately identified 47 "high," 77 "low," and 86 "medium" instances. However, one instance was misclassified – an inherent "high" class instance mistakenly labeled as "medium," indicating a minor accuracy lapse.

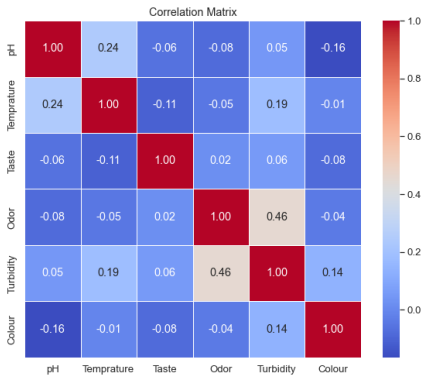

Fig. 4. Correlation Matrix

Figure 4 displays the Correlation Matrix, illustrating the degree and direction of relationships among the key influencers that impact the quality of Carabao milk: pH, Temperature, Taste, Odor, Turbidity, and Colour.

b. Regression Plots:

The Linear Regression model is presented alongside a plot showcasing 'Predicted values vs. Actual values.' This scatter plot situates actual values on the x-axis and predicted values on the y-axis. Importantly, a dashed line within the plot indicates a precise alignment between actual and predicted values, as evidenced in Figures 5, 6, and 7.

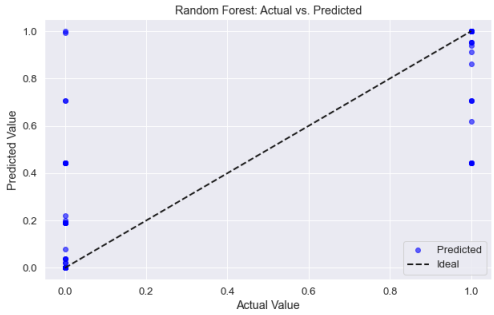

Fig. 5. Random Forest Regression Plot

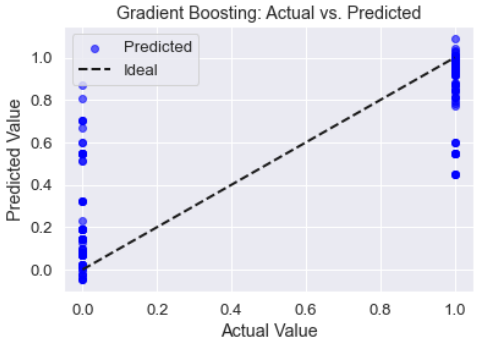

Fig. 6. Gradient Boosting Regression Plot

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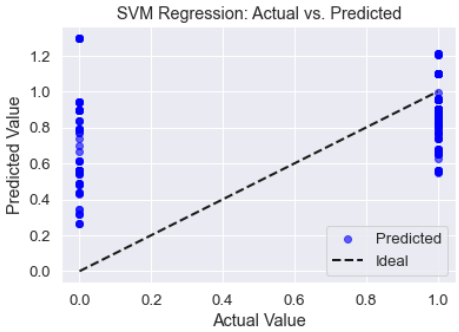

Fig. 7. SVM Regresion Plot

In the discussion of these Figures 1 to 7 visualizations, it's evident that the models' predictions align well with actual classifications and regression trends. These visual insights enhance our understanding of the models' performance and their effectiveness in predicting Carabao milk quality attributes and categories.

IV. Summary, Conclusion and Recommendations

The findings of this study strongly underscore the efficacy of machine learning models in assessing Carabao milk quality. The notably high classification accuracy rates achieved by SVM (83.02%), Random Forests (99.53%), and Gradient Boosting (99.06%) models spotlight their proficiency in categorizing milk quality. Furthermore, the low Mean Squared Error values demonstrated by Random Forest and Gradient Boosting regression models underscore their precision in predicting quantitative quality attributes.

In summary, this research yields valuable insights into the application of machine learning models for the assessment of Carabao milk quality. It is believed that the use of this technique will allow reaching parameters that define whether the milk classification will be low, medium or high quality. The outcomes of the study contribute significantly to the broader objective of enhancing farming practices, meeting consumer demands, and upholding the exceptional reputation of Carabao milk within the dairy industry. As the dairy industry in Marinduque is in its nascent stage, further research that considers region-specific variables can further enhance the accuracy and relevance of predictive models, thus reinforcing the sustainability and efficiency of Carabao milk production in the province.

Based on the study's findings, it's recommended that dairy industry stakeholders consider integrating predictive modeling techniques into quality assessment protocols to enhance Carabao milk production by identifying key influencers and predicting quality attributes. However, while variables like pH, temperature, taste, odor, turbidity, and color contribute significantly to understanding milk quality, they might not encompass all production factors in Marinduque's unique context. To gain a comprehensive view, future research should explore region-specific variables like environmental conditions, feeding practices, and buffalo genetics. Incorporating such data can offer tailored insights for optimizing production. Collaboration with local experts and farmers could enrich predictive models, ensuring their relevance to Marinduque's specific conditions.

Acknowledgment

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References

[1] Xin-xin Zhang et al, “Evaluation of type traits in relation to production, and their importance in early selection for milk performance in dairy buffaloes” *ScienceDirect*. 2022

[2] Viviana Garau, Cristina Manis, Paulo Scano, and Pierluigi Caboni, “Compositional Characteristics of Mediterranean Buffalo Milk and Whey ” in Dairy 2021, 2(3), 469-488

[3] Daniel L. Aquino, “Proper Feeding for Sufficient Nutrition of the Carabao”, Philippine Carabao Center, F-04-2020

[4] Joseph O Ogutu,, Hans-Peter Piepho & Torben Schulz-Streeck, “A comparison of random forests, boosting and support vector machines for genomic selection ” *In BMS Preceeding* Volume 5 Supplement 3, 2011

[5] GMA NEWS, Jansen Ramos, “Why is carabao milk the most complete food?”https://www.gmanetwork.com/entertainment/celebritylife/food/53256/why-is-carabao-milk-the-most-complete-food/story. 2019

[6] Kennlourd Faoust Villo , Roberta D. Lauzon , Felix Amestoso , and Nilda Amestoso, “Optimization of Flavored Toned Milk from Carabao (Bubalus bubalis carabanesis) ” In Science and Humanities Journal. 2018.

[7] Abdlulaziz Aldoseri, Khalifa N. Alkhalifa, and Abdel Magid Hamouda, “Re-Thinking Data Strategy and Integration for Artificial Intelligence: Concepts, Opportunities, and Challenges”, In MDPI , https://www.mdpi.com/2076-3417/13/12/7082. 2023.

[8] Jun Liang, Liang Hou, Zhenhua Luan, and Heiping Huan, “Feature Selection with Conditional Mutual Information Considering Feature Interaction”, In MDPI, 2019

[9] Yang Zhang, Lei Zhang, Yabin Ma, Jinsen Guan et al., “Research on dairy products detection based on machine learning algorithm” MATEC Web of Conferences 355, 03008 (2022).

[10] Laura Ozella, Karina Brotto Rebuli, Claudio Forte, and Mario Giacobini, “A Literature Review of Modeling Approaches Applied to Data Collected in Automatic Milking Systems”. Animals (Basel). 2023.

[11] M.D. Murphy , M.J. O’Mahony , L. Shalloo , P. French , J. Upton, “Comparison of modelling techniques for milk-production forecasting”,In Journal of Dairy Science, Volume 97, Issue 6, June 2014.

[12] Ji, B.; Banhazi, T.; Phillips, C.J.; Wang, C.; Li, B. A machine learning framework to predict the next month’s daily milk yield, milk composition and milking frequency for cows in a robotic dairy farm. Biosyst. Eng. 2022, 216, 186–197.

[13] Fuentes, S.; Gonzalez Viejo, C.; Cullen, B.; Tongson, E.; Chauhan, S.S.; Dunshea, F.R. Artificial intelligence applied to a robotic dairy farm to model milk productivity and quality based on cow data and daily environmental parameters. Sensors 2020, 20, 297

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Sentiment Analysis of Customer Reviews in E-Commerce

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***Abstract*— The study explores the growth of e-commerce, the importance of customer reviews, and the challenges of analyzing sentiments within these reviews. It then delves into the methodology, including data collection, preprocessing, and feature extraction. The study compares the effectiveness of Logistic Regression and Naïve Bayes algorithms for sentiment prediction. Different categorization approaches are investigated, and the impact of removing neutral reviews on sentiment classification is explored. The study finds that Logistic Regression outperforms Naïve Bayes and that incorporating reclassified neutral reviews improves the accuracy of sentiment prediction. Additionally, insights into language usage and phrases associated with positive and negative sentiments are discussed.**

Keywords—sentiment analysis, e-commerce, customer reviews, machine learning, logistic regression, naïve Bayes

I. Introduction

A. The Growth of E-commerce in the Philippines and the Importance of Customer Reviews

Online shopping has become increasingly popular in the Philippines in recent years. In 2019, the gross merchandise volume (GMV) of e-commerce in the Philippines was $3 billion. This figure grew to $12 billion in 2021 and is expected to reach $22 billion in 2025 [1]. This growth has led to massive user-generated content from e-commerce platforms, including customer reviews.

Customer reviews provide valuable insights for both businesses and customers. They can provide insights into customer experiences, opinions, and sentiments towards products and services [2]. Reviews can range from positive and satisfied to negative and dissatisfied. Businesses can better understand customer sentiment by analyzing customer reviews and improving overall product quality and customer satisfaction.

However, understanding customer sentiment from reviews can be challenging. Reviews often contain a mix of positive, negative, and neutral sentiments. Additionally, they can be written in various languages, and the language used in reviews can be subjective and ambiguous. This can make it difficult for businesses to determine a review's overall sentiment accurately.

B. Sentiment Analysis for Customer Reviews

Sentiment analysis studies people's opinions and emotions toward entities expressed in a text [3]. It can classify text as positive, negative, or neutral. This study uses two machine learning algorithms for sentiment prediction in customer reviews: Logistic Regression and Naïve Bayes.

Logistic regression is a statistical model that estimates the probability of an event occurring, such as whether a review is positive or negative [4]. Naïve Bayes is a probabilistic classifier that assumes features of a review (e.g., the words used, the sentiment of the words) are conditionally independent and contributes equally to the outcome [5]. Both models are often used for classification tasks. These models are used to assess their effectiveness in accurately predicting the sentiment of customer reviews. Logistic regression and naïve Bayes have been effective sentiment analysis models for e-commerce and social media data in various studies [6-8].

The reviews are collected from Shopee, one of the largest e-commerce platforms in the Philippines. This dataset is used to train and evaluate the Logistic Regression and Naïve Bayes models. The findings of this study could assist businesses in understanding customer satisfaction better and improving their products and services. This could also help customers to identify informative reviews, which can help them make better buying decisions.

II. Methodology

A. Data Collection

The data were collected from the Shopee Philippines website using their API. The API retrieves a JSON file containing customer reviews of a product. The customer reviews came from the 300 top-selling products in the Home and Living category on July 8, 2023 [9]. For each product, at most 20 reviews were gathered for each star rating, except for 3-star reviews, of which at most 50 were gathered. This was done because the initial setup aimed to categorize the reviews into three groups: negative (1-2 stars), neutral (3 stars), and positive (4-5 stars). Table I shows the number of reviews for each star rating across all products. Table II shows a review of each star rating for a specific product.

TABLE I. Reviews by star rating across products

Star rating	Number of reviews
1 star	4462
2 stars	3768
3 stars	8891
4 stars	4847
5 stars	5816

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TABLE II. REVIEWS FOR A SHADE NET

Star rating	Review
1 star	product is horrible there's a lot of damage as you can see from the pictures stay away but from somewhere else very bad quality
2 stars	It does not really do much. It said 90% but it did not do what it advertised. It said it is not super spaced out and it is more stacked. It is super wide spread and it does not cover the UV light properly and the heat. I actually had to do a double ply to make it work. The thread work is horrible.
3 stars	So far ok nmn.. My ksma na tela na pangtali.. Parang sako lang pla ang texture nya kala ko matibay.. Diko. Lang alam if mgtagal ito.. Prang madaling mg bgay sa ulan at init
4 stars	Thanks seller im happy with my order recieved. I will order soon again next time. More sales to goooooo.. 👍👍👍👍👍👍👍
5 stars	Thank goodness mabilis dumating ang mga paninda.... happy with my beauty thick and well packaged. Ang mesh sa loob ay buo pa rin, hindi man lang gasgas, na katanggap-tanggap. Gusto ko ang mga maliliit na bagay na kasama nito, salamat, sana panatilihin ito ng nagbebenta. Nagbigay ako ng 5 bituin

A statistical analysis of the data in Table I found significantly more 3-star ratings than any other star rating. This suggests that the methodology used for data collection led to a more significant representation of neutral reviews.

Meanwhile, the data in Table II reveals that the reviews exhibited code-switching and informal language. For example, one review switched from English to Tagalog to express gratitude, and another used shortened words and emojis. However, these observations may not represent the entire review population.

B. Data Preprocessing

The actual reviews were extracted from the collected JSON files. The review text and some associated information were retrieved by accessing the relevant fields within the JSON structure. The extracted reviews were then subjected to a series of text preprocessing techniques. The preprocessing process included the following key steps:

1. **Review truncation:** Reviews that were limited to discussing appearance, suitability, and quality were truncated. Only the unconstrained parts of the reviews were kept, which were believed to be more relevant.
2. **Special character removal:** Non-alphabetic and special characters were replaced with spaces. This step eliminates punctuation marks and symbols that contribute minimal semantic value.
3. **Single-character word removal:** Single-character words were removed, as they rarely convey substantial meaning and often introduce noise to the text.
4. **Whitespace normalization:** Consecutive newline and whitespace characters were replaced with a single space. This ensures consistent spacing and formatting across the text.
5. **Lowercasing and trimming:** The entire text was converted to lowercase to achieve uniformity in word comparisons. Leading and trailing spaces were removed to prevent unintended discrepancies.
6. **Stop word removal:** Stop words were filtered out from the text as they contribute little to the overall meaning. Stop words in English were based on those provided by NLTK, a popular natural language processing library [10]. For Tagalog, the stop words used were sourced from a repository on GitHub [11].

The text preprocessing techniques used in this study resulted in the data shown in Table III. However, the stop word removal step had some limitations.

First, some reviews were written in different languages. For example, the 3-star review contained the Tagalog word "may" (have), which was shortened to "my." This word was removed because it is a stop word in English. However, it should be removed because it is a shortened stop word in Tagalog.

Second, some reviews were written in informal language. This can lead to shortened stop words, such as "nya," in the 3-star review. This word was not removed because the Tagalog stop word repository only includes complete spellings of stop words. However, it should have been removed because it is a shortened form of the Tagalog word "niya" (her/his/them). It is also important to note that the repository was last updated in 2016.

The limitations of the stop word removal step can be addressed by using a more sophisticated stop word list. This list, which includes shortened forms and words from various languages, can help improve the accuracy of stop word removal. Additionally, preceding the stop word removal step with a language identification step can determine the language of each review. This would enable using a language-specific stop word list, making the process more accurate.

After text preprocessing, the n-gram frequencies for the reviews were calculated. N-gram models predict the next word in a sentence based on the previous words. They consider both the probability of a word in general and the probability of a word given the previous words. [12]. The n-gram frequencies for the processed reviews are shown in Tables IV, V, and VI. The top 5 most occurring unigrams, bigrams, and trigrams for each star rating are listed in each table, respectively.

TABLE III. PROCESSED REVIEWS OF A SHADE NET IN TABLE II

Star rating	Review
1 star	product horrible lot damage see pictures stay away somewhere else bad quality
2 stars	really much said advertised said super spaced stacked super wide spread cover uv

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	light properly heat actually double ply make work thread work horrible
3 stars	far ok nmn ksma tela pangtali parang sako lang pla texture nya kala matibay diko lang alam mgtagal prang madaling mg bgay ulan init
4 stars	thanks seller im happy order recieved order soon next time sales goooooo
5 stars	thank goodness mabilis dumating paninda happy beauty thick well packaged mesh loob buo rin man lang gasgas katanggap tanggap maliliit bagay kasama salamat sana panatilihin nagbebenta nagbigay bituin

Table IV shows that the unigram "yung" was common across all star ratings except 5. This was likely because it is a shortened form of the Tagalog stop word "iyong." Stop words are commonly used words, and as such, their high frequency is expected. However, "yung" should have been removed as a stop word. This was not done because the used repository did not include "yung." This is a limitation of this study, but the overall findings of this study are still believed to be valid.

Meanwhile, the following are some valuable insights from the table:

1. The unigram "seller" was common across all star ratings, while the unigram "order" was also common across all star ratings except 4. This suggests that these terms are important for customers when evaluating a product.
2. The unigrams "lang" and "naman" were common across all star ratings except 5. These words are Filipino particles that can add emphasis or soften a statement.
3. The unigram "seller" was most common in star rating 5. This suggests that customers are more likely to mention the seller when they are extremely satisfied, possibly to credit the seller for a job well done.
4. The unigram "good" was common in star ratings 4 and 5, while the unigram "thank" was common in star rating 5. This suggests that generally satisfied customers are more likely to use positive language.

TABLE IV: UNIGRAM FREQUENCIES FOR PROCESSED REVIEWS

Star rating	Top unigrams	Frequency
1	yung	1809
	lang	1703
	order	1492
	seller	1469
	naman	925
2	yung	1647
	lang	1449
	naman	983
	order	919
	seller	832
3	yung	3396
	lang	3285
	naman	2441
	po	1816
	seller	1718
4	lang	1746
	seller	1636
	yung	1482
	naman	1460
	good	1365
5	seller	4122
	thank	3018
	order	2366
	po	1816
	good	1667

The following are some valuable insights from Table V:

1. The bigram "man lang" was most common in star ratings 1 and 2. This suggests that customers are more likely to use this phrase when they are generally dissatisfied with a product.
2. The bigrams "yung item" and "si seller" were common in star ratings 1 and 2. This suggests that customers are also likely to mention the specific item and the seller when they are generally dissatisfied.
3. The bigram "sayang pera" was common in star rating 1. This suggests that customers feel they did not get their money's worth when purchasing the product.
4. The bigrams "ok naman" and "okay naman" were common in star ratings 2, 3, and 4. This suggests that customers are not completely satisfied with the product but are not completely dissatisfied.
5. The bigrams "thank seller," "quality good," and "good quality" were common in star ratings 3, 4, and 5. This suggests that customers are more likely to use these phrases when they are generally satisfied with a product. These phrases can be used to express gratitude and satisfaction.

TABLE V: BIGRAM FREQUENCIES FOR PROCESSED REVIEWS

Star rating	Top bigrams	Frequency
1	man lang	186
	sayang pera	152
	yung item	122
	si seller	119
	yung order	112
2	man lang	101
	ok naman	97
	yung item	93
	naman yung	87
	si seller	86
3	ok naman	338
	okay naman	290
	thank seller	256
	next time	240
	quality good	231

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4	thank seller	494
	good quality	260
	ok naman	213
	okay naman	210
	quality good	199
5	thank seller	1288
	thank much	512
	good condition	408
	good quality	381
	thanks seller	354

TABLE VI: TRIGRAM FREQUENCIES FOR PROCESSED REVIEWS

Star rating	Top trigrams	Frequency
1	seller rude seller	66
	rude seller rude	65
	sayang lang pera	54
	wala man lang	45
	di man lang	43
2	wala man lang	24
	di man lang	22
	sana next time	22
	ok sana kaso	19
	maganda sana kaso	18
3	good quality good	61
	sana next time	53
	quality good suitability	54
	ok sana kaso	52
	appearance good quality	46
4	good quality good	58
	good suitability good	57
	quality good suitability	52
	appearance good quality	48
	thank seller rider	36
5	thank much seller	239
	kay kuya rider	84
	thank seller shopee	82
	seller kuya rider	73
	received good condition	67

The following are some valuable insights from Table VI:

1. The trigrams "seller rude seller" and "rude seller rude" were the most common in star rating 1. This suggests that customers are more likely to use these phrases when they are extremely dissatisfied with the seller and feel that the seller was rude.
2. The trigram "sayang lang pera" was common in star rating 1. This suggests that customers feel they did not get their money's worth when purchasing the product.
3. The trigram "wala man lang" and "di man lang" were common in star ratings 1 and 2. This suggests customers are also likely to mention the lack of something when they are generally dissatisfied.
4. The trigram "sana next time" was common in star ratings 2 and 3. This suggests that customers will give the seller or product another chance.
5. The trigram "good quality good" was common in star ratings 3 and 4. This suggests that customers are more likely to use this phrase when they are generally satisfied with the quality of the product.
6. The trigrams "thank much seller" and "kay kuya rider" was most common in star rating 5, suggesting that customers are more likely to use these phrases when they are extremely satisfied with a product or service. They are a way to express gratitude to the seller for a job well done and the rider for delivering the product on time and in good condition.

C. *Review categorization*

In this study, the reviews were grouped into five approaches based on their star ratings:

1. **Negative (1-2), Neutral (3), Positive (4-5):** This grouping is the most basic and straightforward. The reviews are divided into three categories: negative, neutral (neither positive nor negative), and positive. This grouping is useful for general sentiment analysis, as it provides a high-level overview of the overall sentiment of the reviews.
2. **Negative (1-3), Positive (4-5):** This grouping is similar to the first one but merges the neutral reviews with the negative ones. This grouping is useful for focusing on the negative and positive aspects of the product being reviewed.
3. **Negative (1-2), Positive (3-5):** This grouping is similar to the second one but merges the neutral reviews with the positive ones. This grouping is useful for focusing on the negative and positive aspects of the product being reviewed.
4. **Remove 3, Negative (1-2), Positive (4-5):** This grouping removes all neutral reviews. This grouping is useful for focusing on the extreme sentiments of the reviewers.
5. **Remove 3, Negative (1-2), Positive (4-5), Classify 3 based on the trained model, add re-classified reviews, train again**: This grouping is the most complex. It first removes all of the neutral reviews. Then, it uses a trained machine learning model to classify the remaining reviews as negative or positive. The classified reviews are then added to the dataset, and the model is trained again. This grouping is believed to be useful for getting a more accurate assessment of the sentiment of the reviews.

Table VII summarizes the different review categorization approaches investigated in this study.

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D. *Feature extraction*

Vectorization is the process that converts text documents into numerical feature vectors. [13]. This is necessary because machine learning models cannot understand text directly.

Count Vectorizer and TF-IDF Vectorizer are two popular vectorization techniques. Count Vectorizer counts the number of times each word appears in a document [14]. On the other hand, TF-IDF Vectorizer considers both a word's frequency and its inverse document frequency [15]. This means that words more frequent in a document but less frequent in general are given more weight.

This study used Count Vectorizer and TF-IDF Vectorizer to vectorize the reviews. The performances of the two techniques were compared to see which worked better for this problem.

Different n-gram ranges were also explored to improve the vectorization of reviews. By incorporating different n-gram ranges, the vectorization of the reviews can be enhanced to capture more contextual information. This can help improve the classification accuracy because it allows the models to consider the relationships between words in the reviews.

Table VII summarizes the vectorization techniques and n-gram range values investigated in this study.

E. *Classification and evaluation*

This study used Logistic Regression and Multinomial Naïve Bayes to classify the sentiment of reviews. The data was split into 80% training and 20% testing sets. Grid search was used to identify the n-gram range that yielded the best performance for each vectorization technique and reviews the categorization approach. The grid search was conducted using 10-fold cross-validation, and accuracy was used as the evaluation metric. The seeds for data splitting, 10-fold cross-validation, and grid search were set to 42.

TABLE VII. CONFIGURATIONS FOR REVIEW CATEGORIZATION, VECTORIZATION, AND N-GRAM

Review categorization approaches	Negative (1-2), Neutral (3), Positive (4-5); Negative (1-3), Positive (4-5); Negative (1-2), Positive (3-5); Remove 3, Negative (1-2), Positive (4-5); Remove 3, Negative (1-2), Positive (4-5), Classify 3 based on trained model add re-classified reviews, train again
Vectorization techniques	Count Vectorizer, TF-IDF Vectorizer
N-gram range values	(1, 1), (1, 2), (1, 3), (2, 2), (2, 3), (3, 3)

TABLE VIII. PERFORMANCE OF DIFFERENT CATEGORIZATION APPROACHES AND VECTORIZATION TECHNIQUES USING LOGISTIC REGRESSION

Categorization approach	Vectorization technique	Best n-gram range value	Cross-validation accuracy (%)	Test accuracy (%)
1	Count	(1, 3)	62.45	62.21
	TF-IDF	(1, 2)	63.45	62.91
2	Count	(1, 3)	81.75	81.72
	TF-IDF	(1, 2)	81.82	82.18
3	Count	(1, 3)	77.87	78.08
	TF-IDF	(1, 2)	78.63	78.78
4	Count	(1, 2)	85.53	84.92
	TF-IDF	(1, 2)	85.77	86.24
5	Count			88.20
	TF-IDF			88.63

TABLE IX. PERFORMANCE OF DIFFERENT CATEGORIZATION APPROACHES AND VECTORIZATION TECHNIQUES USING MULTINOMIAL NAÏVE BAYES

Categorization approach	Vectorization technique	Best n-gram range value	Cross-validation accuracy (%)	Test accuracy (%)
1	Count	(1, 2)	62.41	61.99
	TF-IDF	(1, 1)	61.29	61.60
2	Count	(1, 3)	80.71	80.76
	TF-IDF	(2, 2)	79.36	80.15
3	Count	(1, 2)	77.92	78.10
	TF-IDF	(1, 1)	74.33	74.48
4	Count	(1, 2)	84.58	85.42
	TF-IDF	(1, 1)	82.71	83.83
5	Count			87.13
	TF-IDF			85.15

III. RESULTS AND DISCUSSION

The results of this study, presented in Tables VIII and IX, indicate that Logistic Regression was more accurate than Multinomial Naïve Bayes in predicting the sentiment of the reviews. This is supported by the fact that the cross-validation accuracy score of Logistic Regression was higher than the accuracy score of Multinomial Naïve Bayes across all rows of the table except for the sixth row, where the difference was 0.05%.

The highest cross-validation accuracy scores for both models (85.77% for Logistic Regression, 84.58% for Multinomial Naïve Bayes) were achieved when 3-star ratings were removed from the dataset. This is likely because 3-star ratings are often more ambiguous than the others and can represent a wide range of sentiments, from neutral to slightly positive to slightly negative. By removing 3-star ratings, the

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model was forced to focus on the more polarized ratings, which are easier to distinguish from each other. This results in a higher accuracy score for both models.

TF-IDF Vectorizer yielded better cross-validation accuracy scores for Logistic Regression, while Count Vectorizer yielded better accuracy scores for Multinomial Naïve Bayes. This suggests that TF-IDF Vectorizer is a better choice for Logistic Regression, while Count Vectorizer is a better choice for Multinomial Naïve Bayes for this dataset.

The highest cross-validation accuracy scores for both models were achieved when the n-gram range is (1, 2), indicating that the models are most effective when considering unigrams and bigrams. This suggests that the models could learn the most important patterns in the data when trained on single words and pairs of words.

Approach 5, based on Approach 4, yielded better test accuracy by incorporating the predicted sentiment of the 3-star reviews into the training data. This approach of incorporating the predicted sentiment of the 3-star reviews resulted in better test accuracy because it allowed the model to learn more about the nuances of sentiment in reviews. The model could now distinguish between 3-star reviews that were negative and 3-star reviews that were positive. This improved the model's ability to predict the sentiment of all reviews, including 3-star reviews.

In addition, Approach 5 allowed for identifying words and phrases associated with positive or negative sentiment. Tables X and XI present the unigram and bigram frequencies for positive and negative reviews from the reclassified neutral reviews.

The results suggest that customers who were satisfied with their purchases tended to use the phrases "thank seller," "ok naman," "good quality," and "maganda naman" more frequently in their reviews. In contrast, customers who were not satisfied with their purchases tended to use the phrases "man lang," "sana kaso," "next time," and "ok sana" more often in their reviews. Meanwhile, the unigram frequencies suggest that the words "seller," "good," "ok," "quality," and "thank" are associated with positive sentiment. In contrast, the words "yung," "lang," "order," "sana," and "di" are associated with negative sentiment.

Tables XII and XIII provide five randomly selected examples of positive and negative reviews from the reclassified neutral reviews.

TABLE X: UNIGRAM AND BIGRAM FREQUENCIES FOR POSITIVE REVIEWS

Top unigram	Frequency	Top bigram	Frequency
lang	1428	thank seller	238
naman	1248	ok naman	225
yung	1086	okay naman	196
seller	958	quality good	156
good	897	good quality	155
ok	870	maganda naman	122
quality	826	naman sya	116
po	808	naman yung	114
sya	765	next time	114
thank	649	nga lang	106

TABLE XI: UNIGRAM AND BIGRAM FREQUENCIES FOR NEGATIVE REVIEWS

Top unigram	Frequency	Top bigram	Frequency
yung	2304	man lang	154
lang	1846	sana kaso	153
ung	1303	yung item	127
naman	1187	next time	126
order	1124	po yung	117
sana	1017	ok naman	111
po	1003	yung order	109
di	881	naman yung	106
lng	765	ok sana	103
dumating	761	si seller	102

TABLE XII: FIVE RANDOMLY SELECTED POSITIVE REVIEWS

ok siguro guess price complete naman parts kaso maliit lang pala mahina nireinforce lang ibang bakal tutumba pag sinampayan basa eh
nag apply shoes glue lang mag stay wall cleaned wall rubbing alcohol first tinuyo using tissue parin nag stay caps lang yung sinabit ganon talaga mura lang naman kasi expect much yon lang star muna
maganda sya kaso damage
malapit matapos salamat po dismaya lang talaga glue talaga sya nagamit
oks naman kaso medyo maliit lang sya personal btw thank

TABLE XIII: FIVE RANDOMLY SELECTED NEGATIVE REVIEWS

tama nman ung dumating order kea nga lng manipis ung
nadisappoint nung dumating kasi yung order cmx cm excited nman tapos cmx cm nman yung dumating
seller malinaw naman magkaiba yung order parehas yung item size haitx ok naman yung quality matibay naman
lang seller pinadala sakin items order lng pinadala mali yung kulay pinadala nga mali yung kulay dismaya uli mag order nag chachat rceve items hndi sinasagot
okay naman po sana kaso di alam hair ba tapos yung pag paint parang minadali

IV. SUMMARY, CONCLUSION AND RECOMMENDATIONS

A. Summary and Conclusion

The study explores the use of sentiment analysis to understand customer sentiment in e-commerce reviews. Two

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machine learning algorithms, Logistic Regression and Naïve Bayes, were used to predict the sentiment of reviews on the e-commerce platform Shopee.

The data was preprocessed by removing words, symbols, and numbers that contribute minimal semantic value. The reviews were then categorized into positive, negative, and neutral sentiment groups. Various feature extraction methods were employed using vectorization techniques.

The results of the study showed that Logistic Regression outperformed Multinomial Naïve Bayes in predicting review sentiment. However, both algorithms achieved high cross-validation scores (85.77% for Logistic Regression, 84.58% for Multinomial Naïve Bayes), suggesting that they are both effective in predicting the sentiment of reviews.

Removing 3-star reviews also led to improved accuracy, likely due to the ambiguity of these ratings. Incorporating the predicted sentiment of 3-star reviews into the training data also improved accuracy.

The choice of vectorization technique depended on the algorithm, with TF-IDF Vectorizer proving effective for Logistic Regression and Count Vectorizer for Multinomial Naïve Bayes. The study suggests that considering both unigrams and bigrams is crucial for effective sentiment prediction.

The study also provides insights into the factors that may have affected the accuracy of sentiment analysis. The reviews were written in different and informal languages, which could have made it difficult for the algorithms to identify sentiment accurately.

Despite these limitations, the findings of this study demonstrate the effectiveness of sentiment analysis for understanding customer sentiment in e-commerce reviews. The results can be used to improve overall product quality and customer satisfaction.

Overall, this study provides a valuable contribution to sentiment analysis. The findings can be used to improve the accuracy of sentiment analysis for various applications, including e-commerce and customer service.

B. Recommendations

The following are some recommendations for improving the accuracy of sentiment analysis of customer reviews:

1. **Data preprocessing:** Improve the data preprocessing pipeline by introducing stemming and lemmatization to reduce inflected words to their common base form [16]. This will make it easier for models to learn patterns in customer reviews.
2. **Shortened words:** Clean shortened words to ensure that all the text's words are correctly identified.
3. **Language identification:** Add a language identification step to ensure that stop words and other preprocessing techniques are applied correctly to the text.
4. **Stopword list:** Create a more sophisticated list for non-English languages to remove words irrelevant to the text's sentiment.
5. **Models:** Experiment with different classifiers, such as convolutional neural networks (CNNs). CNNs have been effective for sentiment analysis in previous studies [17][18].

V. Acknowledgement

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VI. References

[1] Bain & Company, Google, and Temasek, “e-Conomy SEA 2022,” Oct. 27, 2022. https://www.bain.com/insights/e-conomy-sea-2022/ (accessed Aug. 12, 2023).
Full report: goo.gle/econ22bain
[2] Mailchimp, “Importance of embracing reviews in e-commerce,” Mailchimp, Oct. 22, 2022. https://mailchimp.com/resources/importance-of-reviews-in-ecommerce/ (accessed Aug. 12, 2023).
[3] B. Liu, “Introduction,” in Sentiment Analysis: Mining Opinions, Sentiments, and Emotions, 2nd ed., Cambridge University Press, 2020, pp. 1–17. [Online]. Available: https://www.cambridge.org/core/books/sentiment-analysis/introduction/563742A639EEE9F5AB3F29CB2387E41C
[4] IBM, “What is logistic regression,” IBM. https://www.ibm.com/topics/logistic-regression (accessed Aug. 12, 2023).
[5] IBM, “What is naïve Bayes,” IBM. https://www.ibm.com/topics/naive-bayes (accessed Aug. 12, 2023).
[6] G.B. Aliman, et al. “Sentiment analysis using logistic regression,” Journal of Computational Innovations and Engineering Applications, vol. JULY 35, p. 40, 2022.
[7] J. P. Delizo, M. B. Abisado, and M. I. De Los Trinos, “Philippine Twitter sentiments during Covid-19 pandemic using multinomial Naïve-Bayes,” International Journal of Advanced Trends in Computer Science and Engineering, vol. 9, no. 1.3, pp. 408–412, Jun. 2020, doi: 10.30534/ijatcse/2020/6491.32020.
[8] S. A. Rahmaningrum and P. P. Oktaviana, “Sentiment classification of hotel service review on traveloka sites using naïve bayes classifier (NBC) and binary logistic regression,” Journal of Physics, vol. 1490, no. 1, p. 012065, Mar. 2020, doi: 10.1088/1742-6596/1490/1/012065.
[9] Shopee Philippines, “Buy home & living products online at great prices,” Shopee Philippines. https://shopee.ph/Home-Living-cat.11021407?page=0&sortBy=sales (accessed Aug. 12, 2023).
[10] B. Judah and Analytics Vidhya, “Removing stop words with NLTK library in Python,” Medium, Oct. 20, 2021. Accessed: Aug. 12, 2023. [Online]. Available: https://medium.com/analytics-vidhya/removing-stop-words-with-nltk-library-in-python-f33f53556cc1
[11] G. Diaz and A. Suriyawongkul, “Tagalog stopwords collection,” GitHub, Oct. 08, 2016. https://github.com/stopwords-iso/stopwords-tl (accessed Aug. 12, 2023).
[12] S. Gallagher, A. Rafferty, and A. Wu, “NLP - techniques,” Stanford Computer Science Department, 2004. https://cs.stanford.edu/people/eroberts/courses/soco/projects/2004-05/nlp/techniques_word.html (accessed Aug. 12, 2023).
[13] scikit-learn Developers, “Feature extraction,” Scikit-learn. https://scikit-learn.org/stable/modules/feature_extraction.html (accessed Aug. 12, 2023).
[14] scikit-learn Developers, “CountVectorizer,” Scikit-learn. https://scikit-learn.org/stable/modules/generated/sklearn.feature_extraction.text.CountVectorizer.html (accessed Aug. 12, 2023).
[15] scikit-learn Developers, “TfidFVectorizer,” Scikit-learn. https://scikit-learn.org/stable/modules/generated/sklearn.feature_extraction.text.TfidfVectorizer.html (accessed Aug. 12, 2023).

ISSN 3028-0168 (Print) | 3028-0176 (Online)
Volume 3, Issue 1 | AY 2022-2023

[16] Stanford NLP Group, “Stemming and lemmatization,” The Stanford Natural Language Processing Group, Apr. 07, 2009. https://nlp.stanford.edu/IR-book/html/htmledition/stemming-and-lemmatization-1.html (accessed Aug. 12, 2023).
[17] L. Yang, Y. Liu, J. Wang, and R. S. Sherratt, “Sentiment analysis for E-Commerce product reviews in Chinese based on sentiment lexicon and deep learning,” IEEE Access, vol. 8, pp. 23522–23530, Jan. 2020, doi: 10.1109/access.2020.2969854.
[18] H. Zikang, Y. Yong, Y. Guofeng and Z. Xinyu, "Sentiment analysis of agricultural product ecommerce review data based on deep learning," 2020 International Conference on Internet of Things and Intelligent Applications (ITIA), Zhenjiang, China, 2020, pp. 1-7, doi: 10.1109/ITIA50152.2020.9312251.

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TOWARDS AN ADAPTIVE LEARNING FOR TERTIARY EDUCATION: THE POTENTIAL OF UNIVERSAL DESIGN FOR LEARNING (UDL) FRAMEWORK

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***Abstract*— Adaptive learning has evolved together with the advancement of technology, including artificial intelligence, data analytics and machine learning. These technologies are utilized by adaptive learning to analyze the academic performance, learning preferences, and learning patterns of learners to provide a personalized learning environment with efficiency. While the concept of adaptive learning is to innovate the one-size-fits-all model to provide a more personalized learning process, its development and application is still in its infancy. It has been revealed that adaptive learning model research tends to focus on analyzing the cognitive learning characteristics of the learners. This includes learning style, prior knowledge, and other learning preferences. It is argued that besides educational technologies such as adaptive learning, research should consider incorporating educational framework into adaptive learning designs which focus not only cognitive but affective learnings as well. This study identifies methods of how to potentially design and implement Universal Design for Learning (UDL) into adaptive learning. UDL is an educational framework based on cognitive neuroscience which encompasses three core principles: 1) multiple means of representation *(Recognition: the "what" of learning)*, 2) multiple means of action and expression *(Strategic: the "how" of learning)*, and 3) multiple means of engagement *(Affective: the "why" of learning)*. It is important that future development of adaptive learning should implement educational frameworks such as universal design for learning (UDL) that are highly recognized to support personalized learning. This will enable a more inclusive education that adaptive learning is aiming for.**

***Index Terms*—adaptive learning, personalized learning, one-size-fits-all learning, universal design for learning, multiple means of representation, multiple means of action and expression, multiple means of engagement**

1. Introduction

Adaptive learning is based on the idea that learners have different abilities, preferences, and learning styles, and therefore, a one-size-fits-all approach to education may not be the most effective. (Tackett et al., 2018; Zhikharev et al., 2021) The concept of adaptive learning emerged from the intersection of educational psychology and computer-based instruction. Early approaches in researchers began exploring ways to leverage computers to deliver educational content and adapt it to the needs of individual learners. (Ferreira et al., 2017) These early efforts focused on computer-assisted instruction (CAI) systems, which were among the first attempts at adapting learning content based on individual responses and performance. (Dziuban et al., 2017; Talaghzi et al., 2020)

With the advancements in technology, including in artificial intelligence and machine learning, adaptive learning has become more sophisticated. Modern adaptive learning systems leverage algorithms and data analytics to continuously analyze learner data, including performance, preferences, and learning patterns. (Peng et al., 2019; Raj & Renumol, 2022; Zaoudi & Belhadaoui, 2020) These systems gather information through various means, such as quizzes, tests, simulations, and online activities. Based on the collected data, adaptive learning can dynamically adjust the instructional content, sequence, and pace to meet the specific needs of each learner. For example, if a student is struggling with a particular concept, the system may provide additional explanations, examples, or practice exercises to reinforce understanding. (Herder et al., 2017; A. Yang et al., 2022; S. Yang et al., 2019) Alternatively, if a student demonstrates mastery of a topic, adaptive learning may move learners to more advanced material or provide enrichment activities.

Adaptive learning systems can also employ various instructional approaches, such as branching scenarios, intelligent tutoring systems, and recommendation engines. They may offer real-time feedback, adaptive assessments, interactive simulations, and personalized learning pathways to enhance the learning experience. (Ding et al., 2018; J. Liu et al., 2020) Adaptive learning has found applications in different educational settings, including K-12 schools, higher education institutions, and corporate training programs. It enables educators to provide individualized instruction at scale, cater to diverse learner needs, and promote student engagement and achievement.(Nurjanah, 2018)

1.1 Challenges for Adaptive Learning

Cavanagh et al., (2020) argued that implementing adaptive learning requires instructors to fundamentally change and redesign instructional design practices, which may result as an additional workload and challenge in implementing adaptive learning into their courses. In **Error! Reference source not found.**, shows the challenges of implementing adaptive learning. It can be observed that it can be divided in terms of three (3) categories, including organizational, technological, and teaching and learning challenges. In terms of teaching and learning, redesigning instructional materials and courses is one of the challenges of adaptive learning. It can also be observed that it can become an additional workload for a lecturer to

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redesign an instructional or curriculum materials. (Mirata, 2019)

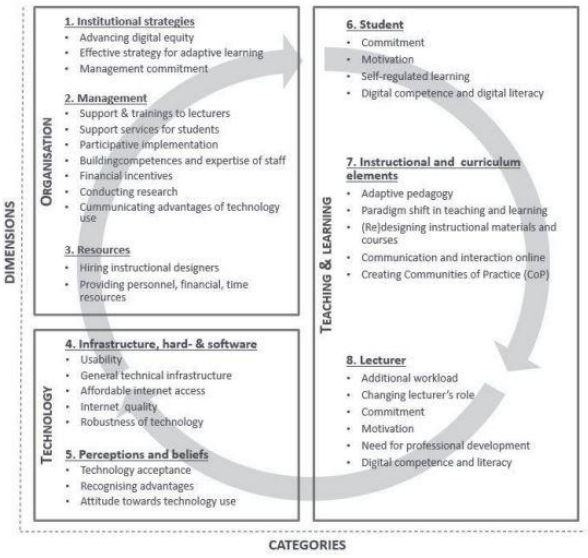

Figure 1: Challenges of adaptive learning, dimensions, and categories (Mirata, 2019)

For the most part, adaptive learning research tend to revolve around learner models, and technological elements. (Gumbheer et al., 2022; Muñoz et al., 2022) However, the role of educators in developing and implementing adaptive learning into higher education remains distinct and highly recognized by researcher. Content and instructional designs are the core area in which educators function as they are involved. (Alajlani et al., 2023; Pak et al., 2020) Considering that learning may vary to individual students, it can be a challenge on how to design personalized learning. A robust adaptive learning should provide multiple modalities of the content delivery (e.g., text, video, interactive activities, personalized assessment methods). (Taylor et al., 2021) Transforming traditional one-size-fits-all learning also requires effort for redesigning curriculum and learning materials as it is a prerequisite for the scaled implementation of adaptive learning, which could potentially require a substantial resource including time and expertise. (Mirata & Bergamin, 2023)

2. Literature Review

Although the premise of adaptive learning is to transform traditional learning pedagogy of one-size-fits-all model to more equitable learning process of personalized learning, its implementation is still in its infancy. (Schmid et al., 2022) Nevertheless, with the increasing diversity of student populations in Higher Education Institutions, a need for a systematic transformation from a one-size-fits-all to personalized learning model through the integration of an adaptive learning environment is in need. (Zhang et al., 2020) Research has argued that adaptive learning can provide an innovative solution to the issues of one-size-fits-all model of learning in higher education. (Schmid et al., 2022; Zhang et al., 2020) However, it has been revealed that adaptive learning model research tends to focus on analyzing the cognitive learning characteristics of the learners for personalized learning. This includes learning style, prior knowledge, and learning preferences. (Al-Chalabi et al., 2021; A. Yang et al., 2022; Zhang et al., 2022)

A recent study by (Chu et al., 2022) conducted a systematic review of the top 50 highly cited research articles about the roles and research trends of artificial intelligence in higher education from 1996 to 2020. The results revealed that while there is a shift of research focus in the role of AI in higher education from profiling and prediction to adaptive learning systems and personalized learning, 68% of the high impact research from the past 25 years in adaptive learning and personalization mainly considered the learners' cognitive characteristics, while other research are focused on learning performance, learning behaviors, and accuracy, sensitivity, or precision of the AI models. (Chu et al., 2022)

While cognitive characteristics are the core of learning, it has been examined that affective characteristics are critical for cognitive processing. Affective factors such as learning motivation, willingness, and self-efficacy, should be considered. (Hwang et al., 2020) These are critical considerations in maximizing the effectiveness of personalized learning in an adaptive learning environment. Moreover, both cognitive and affective characteristics of the learners are a crucial factor in the overall learning process but are often not given focused. (Cheng et al., 2021; Maier & Klotz, 2022; Raj & Renumol, 2022)

Adaptive learning models with only the cognitive characteristics analysis mechanisms may not be sufficient in terms of maximizing to improve the learners' learning performance in an adaptive learning environment, thus considering the affective characteristics mechanisms could potentially improve the effectiveness of adaptive learning. To truly achieve adaptive learning, both the cognitive and affective ability of the learners needs to be considered and explored in developing an adaptive learning environment. (Hwang et al., 2020; M. Liu et al., 2017)

2.1 The Universal Design for Learning (UDL) Principles for Adaptive

Universal Design for Learning (UDL) is an educational framework based on cognitive neuroscience that was originally developed and proposed by Rose and Meyer at the Center for Applied Special Technology (CAST) (Rose & Meyer, 2002) and considered as a scientifically valid framework that promotes inclusive education for all learners. (Balta et al., 2021; Griful-Freixenet et al., 2021) It encompasses three core principles: 1) multiple means of representation *(Recognition: the "what" of learning)*, 2) multiple means of action and expression *(Strategic: the "how" of learning)*, and 3) multiple means of engagement *(Affective: the "why" of learning)* to address the diverse learning needs of the learners. (CAST, 2012; Rose & Meyer, 2002) UDL aims to remove barriers to

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learning and transforms one-size-fits-all instruction by providing a flexible instructional approach, diverse learning materials, and varied assessment guidelines. (Al-Azawei et al., 2016; Schreffler et al., 2019) By implementing UDL principles, adaptive learning can create a learning environment that maximize accessibility, engagement, and inclusivity. (Dalton, 2017; Rogers-Shaw et al., 2018)

With the emphasis on providing access to learning opportunities for individuals with disabilities, UDL was developed upon the architectural design principles of *"Universal Design"*, which aims to create products and environments that are accessible and usable by people with varying abilities. (Al-Azawei et al., 2016; Capp, 2017) Throughout various research, UDL continued to evolve and has expanded to encompass a broader range of learners, recognizing that all learners have unique learning needs and strengths. It emphasizes flexible instructional approaches, multiple means of representation, engagement, and expression, enabling educators to provide various ways to engage learning and serve individual differences. (Hromalik et al., 2020) UDL has gained recognition and adoption across educational settings, by guiding curriculum design, instructional strategies, and assessment practices to enable inclusive education for all learners. (Kang et al., 2018) UDL implementation is supported by nine (9) sets of guidelines and thirty (30) checkpoints that are based on the three (3) core principles which can be observed in figure 1.

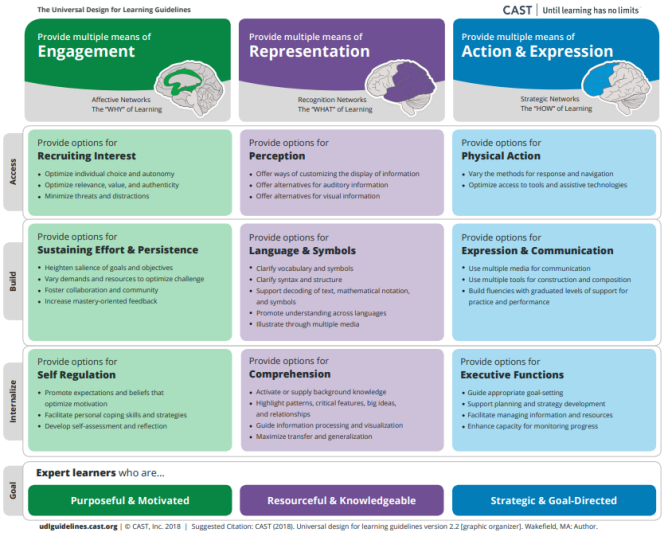

Figure 2: Universal Design for Learning (UDL) Guidelines V2.2 (CAST, 2018)

UDL is recognized as a fundamental educational framework to meet the needs of an increasing number of diverse learners in today's college and university classrooms. For example, according to the Higher Education Opportunity Act of 2008 (HEOA, 2008), UDL is defined as *"a scientifically valid framework for guiding educational practices that provides flexibility in the ways information is presented, student respond or demonstrate knowledge and skills and ways learners are engaged; and reduces barriers in instruction"*. (Boothe et al., 2018) While it is very much possible to implement UDL principles into classrooms without the aid of technology, it is implied that UDL would be much easier and more efficient if it is supported with technology thus making the learning environment more accessible. (Courtad, 2019; Evmenova, 2018; Rogers & Gronseth, 2021; Sasson et al., 2022)

It is argued that besides educational technologies such as adaptive learning, higher learning institutions should consider educational theories and practices of UDL into curriculum and adaptive learning designs. (Arsović, 2018) For example, (Levicky-Townley et al., 2021) examined how learners perceived the use of specific learning activities on attention, memory and multitasking to help them develop as "expert learners"; and sought to identify perceptions of instructional designers who would like to implement UDL in an online higher education course. The result of the study indicated that integrating UDL framework into an online higher education course supported learners' attention, help eliminate distractions, provided relevance to learning and changed learners' belief about attention, memory, and multitasking. Similarly, (Garrad & Nolan, 2023) implemented UDL as the design framework in higher education online learning environment. The result has shown significant increase in student engagements, satisfaction factor rating and noticeable decrease in learners attrition compared to pre-UDL cohorts. Moreover, (Dalton et al., 2019) further recommended leveraging technology to support inclusion, rather than letting it become a barrier.

2.1.1 Multiple Means of Representation: Guidelines to Support Adaptive Learning Content

The first principle of UDL is the multiple means of representation or the "what" of learning. It is described as how information could be perceived. While learners comprehend information in various ways, the principle of "multiple means of representation" ensures that learners have multiple or various options of how they can engage such information. It ensures that the curriculum has a wide range of opportunities and multiples means to access and study the learning contents. (Suleymanov, 2022)

Multiple means of representation as shown in table 1, provides three (3) supporting guidelines and twelve (12) checkpoints on how to implement the principle effectively, and how it should be used for designing and developing instructional materials. These guidelines ensure that the content is presented in diverse ways, enabling learners to access and engage with the information effectively. In addition, multiple means of representation provide practical recommendations, such as presenting content in multiple formats, enhanced readability, integrating multimedia, clarifying vocabulary, simplifying language, organizing information, accommodating individual preferences, providing alternative media, thus creating an inclusive learning environment by ensuring that content is accessible, engaging, and adaptable to meet the needs of all learners. (Murphy, 2021; Roski et al., 2021; Suleymanov, 2022)

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Table 1: UDL Principle 1: Multiple Means of Representation

Guidelines	Checkpoints	Descriptions
1.0 Provide options for Perception	**1.1:** Offer ways of customizing the display of information	Use flexible materials with settings that can be adjusted based on needs and preferences.
	1.2: Offer alternatives for auditory information	Share information in more ways than sound and voice alone.
	1.3: Offer alternatives for visual information	Share information in more ways than images and text alone.
2.0 Provide options for Language & Symbols	**2.1:** Clarify vocabulary and symbols	Construct meaning from words, symbols, and numbers using different representations.
	2.2: Clarify syntax and structure	Make the patterns and properties of systems like grammar, musical notation, taxonomies, and equations explicit.
	2.3: Support decoding of text, mathematical notation, and symbols	Make sure text and symbols don't get in the way of the learning goal.
	2.4: Promote understanding across languages	Use translations, descriptions, movement, and images to support learning in unfamiliar or complex languages.
	2.5: Illustrate through multiple media	Make learning come alive with simulations, graphics, activities, and videos.
3.0 Provide options for Comprehension	**3.1:** Activate or supply background knowledge	Build connections to prior understandings and experiences.
	3.2: Highlight patterns, critical features, big ideas, and relationships	Accentuate important information and how it relates to the learning goal.
	3.3: Guide information processing and visualization	Support the process of meaning-making through models, scaffolds, and feedback.
	3.4: Maximize transfer and generalization	Apply learning to new contexts.
Resourceful, Knowledgeable Learners		

Moreover, these guidelines could potentially fit well with the design and objectives of adaptive learning content. Since adaptive learning content is a model that provides personalized learning content that supports learning through content and resources that are aligned with the learner characteristics, (Apoki et al., 2020) designing learning content based on multiple means of representation guidelines could further accommodate the diverse learning styles and preferences of the learners. Furthermore, these guidelines could offer flexibility for learners to choose the format that suits them best and enables adaptive learning to personalize the presentation of content based on learning style or performance data.

For instance, if learners struggle with traditional text-based content, the adaptive learning model can provide alternative formats, such as visual, auditory representations or other modalities of the same learning objectives, which could enhance their understanding and engagement. (Basham et al., 2020) Educators and instructional designers can also provide varying levels of complexity or scaffolding, allowing learners to progress at their own pace and access to the content that aligns with their current skill level. (Craig et al., 2022; Sasson et al., 2022) The availability of multiple means of representation within an adaptive learning content model can promote learner autonomy and self-regulation. Learners can choose the format or modality that best suits their learning preferences and needs, enabling them to take responsibility of their learning choices that optimize their understanding and engagement. Integrating the guidelines of multiple means of representation in an adaptive learning content model can also potentially support cross-cultural and multilingual differences. By providing content in various formats, such as translated text, audio narration, or relevant visuals, learners from diverse backgrounds could access and engage with the material effectively.

2.1.2 Multiple Means of Action and Expression: Guidelines to support Adaptive Learning Assessment

UDL framework not only applies to providing inclusive information and teaching, but also extends to assessment. (Ali Alsalamah et al., 2020) The second principle of UDL is the multiple means of action and expression, or the "how" of learning. This principle is composed of three (3) supporting guidelines: physical action, expression and communication, and executive function, including nine (9) checkpoints as shown in table 2. It focuses on how learners could demonstrate their learning in various ways. It encourages learners to demonstrate what they have learned and communicate it in a format that would fit and display their individual skills and mastery of the content. (Rose & Meyer, 2002) There are numerous opportunities for multiple means of action and expression that are currently implemented already in higher education classes. For example, quizzes, verbal, or written assessment, hands-on or traditional pen-and-paper final exams that are consist of different question types including multiple choices, matching types, short answer questions, debates, collaboration, or individual performances all of which could potentially demonstrate their learnings. Other opportunities such as feedbacks which includes rubrics, peer-review components could provide learners with choices to demonstrate learning in a way that they are comfortable, mitigating assessment anxieties thus allowing learners the opportunity to succeed where they might otherwise struggle. (Dyjur et al., 2021) Specifically, when learners are more familiar with the modality used to respond, they perform significantly greater. (Kennette & Andrew Wilson, 2019)

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Table 2: UDL Principle 2: Multiple Means of Action and Expression

Guidelines	Checkpoints	Descriptions
4.0 Physical Action	**4.1:** Vary the methods for response and navigation	Interact with tools and environments that make learning physically accessible to all.
	4.2: Optimize access to tools and assistive technologies	Open doors to learning with accessible tools and devices.
5.0 Expression & Communication	**5.1:** Use multiple media for communication	Express learning in flexible ways.
	5.2: Use multiple tools for construction and composition	Share thoughts and ideas using tools that complement the learning goal.
	5.3: Build fluencies with graduated levels of support for practice and performance	Apply and gradually release scaffolds to support independent learning.
6.0 Executive Functions	**6.1:** Guide appropriate goal setting.	Practice setting challenging and authentic goals.
	6.2: Support planning and strategy development	Formulate reasonable plans for reaching goals.
	6.3: Facilitate managing information and resources	Support organization and memory using flexible tools and processes.
	6.4: Enhance capacity for monitoring progress	Analyse growth over time and how to build from it.
Strategic & Goal-Directed		

For example, (Kennette & Wilson, 2019) provided an overview of empirical evidence supporting the benefits to student achievement by implementing UDL principles. Learners demonstrate their learning could vary by discipline, but providing learners with the principle of choices or responsibility to control is a simple way to demonstrate their individual capabilities. Educators might allow learners to choose an essay topic on a test for their assessment based on the parameters that the educators have set or allow learners to select the modalities to express their answers. It could be in the form of video, audio, written or practical test. The key is to provide learners with a broader range of options from which they could demonstrate their knowledge. Furthermore, (Ali Alsalamah et al., 2020) pointed out that the assessment options provided to the learners should always be align to the learning objectives. It is also important to provide clear expectations about the task required; for example, these techniques could include clarifying assessment methods, grading rubrics, and clear due dates. By providing options in assessments, this can make learners more comfortable choosing what suits their abilities.

The guidelines associated with multiple means of action and expression could potentially fit into the design and objectives of adaptive learning assessment model in an adaptive learning; by providing diverse and flexible ways for students to demonstrate their knowledge and skills. Multiple means of action and expression principle could play a crucial role and valuable guidelines within an adaptive learning in supporting an adaptive learning assessment model since this principle encourages the use of diverse modalities, such as written, verbal, visual, and/or kinesthetic, allowing students to express themselves in ways that suit their strengths and preferences. This could ensure inclusivity by accommodating diverse learning styles in adaptive learning assessment design and enables students to take an active role in their learning journey.

2.1.3 Multiple Means of Engagement: Guidelines for Adaptive Learning Path

The third and final principle of UDL is the multiple means of engagement, or the "why" of learning. This principle is composed of three (3) supporting guidelines: recruiting interest, sustaining effort and persistence, and self-regulation including ten (10) checkpoints as shown in table 5. Guidelines of this UDL principle specifically target the affective network of the learner including opportunities to promote expectations and beliefs that potentially optimize motivation. (CAST, 2012; Rose & Meyer, 2002) This principle discusses that learners have varying levels of motivation in a learning environment. By engaging learners into differentiated learning paths with the same learning outcome and goals, they can be motivated to learn while considering and strengthening weaker areas. (Dyjur et al., 2021)

Table 3: UDL Principle 3: Multiple Means of Engagement

Guidelines	Checkpoints	Descriptions
7.0 Recruiting Interest	**7.1:** Optimize individual choice and autonomy	Empower learners to take charge of their own learning.
	7.2: Optimize relevance, value, and authenticity	Connect learning to experiences that are meaningful and valuable.
	7.3: Minimize threats and distractions	Foster a safe space to learn and take risks.
8.0 Sustaining Effort & Persistence	**8.1:** Heighten salience of goals and objectives	Set a vision for the goal and why it matters.
	8.2: Vary demands and resources to optimize challenge	Rise to high expectations using flexible tools and supports.
	8.3: Foster collaboration and community	Cultivate a community of learners.
	8.4: Increase mastery-oriented feedback	Guide learning by emphasizing the role of effort and process.
9.0 Self-Regulation	**9.1:** Promote expectations and beliefs that optimize motivation	Set personal goals that inspire confidence and ownership of learning.
	9.2: Facilitate personal coping skills and strategies	Develop and manage healthy emotional responses and interactions.
	9.3: Develop self-assessment and reflection	Increase awareness around progress toward goals and how to learn from mistakes.
Purposeful & Motivated		

Maintaining engagement among learners in a classroom setting can be challenging, especially throughout long sessions of lecture or studying. However, research has observed that actively engaged learners tend to understand and learn better, enjoy the learning experience and more appreciative about the relevance of what they are learning (Kennette & Wilson, 2019). This could be observed in many settings, for example, if the learning task is too easy, learners might become bored or lose interest in the lesson, or if the challenge is too difficult, learners

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might become frustrated and unfortunately give up learning the lesson. It is also important to self-regulate their own progress and set goals for themselves. (Kennette & Andrew Wilson, 2019; Schreffler et al., 2019) These guidelines for multiple means of engagement prompt educators to consider other paths to achieve the same learning outcomes, including the use of learner's preferences of learning task. (Gronseth & Hutchins, 2020; Kieran & Anderson, 2019)

2.2 Implementation Difficulties with UDL: How learning style theory could assist

Although the goal of UDL is to support inclusive learning, and is recognised by many educational institutions, UDL practices are difficult to observe in higher education classrooms because, for the most part, higher education is not an inclusive environment due to the practice of the traditional one-size-fits-all learning. Hills et al., (2022) study observed that US institutions have used this framework almost exclusively. While many other institutions (McKenzie & Dalton, 2020; Y., Yang & Ma, 2022) were trying to adopt inclusive learning, studies have investigated that UDL is challenging to implement. It requires time, effort, support, and a comprehensive understanding of the framework to successfully implement. (McKenzie & Dalton, 2020; Y. , Yang & Ma, 2022) Further analysis revealed that the biggest challenge to UDL implementation in higher education have consistently with regards to time and workload issues for the faculty, as shown in figure 3. This result is also evident in the conclusion of Rogers & Gronseth, (2021) where the study pointed out that instructors' lack of time to implement, if not all the provided checkpoints as the biggest challenge to UDL.

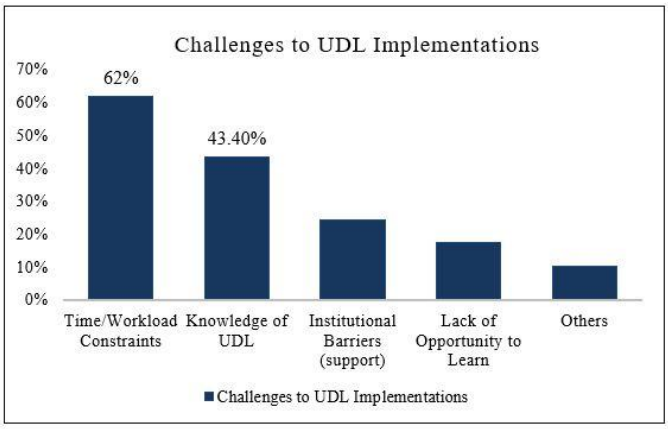

Figure 3: Challenges to UDL Implementation (Hills et al., 2022)

A potential disadvantage with implementing UDL principles is that it takes a lot of time, effort, and other resources to provide each of the various learning options. Due to the numerous sources of instructional materials and interactions needed, the UDL also requires more time to learn than the traditional approach. UDL guidelines must be implemented strategically in order to account for students' and teachers' time constraints. (Balta et al., 2021) To implement UDL principles into adaptive learning models, (Kang et al., 2018) suggested an approach by identifying the learning style first using FSLSM then mapping the identified dominant learning style with UDL principles. This method will allow teachers to focus and prioritize implementing UDL checkpoints which are aligned with the learning styles of the students. Figure 3 shows the proposed implementation approach of UDL principles and learning style theory into an adaptive learning. (Kang et al., 2018)

Conversely, while these challenges exist faculty perceptions revealed that they showed willingness to adopt the principles of UDL into their curriculum designs. Though UDL is inspiring for educators, it is also viewed as a very complex framework. Interestingly, another study pointed out that UDL does not necessarily require the implementation of all the principles, guidelines, and checkpoints. (Roski et al., 2021) This could either be seen as an opportunity or challenge because UDL does not provide a clear direction on which among the principles, guidelines and checkpoints should have the priority to implement or to what learning style does a particular checkpoint is acceptable. Its objective is to simply "include" as many learning opportunities as possible.

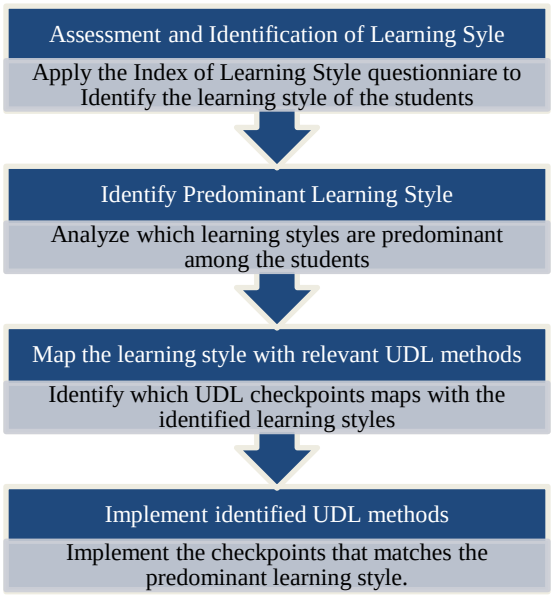

Figure 4: Proposed Implementation approach of learning style and UDL adopted from Kang et al., (2018)

Although ILS presents an excellent method to classify and assess the learning styles, the suggested teaching strategies of FSLSM as shown in table 12 are not very specific. It does not entirely provide an in-depth teaching technique associated with the learning style. Instead, it generally relies on the instructor to deliver the corresponding teaching style that would fit the learning style. On the other hand, as previously mentioned, the checkpoints from UDL guidelines provides an in-depth teaching method but do not provide specific guidelines to whom or what specific student characteristics it should be implemented to given it would take considerable amount of time and resources to implement all the guidelines in the hopes

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of accommodating all the possible learning preferences of the students.

With this, figure 4 shows the proposed a framework to map learning style and UDL checkpoints. By investigating the learning style first and mapping the learning style to UDL checkpoints, this technique specifically addresses the issue of time constraints of UDL by prioritizing the checkpoints that needs to be implemented. First, identifying what characteristics of the students such as which learning style fits best a particular checkpoint would provide alignment to the checkpoints individually to the students instead of implementing all the checkpoints and hoping it would match their characteristics. This approach presents a framework on how to implement UDL effectively and reduce the time required by prioritizing the checkpoints that need to be implemented first.

3. Conclusion

This study identifies methods of how to potentially design and implement UDL into adaptive learning. While design features and development of adaptive learning tends to primarily focus on the technological aspects such as the use of machine learning and deep learning approaches for adaptive learning content, assessment, and path model, it is important that future development of adaptive learning should implement educational theories other than learning style theory such as universal design for learning (UDL) that are highly recognized in higher education. This will enable a more inclusive education that adaptive learning is aiming for.

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References

Alajlani, N., Crabb, M., & Murray, I. (2023). A systematic review in understanding stakeholders' role in developing adaptive learning systems. *Journal of Computers in Education*, 1–20. https://doi.org/10.1007/s40692-023-00283-x

Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2016). Universal Design for Learning (UDL): A Content Analysis of Peer Reviewed Journals from 2012 to 2015. *Journal of the Scholarship of Teaching and Learning*, *16*(3), 39–56. https://doi.org/10.14434/josotl.v16i3.19295

Al-Chalabi, H. K. M., Hussein, A. M. A., & Apoki, U. C. (2021). An Adaptive Learning System Based on Learner's Knowledge Level. *Proceedings of the 13th International Conference on Electronics, Computers and Artificial Intelligence, ECAI 2021*, 1–4. https://doi.org/10.1109/ECAI52376.2021.9515158

Ali Alsalamah, A., Alsalamah, A., & Author, C. (2020). Assessing Students in Higher Education in Light of UDL Principles. *American Research Journal of Humanities & Social Science*, *3*(1), 24–27. www.arjhss.com

Apoki, U. C., Al-Chalabi, H. K. M., & Crisan, G. C. (2020). From Digital Learning Resources to Adaptive Learning Objects: An Overview. *Communications in Computer and Information Science*, *1126*, 18–32. https://doi.org/10.1007/978-3-030-39237-6_2

Arsović, B. B. (2018). Tendencies in future education development: Personalized and adaptive e-learning. *Zbornik Radova*, 283–292.

Balta, J. Y., Supple, B., & O'Keeffe, G. W. (2021). The Universal Design for Learning Framework in Anatomical Sciences Education. *Anatomical Sciences Education*, *14*(1), 71–78. https://doi.org/10.1002/ase.1992

Basham, J. D., Blackorby, J., & Marino, M. T. (2020). Opportunity in Crisis: The Role of Universal Design for Learning in Educational Redesign. *Learning Disabilities: A Contemporary Journal*, *18*(1), 71–91.

Boothe, K. A., Lohmann, M. J., Donnell, K. A., & Dean Hall, D. (2018). Applying the Principles of Universal Design for Learning (UDL) in the College Classroom. *Journal of Special Education Apprenticeship*, *7*(3).

Capp, M. J. (2017). The effectiveness of universal design for learning: a meta-analysis of literature between 2013 and 2016. *International Journal of Inclusive Education*, *21*(8), 791–807. https://doi.org/10.1080/13603116.2017.1325074

CAST. (2012). Universal Design for Learning Guidelines (Version 2.0). *Wakefield, MA: Author.*

Cavanagh, T., Chen, B., Lahcen, R. A. M., & Paradiso, J. (2020). Constructing a Design Framework and Pedagogical Approach for Adaptive Learning in Higher Education: A Practitioner's Perspective. *The International Review of Research in Open and Distributed Learning*, *21*(1), 172–196. https://doi.org/10.19173/irrodl.v21i1.4557

Cheng, Q., Benton, D., & Quinn, A. (2021). Building a Motivating and Autonomy Environment to Support Adaptive Learning. *In 2021 IEEE Frontiers in Education Conference (FIE)*, *2021-October*, 1–7. https://doi.org/10.1109/FIE49875.2021.9637397

Chu, H.-C., Hwang, G.-H., Tu, Y.-F., & Yang, K.-H. (2022). Roles and research trends of artificial intelligence in higher education: A systematic review of the top 50 most-cited articles. *Australasian Journal of Educational Technology*, *38*(3), 22–44.

Courtad, C. A. (2019). Making your classroom smart: Universal design for learning and technology. *Smart Innovation, Systems and Technologies*, *144*, 501–510. https://doi.org/10.1007/978-981-13-8260-4_44

Craig, S. L., Smith, S. J., & Frey, B. B. (2022). Professional development with universal design for learning: supporting teachers as learners to increase the implementation of UDL. *Professional Development in Education*, *48*(1), 22–37. https://doi.org/10.1080/19415257.2019.1685563

Dalton, E. M. (2017). Universal Design for Learning: Guiding Principles to Reduce Barriers to Digital & Media Literacy

ISSN 3028-0168 (Print) | 3028-0176 (Online)
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FACULTY RESEARCHES

Competence. *Journal of Media Literacy Education*, *9*(2), 17–29. https://doi.org/10.23860/jmle-2019-09-02-02

Dalton, E. M., Lyner-Cleophas, M., Ferguson, B. T., & McKenzie, J. (2019). Inclusion, universal design and universal design for learning in higher education: South Africa and the United States. *African Journal of Disability*, *8*(1), 1–7. https://doi.org/10.4102/ajod.v8i0.519

Ding, W., Zhu, Z., & Guo, Q. (2018). A New Learner Model in Adaptive Learning System. *In 2018 3rd International Conference on Computer and Communication Systems (ICCCS)*, 440–443.

Dyjur, P. , Ferreira, C. , & Clancy, T. (2021). Increasing Accessibility and Diversity by Using a UDL Framework in an Infographics Assignment. *Currents in Teaching & Learning*, *12*(2), 71–83. http://listserv.worcester.edu/scripts/

Dziuban, C., Moskal, P., Johnson, C., & Evans, D. (2017). Adaptive Learning: A Tale of Two Contexts. *Current Issues in Emerging ELearning*, *4*(1). https://scholarworks.umb.edu/cieeAvailableat:https://scholarworks.umb.edu/ciee/vol4/iss1/3

Evmenova, A. (2018). Preparing Teachers to Use Universal Design for Learning to Support Diverse Learners. *Journal of Online Learning Research*, *4*(2), 147–171.

Ferreira, H. N. M., Brant-Ribeiro, T., Araujo, R. D., Dorca, F. A., & Cattelan, R. G. (2017). An Automatic and Dynamic Knowledge Assessment Module for Adaptive Educational Systems. *Proceedings - IEEE 17th International Conference on Advanced Learning Technologies, ICALT 2017*, 517–521. https://doi.org/10.1109/ICALT.2017.86

Garrad, T.-A., & Nolan, H. (2023). Rethinking Higher Education Unit Design: Embedding Universal Design for Learning in Online Studies. *Student Success*, *14*(1), 1–8. https://doi.org/10.5204/ssj.2300

Griful-Freixenet, J., Struyven, K., & Vantieghem, W. (2021). Toward More Inclusive Education: An Empirical Test of the Universal Design for Learning Conceptual Model Among Preservice Teachers. *Journal of Teacher Education*, *72*(3), 381–395. https://doi.org/10.1177/0022487120965525

Gronseth, S. L., & Hutchins, H. M. (2020). Flexibility in Formal Workplace Learning: Technology Applications for Engagement through the Lens of Universal Design for Learning. *TechTrends*, *64*(2), 211–218. https://doi.org/10.1007/s11528-019-00455-6

Gumbheer, C. P., Khedo, K. K., & Bungaleea, A. (2022). Personalized and Adaptive Context-Aware Mobile Learning: Review, challenges and future directions. *Education and Information Technologies*, *27*(6), 7491–7517. https://doi.org/10.1007/s10639-022-10942-8

Herder, E., Sosnovsky, S., & Dimitrova, V. (2017). Adaptive intelligent learning environments. *Technology Enhanced Learning: Research Themes*, 109–114. https://doi.org/10.1007/978-3-319-02600-8_10

Hills, M., Overend, A., & Hildebrandt, S. (2022). Faculty Perspectives on UDL: Exploring Bridges and Barriers for Broader Adoption in Higher Education. *The Canadian Journal for the Scholarship of Teaching and Learning*, *13*(1). https://doi.org/10.5206/cjsotlrcacea.2022.1.13588

Hromalik, C. D., Myhill, W. N., & Carr, N. R. (2020). "ALL Faculty Should Take this": a Universal Design for Learning Training for Community College Faculty. *TechTrends*, *64*(1), 91–104. https://doi.org/10.1007/s11528-019-00439-6

Hwang, G. J., Sung, H. Y., Chang, S. C., & Huang, X. C. (2020). A fuzzy expert system-based adaptive learning approach to improving students' learning performances by considering affective and cognitive factors. *Computers and Education: Artificial Intelligence*, *1*. https://doi.org/10.1016/j.caeai.2020.100003

Kang, Z., Dragoo, M., Yeagle, L., Shehab, R., Yuan, H., Ding, L., & West, S. (2018). Adaptive Learning Pedagogy of Universal Design for Learning (UDL) for Multimodal Training. *Journal of Aviation/Aerospace Education & Research*, *27*(1), 23–48. https://doi.org/10.15394/jaaer.2018.1752

Kennette, L. N., & Andrew Wilson, N. (2019). Universal Design for Learning (UDL): Student and Faculty Perceptions. *Journal of Effective Teaching in Higher Education*, *2*(1), 1–26.

Kennette, L. N., & Wilson, N. A. (2019). Universal Design for Learning (UDL): What is it and how do I implement it? *Transformative Dialogues: Teaching & Learning Journal*, *12*(1), 1–6.

Kieran, L., & Anderson, C. (2019). Connecting Universal Design for Learning With Culturally Responsive Teaching. *Education and Urban Society*, *51*(9), 1202–1216. https://doi.org/10.1177/0013124518785012

Levicky-Townley, C., Stork, M. G., Zhang, J., & Weatherford, E. (2021). Exploring the Impact of Universal Design for Learning Supports in an Online Higher Education Course. *The Journal of Applied Instructional Design*, *10*(1).

Liu, J., Loh, L., Ng, E., Chen, Y., Wood, K. L., & Lim, K. H. (2020). Self-evolving adaptive learning for personalized education. *Proceedings of the ACM Conference on Computer Supported Cooperative Work, CSCW*, 317–321. https://doi.org/10.1145/3406865.3418326

Liu, M., Kang, J., Zou, W., Lee, H., Pan, Z., & Corliss, S. (2017). Using Data to Understand How to Better Design Adaptive Learning. *Technology, Knowledge and Learning*, *22*(3), 271–298. https://doi.org/10.1007/s10758-017-9326-z

Maier, U., & Klotz, C. (2022). Personalized feedback in digital learning environments: Classification framework and literature review. *Computers and Education: Artificial Intelligence*, *3*. https://doi.org/10.1016/j.caeai.2022.100080

McKenzie, J. A., & Dalton, E. M. (2020). Universal design for learning in inclusive education policy in South Africa. *African Journal of Disability*, *9*, 1–8. https://doi.org/10.4102/AJOD.V9I0.776

Mirata, V. (2019). Developing an Implementation Framework for Adaptive Learning: a Case Study Approach.

ISSN 3028-0168 (Print) | 3028-0176 (Online)
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FACULTY RESEARCHES

Proceedings of the 18th European Conference on E-Learning 18th European Conference on e-Learning.

Mirata, V., & Bergamin, P. (2023). Role of organisational readiness and stakeholder acceptance: an implementation framework of adaptive learning for higher education. *Educational Technology Research and Development*. https://doi.org/10.1007/s11423-023-10248-7

Muñoz, J. L. R., Ojeda, F. M., Jurado, D. L. A., Peña, P. F. P., Carranza, C. P. M., Berríos, H. Q., Molina, S. U., Farfan, A. R. M., Arias-Gonzáles, J. L., & Vasquez-Pauca, M. J. (2022). Systematic Review of Adaptive Learning Technology for Learning in Higher Education. *Eurasian Journal of Educational Research*, *2022*(98), 221–233. https://doi.org/10.14689/ejer.2022.98.014

Murphy, M. P. A. (2021). Belief without evidence? A policy research note on Universal Design for Learning. *Policy Futures in Education*, *19*(1), 7–12. https://doi.org/10.1177/1478210320940206

Nurjanah, D. (2018). LifeOn, a ubiquitous lifelong learner model ontology supporting adaptive learning. *In 2018 IEEE Global Engineering Education Conference (EDUCON)*, 866–871.

Pak, K., Polikoff, M. S., Desimone, L. M., & Saldívar García, E. (2020). The Adaptive Challenges of Curriculum Implementation: Insights for Educational Leaders Driving Standards-Based Reform. *AERA Open*, *6*(2). https://doi.org/10.1177/2332858420932828

Peng, H., Ma, S., & Spector, J. M. (2019). Personalized adaptive learning: an emerging pedagogical approach enabled by a smart learning environment. *Smart Learning Environments*, *6*(1), 1–14. https://doi.org/10.1186/s40561-019-0089-y

Raj, N. S., & Renumol, V. G. (2022). A systematic literature review on adaptive content recommenders in personalized learning environments from 2015 to 2020. *Journal of Computers in Education*, *9*(1), 113–148. https://doi.org/10.1007/s40692-021-00199-4

Rogers, S. A., & Gronseth, S. L. (2021). Applying UDL to Online Active Learning Instructional Designer Perceptions. *The Journal of Applied Instructional Design*, *10*(1).

Rogers-Shaw, C., Carr-Chellman, D. J., & Choi, J. (2018). Universal Design for Learning: Guidelines for Accessible Online Instruction. *Adult Learning*, *29*(1), 20–31. https://doi.org/10.1177/1045159517735530

Rose, & Meyer. (2002). *Teaching Every Student in the Digital Age: Universal Design for Learning* (1st ed.). Association for Supervision and Curriculum Development (ASCD) Publishing.

Roski, M., Walkowiak, M., & Nehring, A. (2021). Universal design for learning: The more, the better? *Education Sciences*, *11*(4), 164. https://doi.org/10.3390/educsci11040164

Sasson, I., Yehuda, I., & Miedijensky, S. (2022). Innovative learning spaces: class management and universal design for learning. *Learning Environments Research*, *25*(3), 725–739. https://doi.org/10.1007/s10984-021-09393-8

Schmid, R., Pauli, C., Stebler, R., Reusser, K., & Petko, D. (2022). Implementation of technology-supported personalized learning—its impact on instructional quality. *Journal of Educational Research*, *115*(3), 187–198. https://doi.org/10.1080/00220671.2022.2089086

Schreffler, J., Vasquez, E., Chini, J., & James, W. (2019). Universal Design for Learning in postsecondary STEM education for students with disabilities: a systematic literature review. *International Journal of STEM Education*, *6*(1), 1–10. https://doi.org/10.1186/s40594-019-0161-8

Suleymanov, F. (2022). UNIVERSAL DESIGN FOR LEARNING (UDL). *Preschool and Primary Education*, *2*(2), 63–69. https://doi.org/10.29228/imcra.32

Tackett, S., Raymond, M., Desai, R., Haist, S. A., Morales, A., Gaglani, S., & Clyman, S. G. (2018). Crowdsourcing for assessment items to support adaptive learning. *Medical Teacher*, *40*(8), 838–841. https://doi.org/10.1080/0142159X.2018.1490704

Talaghzi, J., Bennane, A., Himmi, M. M., Bellafkih, M., & Benomar, A. (2020). Online adaptive learning: A review of literature. *ACM International Conference Proceeding Series*, 115–120. https://doi.org/10.1145/3419604.3419759

Taylor, D. L. , Yeung, M. , & Bashet, A. Z. (2021). Personalized and adaptive learning. *Innovative Learning Environments in STEM Higher Education: Opportunities, Challenges, and Looking Forward*, 17–34. http://www.springer.com/series/8921

Yang, A., Flanagan, B., & Ogata, H. (2022). Adaptive formative assessment system based on computerized adaptive testing and the learning memory cycle for personalized learning. *Computers and Education: Artificial Intelligence*, *3*. https://doi.org/10.1016/j.caeai.2022.100104

Yang, S., Tian, H., Sun, L., & Yu, X. (2019). From One-size-fits-all Teaching to Adaptive Learning: The Crisis and Solution of Education in the Era of AI. *Journal of Physics: Conference Series*, *1237*(4). https://doi.org/10.1088/1742-6596/1237/4/042039

Yang, Y. , & Ma, J. (2022). A Study on the Significance of UDL-Based Teaching Practices for Students with Intellectual Disabilities. *Advances in Educational Technology and Psychology*, *6*(12), 17–22. https://doi.org/10.23977/aetp.2022.061203

Zaoudi, M., & Belhadaoui, H. (2020). Adaptive E-learning: Adaptation of Content According to the Continuous Evolution of the Learner during his Training. *Proceedings of the 3rd International Conference on Networking, Information Systems & Security*, 1–6. https://doi.org/10.1145/3386723.3387890

Zhang, L., Basham, J. D., & Yang, S. (2020). Understanding the implementation of personalized learning: A research synthesis. *Educational Research Review*, *31*. https://doi.org/10.1016/j.edurev.2020.100339

Zhang, L., Zeng, X., & Lv, P. (2022). Higher Education-Oriented Recommendation Algorithm for Personalized Learning Resource. *International Journal of Emerging*

ISSN 3028-0168 (Print) | 3028-0176 (Online)
Volume 3, Issue 1 | AY 2022-2023

Technologies in Learning, *17*(16), 4–20. https://doi.org/10.3991/ijet.v17i16.33179

Zhikharev, A. G., Deeney, I. A., Igrunova, S. V., Klyuchnikov, D. A., & Frolova, A. Y. (2021). To the development of intelligent adaptive learning systems. *Journal of Physics: Conference Series*, *2060*(1). https://doi.org/10.1088/1742-6596/2060/1/012012

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UTILIZING LEARNING STYLE THEORIES IN TERTIARY EDUCATION: TOWARDS ADAPTIVE LEARNING

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***Abstract*— The traditional one-size-fits-all learning model has always been the foundation of learning in higher education, despite the fact that the students at colleges and universities serve have become more diverse in terms of various characteristics. This may include differences in how they engage in learning such as learning styles, learning motivation or other learning preferences. Modern classrooms are becoming more complex and unpredictable environments for both students and teachers. As a result, one-size-fits-all learning becomes a less effective strategy to implement in the modern classroom with such diverse students, thus it needs transformation. Adaptive learning is one of the potential solutions to the issues with the traditional one-size-fits-all learning model to higher education. Adaptive learning is described as an educational technology that utilizes methods such as artificial intelligence, data analytics and algorithms to promote personalized learning. It can provide learners with a learning environment with enhanced learning efficiency and effectiveness. The concept of adaptive learning is considered as the transformation for future education. It shifts the focus from the traditional one-size-fits-all learning to personalized learning. This study was conducted to review and explore the learning style theories and the method to classify learning styles for adaptive learning for higher education.**

***Index Terms*—learning style theory, one-size-fits-all learning, adaptive learning, learner model.**

1. Introduction

The advancement of technology in the 21st century has a significant influence on Higher Education (HE). It enabled the transformation of the new Education 4.0, an era of education that is driven by e-learning, data analytics, artificial intelligence (AI), and other innovative data-driven solution that help support the learners and educators in the learning pedagogy. (Ciolacu et al., 2019) Since the introduction and the potential use cases of these innovative solutions, it has begun to revolutionize traditional teaching methods and learning models. Under these technological influences, higher education is beginning to dive deeper into a more AI-driven approach toward digitalization, automation, and intelligent education solutions. (Ocaña-Fernández et al., 2019) On the other hand, it is also important to note that while innovation in AI for higher education opens new opportunities and challenges, higher education is still exceptionally a human-centric endeavor and not a technology-centric solution. The role of technology such as A.I. in higher education is to assist the learning or teaching process. (Kong et al., 2022; Popenici & Kerr, 2017).

When examining the utilization of AI for higher education, its application may differ to various degrees. This could be for a strategic application or a direct teaching-and-learning application. Strategic applications may involve dealing with big data, statistical analysis, or advanced machine learning and deep learning approach to tackle problems such as student selection, dropouts, learning behavior analysis, academic performance, and any techniques that could redirect learners to a better learning journey. Conversely, a direct teaching-and-learning approach could deal with the facilitation or management of pedagogical processes, such as a better learning assistant. (Bates et al., 2020) Systematic review has revealed that the most adopted role of AI applications in higher education research is the prediction of learners' learning status which may also include learners' dropout and retention prediction, student modeling, and academic performance analysis. (Raj & Renumol, 2022)

However, in the recent years of research in the applications of AI in higher education has begun to shift its focus from prediction to improving academic performance by supporting personalized learning pedagogy through adaptive learning systems (Chu et al., 2022a), where AI models are now designed to examine the learners' diverse learning characteristics to enable personalized learning experience. (Bates et al., 2020) In addition, AI research in higher education has begun to concentrate on finding solutions to the problems with the traditional one-size-fits-all learning model through adaptive learning technology to improve learning effectiveness and efficiency. (Chu et al., 2022a). Adaptive learning is where AI models are designed to detect learners' learning characteristics to provide learners with personalized learning. (Chu et al., 2022b) Adaptive learning could help provide greater access to higher education and identify learners' potential in academic achievements.

1.1 One-size-fits-all model of Traditional Education

The concept of one-size-fits-all learning in education refers to an approach where curriculum and teaching methods are standardized and designed to cater to a large group of learners without considering their individual needs, abilities, or learning styles. (S. Yang et al., 2019) Higher education has always been based on a traditional education model of one-size-fits-all, while in contrast, the learners that colleges and universities serve are increasingly becoming more diverse in various characteristics. This includes diversity in culture, linguistic,

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economic, social, or in learning context this also includes, learning motivation, learning styles, or learning preferences, thus making the modern classrooms a complex and unpredictable learning environment for both learners and educators. (Ankrum et al., 2020)

One-size-fits-all learning model is argued as an impartial access to the learning process. (Ali et al., 2021) This educational model is inflexible to accommodate a complex group of learners, and views learner with the same phases of learning, rather than individuals with differentiated cognitive and affective capabilities and needs. (Sykes et al., 2015) Consequently, the effectiveness of curriculum design may be compromised, even with the application of the Taxonomy of Educational Objectives as the design tool in such a diverse and large class setting. (J. Liu et al., 2020) Moreover, even when the learning materials and assessments are properly designed using the taxonomy of learning objectives, it is a challenge for educators to provide a learning path, contents, and learning assessments that are personalized for individual learners in the traditional or virtual learning classroom and many popular online learning management system (LMS) platforms utilized in colleges and universities fails to recognize these crucial aspects of learning. (Almohammadi et al., 2017; Maaliw III, 2020) Unfortunately, one-size-fits-all learning model may not be fit for the diverse demands of learning of the learners to individually accommodate their cognitive and affective needs. (Li, 2019)

1.2 Adaptive Learning

Adaptive learning is an AI-driven learning technology that is designed to analyze learners' diverse nature of learning features such as learning behavior, learning styles, or preferences by using the data to dynamically modify learning contents, path, and assessments at any time to adapt to individual learners' learning needs, abilities, and differences in learning performance. (Becker et al., 2017) It promotes the educational paradigm of personalized learning that aims to support learners in an individual level both with automated and instructor interventions. (Abadia & Liu, 2021; Mirata et al., 2020; Qu et al., 2019) Adaptive learning can range from a preconceived rule-based approach to more complex self-learning AI-based algorithms. AI-driven Adaptive learning is more effective than the traditional LMSs and conventional classroom instructions. (Nazaretsky et al., 2021) When applied correctly to an online learning environment, adaptive learning can support individual learners with personalized learning experiences and flexibility (Abadia & Liu, 2021)

Research in adaptive learning has emphasized its potential to change higher education for over a decade. (Qu et al., 2019) Though the empirical impact of adaptive learning is still limited, mainly since adaptive learning is still in early development, educational institutions are now being driven more and more by artificial intelligence methods and the continuously growing demand for an adaptive and personalized learning environment is being observed. (Ciolacu et al., 2019) Higher education institutions are now increasingly interested in considering adaptive learning as an innovative AI-driven method for teaching and learning for 21st-century higher education. (Mirata et al., 2020)

2. Literature Review

The academic performance of the learners can be at risk when there is a mismatch between their learning characteristics and the method of instruction or curriculum. (Tulabing, 2018) It has been argued that student learning traits, such as learning styles, have a significant impact on the learning process. When learning is delivered with consideration for the diverse learning characteristics of the learners not only in their cognitive but also in their affective characteristics, this can promote motivation and interest among learners of how they perceive, process, and retain information, thus may positively affect their academic performances. (Peng et al., 2019) Conversely, when educators are aware of these learning characteristics, they can create personalized learning materials and assessments that could meet the diverse learning needs of the learners. (Willems, 2023; Zhang et al., 2020). This educational model has been investigated by several research regarding its implications to the learning process, these can be summarized into:

1. Every student is unique in learning preferences. learners are different both in terms of how they approach learning and their preferred learning methods, and one-size-fits-all learning may limit their academic potentials. Understanding and considering student's characteristics such as learning styles is a crucial aspect of learning to achieve an effective and more efficient learning process to develop their cognitive and affective capabilities. (Almohammadi et al., 2017; J. Liu et al., 2020)
2. Curriculum designs with general instructional materials and learning assessments used in a classroom with diverse characteristics of learners may not be as effective individually. Each learners may learn differently and unique in many aspects. (Nazaretsky et al., 2021) A learning content or assessments that works well for some learners may not work as well for others who would be much more effective in a different learning approach. (Kolekar et al., 2017)

It's important to move beyond the inflexible one-size-fits-all model of education towards a more learner-centered paradigm (S. Yang et al., 2019) in which emphasis is placed on curriculum with personalized instructional content, pace, and assessment to establish learning that focuses more on the learners first rather than the educators. (Alamri et al., 2020; Sykes et al., 2015; Wouda et al., 2023) Adaptive learning is one of the potential solutions to the issues with the traditional one-size-fits-all learning paradigm to higher education and provide learners with personalized learning environment with enhanced learning efficiency and effectiveness. (Chu et al., 2022a)

2.1 Adaptive Learning: The Challenge to the paradigm of One-size-fits-all Learning

Adaptive learning is described as an educational technology that utilizes methods such as artificial intelligence, data analytics and algorithms to promote personalized learning. This can include personalization of learning path, learning contents,

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and/or learning assessments which aims to provide a more efficient learning process that fits according to individual learning preferences and needs.(Khosravi et al., 2020) The goal of this educational technology is to innovate from the traditional "one-size-fits-all" approach to learning, to personalized learning. (Dziuban et al., 2017) Adaptive learning could also fit well with online, face-to-face, or blended learning. (Pandit & Bansal, 2019) In addition, it aims to provide learners with its "exclusive teacher" learning experience. (Zhao & Wang, 2019) Establishing the concept of adaptive learning and shifting the focus from the traditional one-size-fits-all learning to personalized learning is considered as the transformation for future education (S. Yang et al., 2019).

Though the term "adaptive learning" is challenging to describe because this technology is still currently being explored, there are no established standards or taxonomies for describing or designing adaptive learning systems. Research description may vary depending on its research focus and objectives. For example, EdSurge, (2016) classify adaptive learning into three categories: personalized learning resources, learning paths, and learning assessments, while (Khosravi et al., 2020) separate adaptive learning systems into four categories depending on the adaptive algorithms: decision tree systems, advanced algorithm systems, machine learning systems, and rule-based systems. Therefore, it has become increasingly important to verify that systems termed "adaptive learning" correspond to the same fundamental characteristics as the effort has expanded to a more institutional level.

2.1.1 Learning Style Theories: The Catalyst for Adaptive Learning

It is complicated for curriculum design to be held responsible for the academic failure among learners; rather, it is the ineffective instructional strategies that do not match the student's learning preferences. Minimal learning could be observed when the teaching method does not accommodate a certain learning need. (Oweini & Daouk, 2016). "Style" refers to an individual's distinctive characteristics or means of interacting with the world, and "learning styles" refer to such qualities or ways of interacting with learning, as characterized by various learning style theories (Nongkhai & Kaewkiriya, 2015). Learning styles, often referred to as cognitive or intellectual styles, are a personality variation on how people perceive, organize, process, and recall information. (Al-Azawei, 2016; Schunk, 2012) Learning style have been extensively studied by researchers who are interested in designing personalized learning. In addition, researchers believe that one aspect of success in terms of academic performance in higher education is understanding the learners' learning styles. Several learning styles theories can be utilized to identify these learning styles. The most popular are shown in table 1.

Table 1: Learning Style Theories

Learning Styles	***Classifications and Dimensions***
Felder–Silverman Learning Style Theory	Input (visual or verbal), processing (active or reflective), perception (sensory or intuitive), organization (sequential or global)
Fleming Learning Style Theory	visual, aural, reading/writing, and kinesthetic
Kolb Experiential Learning Theory	divergers, assimilators, convergers, and accommodators
Myers-Briggs Learning Style Theory	extraversion or introversion, judging or perceptive, feeling or thinking, sensing or intuition
Honey and Mumford Learning Style Theory	theorists or pragmatists, actors, or reflectors
Dunn and Dunn Learning Style Theory	Society, physiology, psychology, environment, emotion

Dunn and Dunn's Learning Style Theory suggest that five classifications can affect a learner's learning style: environmental influences, biological factors, psychological aspects, emotional elements, and social aspects and the fact that the Dunn and Dunn model (1979) was developed through classroom experience and has subsequent ecological validity is one of the reasons it is one of the most popular. (Dunn & Dunn, 1979) On the other hand, Felder and Silverman (1988) proposed the Index of Learning Styles (ILS) as a tool to classify the learning style. Felder–Silverman theory suggests that learning style has four (4) major classifications as shown in table 2. (Felder & Silverman, 1988)

Table 2: Felder-Silverman (1988) Index of Learning Styles

Classification	Description
Processing (active/reflective)	**Active learners** can start their assigned tasks promptly and enjoy collaborating with others. They need to experiment to understand. **Reflective learners** need to be taught how to experiment; they take their time to begin activities, and they prefer doing their own work
Input (visual/verbal)	Information presented using visual methods is understood better by **visual learners**. **Verbal learners** prefer reading and listening to learn.
Perception (sensing/intuitive)	**Sensory learners** heavily rely on their four senses to make decisions and perceive information. While it is easier for **intuitive learners** to recognize and decipher symbols and texts
Understanding (sequential/global)	**Sequential learners** are those who learn in sequence to organize the data to understand generalized data. On the other hand, **global learners** arrange the data according to general principles to produce additional, more in-depth information

Another learning style model was developed by Fleming & Mills, (1992) called the VARK model. According to the author, learning styles have four dimensions namely, visual, aural, reading/writing, and kinesthetic as the VARK abbreviation stands for as shown in table 3. The VARK model also suggests that learners may prefer multiple learning styles (unimodal, bimodal, or multimodal). (Hasibuan et al., 2019; Mozaffari et al., 2020)

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Table 3: Fleming & Mill (1992) VARK Learning Style Model

Classification	Description
Visual	Learners who prefer visual aspects to learn such as image information, and other variations of illustrations. Visual learners can interpret better with diagrams
Aural	These learning styles prefer the audio techniques to learn. They choose learning contents with audio as a guidance. This can include discussions or conversations, lectures via voice, and oral presentations.
Read/Writing	This classification of learners prefers to learn through reading and writing information. To learn more effectively, they typically turn to notes, diagrams, and various types of writing. These individuals prefer activities involving texts, reading, abstraction, articles, or any other form of textual input
Kinaesthetic	Learners with this learning style need movement, physical touch, and interaction with the environment to process information and create knowledge. Activities such as hands-on, problem-solving, demonstrations, or physical activities are best suited for learners with this learning style

Kolb's Experimental Learning Theory (Kolb, 1984) as shown in table 4 separates the learning cycle into four major methods that start with Concrete Experience (CE), moving toward Reflective Observation (RO), then Abstract Conceptualization (AC), and finally to Active Experimentation (AE). Individual learning styles are classified into 4 fundamental learning styles based on how well each learner performs on the two elements of perception and information processing (Min et al., 2018):

Table 4: Kolb's (1984) Experimental Learning Theory

Classification	Description
Divergers	learners that prefer concrete experience (CE) and reflective observations (RO)
Assimilators	A learner that prefers reflective observation (RO) and abstract conceptualization (AC)
Converger	Learners that prefer abstract conceptualization (AC) and active experiments (AE)
Accommodators	Learners that prefer concrete experiences (CE) and active experimentation (AE)

Myers-Briggs Learning Style Theory (1943) is based on Jung's theory of personality. This theory suggests that learning styles are separated into eight (8) classifications: extraversion or introversion, sensing, or intuition, judging or perceptive, and feeling or thinking. This learning theory is mostly concerned with psychological factors related to study, with emphasis on the learner's emotion, perception, motivation, and psychological characteristics connected with learning styles. (Min et al., 2018) Lastly, the (Honey & Mumford, (1982) was based on (Kolb, 1984)experimental learning theory as the foundation for the learning style as shown in table 5. (Dantas & Cunha, 2020)

Table 5: Honey & Mumford, (1982) Learning Style Theory

Classification	Description
Activist	Learning occurs most effectively in situations involving actual action when trying new things, making mistakes, and getting things right are most valued. Group discussion exercises, puzzles, problem-solving, and brainstorming are preferable cognitive inputs that are valuable for activists' learning styles
Reflector	This style of learning chooses a mixture of observation and thinking to enable learning. Before making a choice, they consider multiple options and outcomes. Reflectors prefer activities without deadlines that give them time to research and consider, look back, observe, and review what happened
Theorist	Learning from descriptive models, theories, statistical data, evaluation, and synthesis is much more comfortable for theorist learners. These types of learners must understand the reasoning behind their actions. The learning activities best suited for these learners include debates, reading, or case studies, that give them time to reflect, seek out hypothetical justifications, create models, and base problem-solving
Pragmatist	Pragmatic learners put their analytical skills to work in problem-solving and innovation. Pragmatists prefer activities that have a direct connection between the topic and an urgent need, use techniques to solve current issues, and have clear guidelines

The one-size-fits-all approach assumes that learners in traditional classrooms or online learn in a similar way to how other learners learn and ignores the possibility that learners learn in a way that varies from one learner to another. Understanding and consideration of the learners' learning styles can give way to a new adaptive and personalized learning environment. It has been observed that integrating learning styles into adaptive learning helps learners improve the learning process.(Kika et al., 2019) An understanding and consideration of the learning styles to instructional strategies are considered essential for personalized learning. Learning style has been utilized by adaptive learning to help identify the most efficient learning process to involve the students. (Kika et al., 2019) But which among the learning style theory, out of the many that exist, has been the most widely used and effective?

2.1.2 Learning Style Theories: Which learning style theory is the most adopted?

Which learning style theory is the most effective and utilized for adaptive learning? (Zine et al., 2019) conducted a comparative study of the most influential learning style theories used in adaptive educational environments. The research aimed to answer the question, "*What learning style model is most appropriate for use in adaptive educational environments?*". These learning style theories including, Myers-Briggs Learning Style Theory, Felder-Silverman Learning Style Model, Kolb's Experiential Learning Theory and Honey and Mumford's Model. The study revealed that Felder-Silverman model is the most effective for adaptive learning. The paper argues that the Index of Learning Style (ILS) instrument shown in table 5 from Felder-Silverman has undertaken multiple studies and

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according to the literatures reviewed, it has proven to be effective for instructions and assessments designing in alignment with the learner's learning style. In addition, the result of the ILS instrument is simple to interpret, and the number of dimensions can be controlled and can be easily applied.

Table 6: FSLTM-Index of Learning Style (ILS) Sample Questions

Sample Questions	Sample Answer	Classification
I understand something better after I:	a) try it out. b) Think it through.	Active or Reflective
I prefer to study:	a) In a group b) alone	Active or Reflective
If I were a teacher, I would rather teach a course:	a) that deals with facts and real-life situations. b) that deals with ideas or theories	Sensing or Intuitive
In reading nonfiction, I prefer:	a) something that teaches me new facts or tells me how to do something. b) something that gives me new ideas to think about	Sensing or Intuitive
When I think about what I did yesterday, I am most likely to get:	a) a picture b) words	Visual or Verbal
When I get directions to a new place, I prefer:	a) a map b) written or verbal directions	Visual or Verbal
It is more important to me that an instructor:	a) lay out material in clear sequential steps. b) give me an overall picture and relate materials to another subject	Sequential or Global
When I solve problems:	a) I usually work my way to the solutions one step at a time. b) I often just see the solutions but then must struggle to figure out the steps to get to them	Sequential or Global

Felder and Silverman (1988) proposed the Index of Learning Styles (ILS) as a tool to classify the learning style. Felder–Silverman theory suggests that learning style has four (4) major classifications (Felder & Silverman, 1988) as shown in table 2.

(Kolekar et al., 2018) adopted and use Felder-Silverman Learning Style Model (FSLSM) to understand the learning style characteristics of Engineering learners to generate personalized learning materials based on learning styles. The research stated that FSLSM is a combination of three other models which combine the effectiveness of the other models. Similarly, (Kika et al., 2019) also adopted the Felder-Silverman Learning Style Model (FSLSM) to identify the learning style of the learners from the log data on MOODLE. The results were used in a classification algorithm (i.e., decision tree classifier and naïve bayes) to predict the preferred learning style of the learner and build adaptive learning content. Moreover, (Kika et al., 2019) argued that Felder–Silverman's model is largely used by researchers for learning style classification.

Several learning style models have been thoroughly examined throughout research history but for the classification of learning styles in adaptive learning, the Felder-Silverman learning style model (FSLSM) is arguably the most suggested. In addition, understanding learners' learning styles has become the fundamental catalyst in designing and implementing adaptive learning. (Khamparia & Pandey, 2020; Kolekar et al., 2018; Maaliw III, 2020; Zine et al., 2019)

2.2 Implicit Modelling Approach to Identify the Learning Style

A learner model can consist of several characteristics, but the most adopted characteristics is the learning style and has become the foundation of many learner models to support personalized learning. (Ding et al., 2018; Ulfa et al., 2019) While most learner modelling techniques involves explicit techniques, it is suggested that utilizing implicit techniques to classify and analyses the learning characteristics is recommended for future models to enable a more flexible and dynamic learner model. (Afini Normadhi et al., 2019; Katsaris & Vidakis, 2021) This will enable the adaptive learning to evolve along with the learner. For example, using machine learning technique such as decision tree classifier or naïve bayes to classify the learning style of the students instead of relying only on the ILS questionnaire which is only facilitated prior to engaging into the adaptive learning. This will make the learner model implicit and evolve or change along the learning process. (Kika et al., 2019)

Nguyen, (2022) proposed a model to detect learning styles in a blended learning course to classify the learner for personalization of the course. The proposed learner model has two detection process for the learning style: first is the literature-based approach using the FSLSM index of learning style (ILS), second is the data driven-based approach using the activity logs and learning behavior from the Moodle and using clustering (k-means) to identify similarities among the behaviors and then using support vector machine (SVM) technique to analyses the data of a particular learner based on the behavior to determine the learning style. The study also pointed out that, however the first approach is explicit, the method is still suitable for initial classification process for the student if no record exists or if new student is introduced to an adaptive learning environment. The study also presented parameters to map the learning materials, resources, and assessments in a blended-learning course to the learning style according to the learning behaviors of the learner recorded from Moodle system. The result of the study was able to detect 3 group of students with the same learning style, and the implementation of automatic detection of learning style using the model has produced an accuracy of 83.2%. The study also pointed out that the process will enable the students to change the learning style depending on their learning behavior along the learning process.

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From a different study, H. Chen et al., (2019) introduced a learning style model to represent features of online learners, and an enhanced recommendation method named Adaptive Recommendation based on Online Learning Style (AROLS) which provide personalized learning recourses by mining learner's behavior data from the online learning management system. The model creates a cluster using k-means technique according to their online learning style based on their learning behavior pattern, second a collaborative filtering method and association rule mining extracts the preferences and behavioral pattern of each cluster and uses it to provide personalized learning materials based on their shared characteristics. The experiment shows that AROLS achieves the best recommendation precision among other tested methods and has proved the value of integrating the leaning style in learning resources recommendation. The proposed method not only identifies the learning style but also identifies patterns in their learning behavior.

In a different approach, Hasibuan et al., (2019) proposed a modelling method using prior knowledge to predict the learning style using artificial neural network (ANN) as shown in figure 12. According to the study, the automatic detection of learning style (VARK) models are approaches that are based on interactions with the adaptive systems through teaching materials, discussions, forums, quizzes, and online chats. This approach is also classified as external approaches. The study used internal approach where detecting students learning style is derived from personality and attitude of learners through prior knowledge (PK). To confirm that the detected learning style is appropriate, confirmation is made by giving online questions by adopting the VARK learning style questionnaire. Although the result of the study has stated that it has successfully detected the learning style, it did not present any comparative analysis.

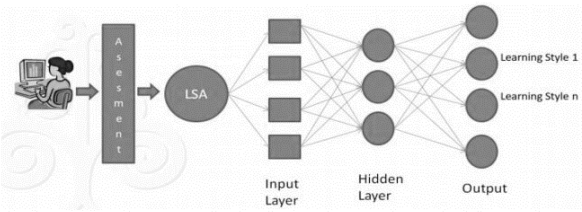

Figure 1: Detection of learning style using ANN (Hasibuan et al., 2019)

Maaliw III, (2020) adopted classification technique using J48 decision tress algorithm to develop a model that detects the learning style of the learner using behavioural learning pattern from an online learning environment of five hundred seven (507) tertiary students. The model is used to provide adaptive content to the learner. The model was also implemented using a prototype through an adaptive learning framework and proposed an architectural design of an adaptive virtual learning environment. The result has also presented an interesting mapping of learning behaviour to the learning style as shown in table 7 showing that learning behaviours can be correlated with learning style.

Table 7: Mapping of learning Style to Learning Behavior (Maaliw III, 2020).

Learning Style	Behaviour	Learning Style	Behaviour
Active	Post more often in discussion	Reflective	Reading post but rarely posting
	Perform more self-assessment test		Prefer learning materials in textual form
Sensing	Prefer concrete learning materials (facts and data)	Intuitive	Prefer abstract learning materials
	Prefer examples		Prefer to review answers in graded exercises
Visual	Prefer learning materials with pictures, diagrams, and graphs	Verbal	Prefer learning materials in text or audio form
	Prefer learning materials presented in video format		Post more often in discussion forums
Sequential	Prefer to go through the course step by step	Global	Prefer overviews, and outlines
			Prefer to learn in large leaps by skipping learning materials and jumping into more complex materials

Another study (Sweta & Lal, 2017) presented a learner modelling technique by dynamically detecting the learning style using the learner's navigational access data and learning behavioral patterns using fuzzy cognitive maps and fuzzy inference system and provides personalization according to their learning style in the learning process. The result shows that the learner efficiently access relevant information according to their learning style which enhances their learning process effectively, thus improving learning engagement.

2.3 Learner Model

While it is possible to identify learning style using the explicit method through ILS questionnaire, this process doesn't consider the learning behavior of the students. This learning behavior can be identified during learning process thus, the learning style could also be identified. By allowing the students to implicitly express their learning behavior, this would allow the learning style to change or evolve along with the students as the learning progresses.

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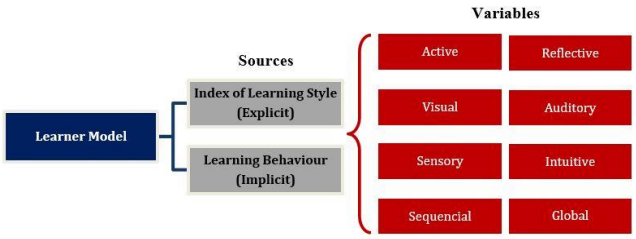

Figure 2: Adaptive Source: Proposed Learner Model

Moreover, these learning style can also potentially evolve or change during the learning process depending on different circumstances. Learning style can also be observed and classified based on their learning patterns or behavior. These independent variables are the adaptive source or the learner model from the proposed framework. Therefore, this research considers the index of learning style and learning behavior as the independent variables.

3. Conclusions and Future Research

It is important to move beyond the inflexible one-size-fits-all model of education towards a more learner-centered approach to learning in which emphasis is placed on personalized instructional content, pace, and assessment to establish learning that focuses more on the learners first rather than the educators. Adaptive learning can potentially provide the technological solutions to the issues with the traditional one-size-fits-all approach to higher education and provide learners with personalized learning experiences and enhanced learning efficiency and effectiveness.

This review has revealed several theories and approaches to examine the learning styles and designs of the learner model. While there are several learning style theories utilized to identify the learning style, the Index of Learning Style (ILS) from FSLSM is the most adopted and recommended technique for higher education students. In addition, understanding learning styles has become the fundamental catalyst in designing and implementing adaptive learning. (Khamparia & Pandey, 2020; Kolekar et al., 2018; Maaliw III, 2020; Zine et al., 2019)

Moreover, it has been observed that learning style can be detected and classified not only through literature-based approach such as the ILS but also from data-driven approach or implicit technique such as machine learning techniques by examining the learning behaviours from e-learning systems. By analysing various data sources, including interactions, performance, and learning responses, machine learning algorithms can detect patterns and correlations that reveal individual learning style from an online learning environment, and machine learning models can be trained to identify these distinct learning styles.

Implicit Learner Modelling would allow adaptive learning to dynamically personalize learning content, methods of assessments and learning engagements to match each student through continuous data analysis and feedback allowing a more flexible learner model that evolves along with the progression of the student. In addition, if no data exist about the learning style of the students, the ILS is still considered an effective technique for classifying learning style. Both ILS approach (explicit) and machine learning approach (implicit) has shown effectiveness in different situations.

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References

Abadia, R., & Liu, S. (2021). Low Adoption of Adaptive Learning Systems in Higher Education and How Can It Be Increased in Fully Online Courses. *Proceedings of the 29th International Conference on Computers in Education. Asia-Pacific Society for Computers in Education*, *1*, 569–578.

Afini Normadhi, N. B., Shuib, L., Md Nasir, H. N., Bimba, A., Idris, N., & Balakrishnan, V. (2019). Identification of personal traits in adaptive learning environment: Systematic literature review. *Computers and Education*, *130*, 168–190. https://doi.org/10.1016/j.compedu.2018.11.005

Alamri, H., Lowell, V., Watson, W., & Watson, S. L. (2020). Using personalized learning as an instructional approach to motivate learners in online higher education: Learner self-determination and intrinsic motivation. *Journal of Research on Technology in Education*, *52*(3), 322–352. https://doi.org/10.1080/15391523.2020.1728449

Al-Azawei, A. (2016). *Modelling E-Learning Adoption: The Influence of Learning Style and Universal Learning Theories* [Doctoral dissertation]. University of Reading.

Ali, S., Gulliver, S. R., Uppal, M. A., & Basir, M. (2021). Research investigating individual device preference and e-learning quality perception: can a one-solution-fits-all e-learning solution work? *Heliyon*, *7*(6). https://doi.org/10.1016/j.heliyon.2021.e07343

Almohammadi, K., Hagras, H., Alghazzawi, D., & Aldabbagh, G. (2017). A survey of artificial intelligence techniques employed for adaptive educational systems within e-learning platforms. *Journal of Artificial Intelligence and Soft Computing Research*, *7*(1), 47–64. https://doi.org/10.1515/jaiscr-2017-0004

Alshalabi, I. A., Hamada, S., & Elleithy, K. (2015). Automated Adaptive Learning using Smart Shortest Path Algorithm for Course Units. *2015 Long Island Systems, Applications and Technology*, 1–5.

Ankrum, J. W., Morewood, A. L., Parsons, S. A., Vaughn, M., Parsons, A. W., & Hawkins, P. M. (2020). Documenting Adaptive Literacy Instruction: The Adaptive Teaching Observation Protocol (ATOP). *Reading Psychology*, *41*(2), 71–86. https://doi.org/10.1080/02702711.2020.1726845

ISSN 3028-0168 (Print) | 3028-0176 (Online)
Volume 3, Issue 1 | AY 2022-2023
FACULTY RESEARCHES

Apoki, U. C., Al-Chalabi, H. K. M., & Crisan, G. C. (2020). From Digital Learning Resources to Adaptive Learning Objects: An Overview. *Communications in Computer and Information Science*, *1126*, 18–32. https://doi.org/10.1007/978-3-030-39237-6_2

Bates, T., Cobo, C., Mariño, O., & Wheeler, S. (2020). Can artificial intelligence transform higher education? *International Journal of Educational Technology in Higher Education*, *17*(1), 1–12. https://doi.org/10.1186/s41239-020-00218-x

Becker, A., Cummins, M., Davis, A., Freeman, A., Hall Giesinger, C., & Ananthanarayanan, V. (2017). NMC horizon report: 2017 higher education edition. *The New Media Consortium*, 1–60.

Bian, C., Dong, S., Li, C., Shi, Z., & Lu, W. (2017). Generation of adaptive learning path based on concept map and immune algorithm. *In 2017 12th International Conference on Computer Science and Education (ICCSE)*, 409–414.

Bian, C. L., Wang, D. L., Liu, S. Y., Lu, W. G., & Dong, J. Y. (2019). Adaptive learning path recommendation based on graph theory and an improved immune algorithm. *KSII Transactions on Internet and Information Systems*, *13*(5), 2277–2298. https://doi.org/10.3837/tiis.2019.05.003

Boussakssou, M., Hssina, B., & Erittali, M. (2020). Towards an Adaptive E-learning System Based on Q-Learning Algorithm. *Procedia Computer Science*, *170*, 1198–1203. https://doi.org/10.1016/j.procs.2020.03.028

Cai, R. (2018). Adaptive learning practice for online learning and assessment. *ACM International Conference Proceeding Series*, 103–108. https://doi.org/10.1145/3231848.3231868

Carvalho, L., Martinez-Maldonado, R., Tsai, Y. S., Markauskaite, L., & De Laat, M. (2022). How can we design for learning in an AI world? *Computers and Education: Artificial Intelligence*, *3*. https://doi.org/10.1016/j.caeai.2022.100053

Cavanagh, T., Chen, B., Lahcen, R. A. M., & Paradiso, J. (2020). Constructing a Design Framework and Pedagogical Approach for Adaptive Learning in Higher Education: A Practitioner's Perspective. *The International Review of Research in Open and Distributed Learning*, *21*(1), 172–196. https://doi.org/10.19173/irrodl.v21i1.4557

Chen, H., Yin, C., Li, R., Rong, W., Xiong, Z., & David, B. (2020). Enhanced Learning Resource Recommendation Based on Online Learning Style Model. *Tsinghua Science and Technology*, *25*(3), 348–356. http://creativecommons.org/licenses/by/4.0/

Choi, Y., & McClenen, C. (2020). Development of adaptive formative assessment system using computerized adaptive testing and dynamic bayesian networks. *Applied Sciences (Switzerland)*, *10*(22), 1–17. https://doi.org/10.3390/app10228196

Chu, H.-C., Hwang, G.-H., Tu, Y.-F., & Yang, K.-H. (2022a). Roles and research trends of artificial intelligence in higher education: A systematic review of the top 50 most-cited articles. *Australasian Journal of Educational Technology*, *38*(3), 22–44.

Chu, H.-C., Hwang, G.-H., Tu, Y.-F., & Yang, K.-H. (2022b). Roles and research trends of artificial intelligence in higher education: A systematic review of the top 50 most-cited articles. *Australasian Journal of Educational Technology*, *38*(3), 22–44. https://doi.org/https://doi.org/10.14742/ajet.7526

Ciolacu, M., Ciolacu, M., Binder, L., & Svasta, P. M. (2019). Education 4.0 - Artificial Intelligence Assisted Higher Education: Early recognition System with Machine Learning to support Students' Success. *IEEE 24th International Symposium for Design and Technology in Electronic Packaging (SIITME)*, 23–30.

Connors, C. B. (2021). Summative and Formative Assessments: An Educational Polarity. *Kappa Delta Pi Record*, *57*(2), 70–74. https://doi.org/10.1080/00228958.2021.1890441

Ding, W., Zhu, Z., & Guo, Q. (2018). A New Learner Model in Adaptive Learning System. *In 2018 3rd International Conference on Computer and Communication Systems (ICCCS)*, 440–443.

Dunn, R., & Dunn, K. (1979). Learning styles/teaching styles: Should they be matched. *Educational Leadership.*

Dyulicheva, Y. (2019). The swarm intelligence algorithms and their application for the educational data analysis. *Open Education*, *23*(5), 33–43.

Dziuban, C., Moskal, P., Johnson, C., & Evans, D. (2017). Adaptive Learning: A Tale of Two Contexts. *Current Issues in Emerging ELearning*, *4*(1). https://scholarworks.umb.edu/cieeAvailableat:https://scholarworks.umb.edu/ciee/vol4/iss1/3

EdSurge. (2016). *Decoding Adaptive*. London: Pearson.

El-Sabagh, H. A. (2021). Adaptive e-learning environment based on learning styles and its impact on development students' engagement. *International Journal of Educational Technology in Higher Education*, *18*(1), 1–24. https://doi.org/10.1186/s41239-021-00289-4

Felder, R. M., & Silverman, L. K. (1988). Learning and teaching styles in engineering education. *Engineering Education*, *78*(7), 674–681.

Ferreira, H. N. M., Brant-Ribeiro, T., Araujo, R. D., Dorca, F. A., & Cattelan, R. G. (2017). An Automatic and Dynamic Knowledge Assessment Module for Adaptive Educational Systems. *Proceedings - IEEE 17th International Conference on Advanced Learning Technologies, ICALT 2017*, 517–521. https://doi.org/10.1109/ICALT.2017.86

Katsaris, I., & Vidakis, N. (2021). Adaptive e-learning systems through learning styles: A review of the literature. *Advances in Mobile Learning Educational Research*, *1*(2), 124–145. https://doi.org/10.25082/AMLER.2021.02.007

Khamparia, A., & Pandey, B. (2020). Association of learning styles with different e-learning problems: a systematic review and classification. *Education and Information Technologies*, *25*(2), 1303–1331. https://doi.org/10.1007/s10639-019-10028-y

ISSN 3028-0168 (Print) | 3028-0176 (Online)
Volume 3, Issue 1 | AY 2022-2023
FACULTY RESEARCHES

Khosravi, H., Sadiq, S., & Gasevic, D. (2020). Development and adoption of an adaptive learning system reflections and lessons learned. *SIGCSE 2020 - Proceedings of the 51st ACM Technical Symposium on Computer Science Education*, 58–64. https://doi.org/10.1145/3328778.3366900

Kika, A., Leka, L., Maxhelaku, S., & Ktona, A. (2019, August 22). Using data mining techniques on Moodle data for classification of student's learning styles. *Proceedings of International Academic Conferences 9211567, International Institute of Social and Economic Sciences.* https://doi.org/10.20472/iac.2019.047.010

Kolekar, S. V., Pai, R. M., & Manohara Pai, M. M. (2017). Prediction of Learner's Profile Based on Learning Styles in Adaptive E-learning System. *International Journal of Emerging Technologies in Learning*, *12*(6), 31–51. https://doi.org/10.3991/ijet.v12i06.6579

Kolekar, S. V., Pai, R. M., & Manohara Pai, M. M. (2018). Adaptive User Interface for Moodle based E-learning System using Learning Styles. *Procedia Computer Science*, *135*, 606–615. https://doi.org/10.1016/j.procs.2018.08.226

Kong, S. C., Cheung, W. M. Y., & Zhang, G. (2022). Evaluating artificial intelligence literacy courses for fostering conceptual learning, literacy and empowerment in university students: Refocusing to conceptual building. *Computers in Human Behavior Reports*, *7*(100223). https://doi.org/10.1016/j.chbr.2022.100223

Koushik, S. , & Patil, A. P. (2021). Adaptive Content Planning and Delivery With Assessment Methodology Using Swarm Intelligence on Cloud Computing. *Handbook of Research on Developing a Post-Pandemic Paradigm for Virtual Technologies in Higher Education*, 217–240.

Krouska, A., Troussas, C., & Virvou, M. (2019). Computerized Adaptive Assessment using accumulative learning activities based on Revised Bloom's Taxonomy. *In Knowledge-Based Software Engineering: 2018: Proceedings of the 12th Joint Conference on Knowledge-Based Software Engineering (JCKBSE 2018) Corfu, Greece 12*, *108*, 252–258.

Li, R. (2019). Adaptive learning model based on ant colony algorithm. *International Journal of Emerging Technologies in Learning*, *14*(1), 49–57. https://doi.org/10.3991/ijet.v14i01.9487

Liu, J., Loh, L., Ng, E., Chen, Y., Wood, K. L., & Lim, K. H. (2020). Self-evolving adaptive learning for personalized education. *Proceedings of the ACM Conference on Computer Supported Cooperative Work, CSCW*, 317–321. https://doi.org/10.1145/3406865.3418326

Liu, M., McKelroy, E., Corliss, S. B., & Carrigan, J. (2017). Investigating the effect of an adaptive learning intervention on students' learning. *Educational Technology Research and Development*, *65*(6), 1605–1625. https://doi.org/10.1007/s11423-017-9542-1

Louhab, F. E., Bahnasse, A., & Talea, M. (2018). Towards an Adaptive Formative Assessment in Context-Aware Mobile Learning. *Procedia Computer Science*, *135*, 441–448. https://doi.org/10.1016/j.procs.2018.08.195

Maaliw III, R. R. (2020). Adaptive Virtual Learning Environment based on Learning Styles for Personalizing E-learning System: Design and Implementation. *International Journal of Recent Technology and Engineering (IJRTE)*, *8*(6), 3398–3406. https://doi.org/10.35940/ijrte.F8901.038620

Mahshanian, A., Shoghi, R., & Bahrami, M. (2019). Investigating the differential effects of formative and summative assessment on efl learners' end-of-term achievement. *Journal of Language Teaching and Research*, *10*(5), 1055–1066. https://doi.org/10.17507/jltr.1005.19

Maier, U., & Klotz, C. (2022). Personalized feedback in digital learning environments: Classification framework and literature review. *Computers and Education: Artificial Intelligence*, *3*. https://doi.org/10.1016/j.caeai.2022.100080

Martin, F., Chen, Y., Moore, R. L., & Westine, C. D. (2020). Systematic review of adaptive learning research designs, context, strategies, and technologies from 2009 to 2018. *Educational Technology Research and Development*, *68*(4), 1903–1929. https://doi.org/10.1007/s11423-020-09793-2

Mirata, V., Hirt, F., Bergamin, P., & van der Westhuizen, C. (2020). Challenges and contexts in establishing adaptive learning in higher education: findings from a Delphi study. *International Journal of Educational Technology in Higher Education*, *17*(32), 1–25. https://doi.org/10.1186/s41239-020-00209-y

Nazaretsky, T., Cukurova, M., Ariely, M., & Alexandron, G. (2021). Confirmation bias and trust: Human factors that influence teachers' attitudes towards AI-based educational technology. *AI for Blended-Learning: Empowering Teachers in Real Classrooms Co-Located with 16th European Conference on Technology Enhanced Learning*. https://www.fastcompany.com/90266263/brooklyn-students-walk-out-of-school-over-zuckerberg-backed-

Nongkhai, L. N., & Kaewkiriya, T. (2015). Framework for e-Leaming recommendation based on index of learning styles model. *Proceedings - 2015 7th International Conference on Information Technology and Electrical Engineering: Envisioning the Trend of Computer, Information and Engineering, ICITEE 2015*, 587–592. https://doi.org/10.1109/ICITEED.2015.7409015

Nurjanah, D. (2018). LifeOn, a ubiquitous lifelong learner model ontology supporting adaptive learning. *In 2018 IEEE Global Engineering Education Conference (EDUCON)*, 866–871.

Ocaña-Fernández, Y., Valenzuela-Fernández, L. A., & Garro-Aburto, L. L. (2019). Artificial Intelligence and its Implications in Higher Education. *Ournal of Educational Psychology-Propositos y Representaciones*, *7*(2), 553–568. https://doi.org/10.20511/pyr2019.v7n2.274

Oweini, A., & Daouk, C. (2016). Effects of the Dunn and Dunn Learning Styles Model on Reading Comprehension and Motivation: A Case Study in Innovative Learning.

ISSN 3028-0168 (Print) | 3028-0176 (Online)
Volume 3, Issue 1 | AY 2022-2023
FACULTY RESEARCHES

International Journal for Talent Development and Creativity, *4*(1), 63–70. www.learningstyles.net

Pandit, D., & Bansal, A. (2019). A declarative approach for an adaptive framework for learning in online courses. *Proceedings - International Computer Software and Applications Conference*, *1*, 212–215. https://doi.org/10.1109/COMPSAC.2019.00039

Peng, H., Ma, S., & Spector, J. M. (2019). Personalized adaptive learning: an emerging pedagogical approach enabled by a smart learning environment. *Smart Learning Environments*, *6*(1), 1–14. https://doi.org/10.1186/s40561-019-0089-y

Popenici, S. A. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning*, *12*(1), 1–13. https://doi.org/10.1186/s41039-017-0062-8

Qu, Y., Cai, R., & Haj-Hussein, M. (2019). Research and Practice of Applying Adaptive Learning in Computer Science and IT Degree Programs. *In 2019 IEEE Frontiers in Education Conference (FIE)*, 1–8.

Raj, N. S., & Renumol, V. G. (2022). A systematic literature review on adaptive content recommenders in personalized learning environments from 2015 to 2020. *Journal of Computers in Education*, *9*(1), 113–148. https://doi.org/10.1007/s40692-021-00199-4

Rastegarmoghadam, M., & Ziarati, K. (2017). Improved modeling of intelligent tutoring systems using ant colony optimization. *Education and Information Technologies*, *22*(3), 1067–1087. https://doi.org/10.1007/s10639-016-9472-2

Saito, T., & Watanobe, Y. (2020). Learning path recommendation system for programming education based on neural networks. *International Journal of Distance Education Technologies*, *18*(1), 36–64. https://doi.org/10.4018/IJDET.2020010103

Schunk, D. H. (2012). *Learning theories : an educational perspective*. Pearson Education, Inc.

Sein Minn. (2022). AI-assisted knowledge assessment techniques for adaptive learning environments. *Computers and Education: Artificial Intelligence*, *3*. https://doi.org/10.1016/j.caeai.2022.100050

Sweta, S., & Lal, K. (2017). Personalized Adaptive Learner Model in E-Learning System Using FCM and Fuzzy Inference System. *International Journal of Fuzzy Systems*, *19*(4), 1249–1260. https://doi.org/10.1007/s40815-017-0309-y

Sykes, C., Freeman, M., Simpson, L., & Hancock, P. (2015). Improving learning and teaching through a multi-institutional, discipline-specific project. *Journal of Higher Education Policy and Management*, *32*(2), 173–184. https://doi.org/10.1080/13600800903575512

Tackett, S., Raymond, M., Desai, R., Haist, S. A., Morales, A., Gaglani, S., & Clyman, S. G. (2018). Crowdsourcing for assessment items to support adaptive learning. *Medical Teacher*, *40*(8), 838–841. https://doi.org/10.1080/0142159X.2018.1490704

Talaghzi, J., Bennane, A., Himmi, M. M., Bellafkih, M., & Benomar, A. (2020). Online adaptive learning: A review of literature. *ACM International Conference Proceeding Series*, 115–120. https://doi.org/10.1145/3419604.3419759

Tempelaar, D. (2020). Supporting the less-adaptive student: the role of learning analytics, formative assessment and blended learning. *Assessment and Evaluation in Higher Education*, *45*(4), 579–593. https://doi.org/10.1080/02602938.2019.1677855

Tulabing, A. J. (2018). Learning Experiences, Learning Styles, and Academic Performance of the Students. *Graduate School Book of Abstracts*, *2*(1).

Ulfa, S., Barnabas Lasfeto, D., & Kurniawan, C. (2019). Modelling the learner model based ontology in adaptive learning environment. *Journal of Disruptive Learning Innovation (JODLI)*, *1*(1), 34–45.

Wang, H., & Fu, W. (2020). Personalized Learning Resource Recommendation Method Based on Dynamic Collaborative Filtering. *Mobile Networks and Applications*, *26*(1), 473–487. https://doi.org/10.1007/s11036-020-01673-6

Willems, J. (2023). Does style matter? Considering the impact of learning styles in e-learning. *The Australasian Society for Computers in Learning in Tertiary Education*, 1068–1069. http://www.deviantart.com/deviation/22354574

Wouda, N. A., Aslan, A., & Vis, I. F. A. (2023). An adaptive large neighbourhood search metaheuristic for hourly learning activity planning in personalised learning. *Computers and Operations Research*, *151*. https://doi.org/10.1016/j.cor.2022.106089

Yang, A., Flanagan, B., & Ogata, H. (2022). Adaptive formative assessment system based on computerized adaptive testing and the learning memory cycle for personalized learning. *Computers and Education: Artificial Intelligence*, *3*. https://doi.org/10.1016/j.caeai.2022.100104

Yang, S., Tian, H., Sun, L., & Yu, X. (2019). From One-size-fits-all Teaching to Adaptive Learning: The Crisis and Solution of Education in the Era of AI. *Journal of Physics: Conference Series*, *1237*(4). https://doi.org/10.1088/1742-6596/1237/4/042039

Yang, X., Zhou, Z., & Xiao, Y. (2021). Research on Students' Adaptive Learning System Based on Deep Learning Model. *Scientific Programming*, *2021*, 1–13. https://doi.org/10.1155/2021/6593438

Zhang, L., Basham, J. D., & Yang, S. (2020). Understanding the implementation of personalized learning: A research synthesis. *Educational Research Review*, *31*. https://doi.org/10.1016/j.edurev.2020.100339

Zhao, L., & Wang, H. (2019). Research on adaptive learning system based on three core modules. *Proceedings - 10th International Conference on Information Technology in Medicine and Education, ITME 2019*, 447–452. https://doi.org/10.1109/ITME.2019.00106

Zine, O., Derouich, A., & Talbi, A. (2019). A comparative study of the most influential learning styles used in adaptive educational environments. *International*

ISSN 3028-0168 (Print) | 3028-0176 (Online)
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Journal of Advanced Computer Science and Applications, *10*(11), 520–528. https://doi.org/10.14569/IJACSA.2019.0101171

Student Researches

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DEVELOPMENT OF BUREAU OF FIRE PROTECTION MANAGEMENT INFORMATION AND BILLING SYSTEM IN THE MUNICIPALITY OF SANTA CRUZ, MARINDUQUE

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Abstract – Records and information are the lifeblood of an organization. Protecting and managing these valuable assets is a must. The Bureau of Fire Protection Office as one of the government agencies, has encountered in managing records such as adding, and updating records, generating reports, recording billing or collection of fees, and monitoring nearly to expired certificates. The development of the Management Information and Billing Systems aims to solve the problems and help the organization to easily add, update, search, and retrieve a record and generating of reports, record client's information or transaction on fire code collection fees, bank deposit information, fire safety evaluation/inspection results, and issue certificate details, the monitors expiration date of the Fire Safety Inspection Certificate (FSIC), which will notify the BFP personnel five days before the expiration date, and to create a ledger that will display information about clients and establishments. The agile model was used in the development process; data gathering, interviews, and observation were used to analyze the existing system, and feasibility analysis was conducted to determine whether the developed system was feasible. Regarding testing, developers conducted alpha and beta testing and used ISO 9126 as the evaluation tool to evaluate the functionality, reliability, usability, efficiency, maintainability, and profitability of the developed system. As a result of feasibility analysis, the organization can recoup their investment in the developed system in 1 year and 11 months and was found to be financially viable. The system can accurately record information about the client/transaction, fire code collection fees and information about bank deposits, evaluation or inspection results, and details about a certificate issued. It also easily monitors the expiration date of the FSIC and notifies the BFP personnel five (5) days before expiration and monitors the 15 grace period from the result of the conducted inspection to 15 days notice to correct the violation and 15 days before proceeding to abatement. The system meets the organization's requirements that can help it efficiently and effectively improve its daily processes.

Keywords: bureau of fire protection, management information, billing system.

1.INTRODUCTION

Technology is important to optimize business operations for organizations. It is considered to be one of the advantages that companies need to grow their business and is widely used for management not just by companies but also by the government and other private organizations.

The Bureau of Fire Protection (BFP), also known as the "Kawanihan ng Pagtatanggol sa Sunog in Filipino," is a government body in the Philippines that is responsible for providing fire services. It was established on January 29, 1991, by the units of the Integrated National Police Office of Fire Protection Service [1]. BFP was created through Republic Act No. 6975, which created the present Interior Department [2]. This organization oversees a monthly report that includes fire safety evaluation and inspection activities, collections, deposits, and a summary achievement report (FSES). These reports include crucial data that the regional office of the Bureau of Fire Protection requires. In the Fire Code of the Philippines, or Republic Act 9514, the establishment must comply with these laws to ensure it has been duly inspected. A fire safety inspection certificate will be issued if the establishment has not violated these laws during the inspection [2]. There are two types of fire safety inspection certificates: the fire safety inspection for occupancy and the fire safety inspection for business. The establishment must renew the fire safety inspection for businesses every year. The Fire Safety Evaluation Clearance requires the construction of new and renovated establishments. The documents required in this application are three complete sets of building plans and specifications and the estimated cost of the building to be constructed or renovated as

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reflected in the bill of materials, including the labor cost signed by the contractor. The documents required by the Bureau of Fire Protection in applying for the Fire Safety Inspection Certificate are the duly completed application form, building permit, assessment of occupancy permit fee, fire safety evaluation clearance, certificate of compilation, and endorsement for building officials. Buildings, establishments, and households are all monitored by the BFP, just like any other government organization [2, 3].

The Bureau of Fire Protection in the BFP encountered difficulties in monitoring the expiration of the fire safety certificates of different establishments, which made it difficult for the Bureau of Fire Protection to easily identify what establishments have their fire safety inspection certificates expired and if they complied with Republic Act 9514. It will be inclined to delay the submission of reports, which will require the information of the specific establishment to the Bureau of Fire Protection, which will cause delays in submitting the report to the Regional Office. In addition, the BFP Santa Cruz is still using Excel files to record client information, fire code transactions, and create reports. It is challenging for BFP personnel to transfer data one at a time into required reports, which may result in inaccurate data. The data in the report must be correct because it must be submitted to the regional office.

Thus, the development of the Bureau of Fire Protection Management Information and Billing Systems helps reduce the paperwork, minimize problems currently facing the BFP Santa Cruz, minimize the time needed for creating reports, and relieve the workload of personnel. The system can accurately record information about the client/transaction, fire code collection fees and information about bank deposits, evaluation or inspection results, and details about a certificate issued.

2.METHODS AND PROCEDURES

2.1 Requirement Analysis

A variety of gathering of information approaches and a variety of analytical tools was used to aid and justify the study's conduct. Interviewing and observation were used to comprehend the organizational process. The officer-in-charge was interviewed, as well as other staff, to identify and analyze the business process. Some clients were observed during transactions to depict the information flow within the system and how the data is processed in current and newly designed system operations. The issues were experienced during recording and report generation. In addition, ICT resources were requested for the feasibility analysis. Furthermore, the organization was asked for sample forms and reports, which were used to reference the system's development.

2.2 Feasibility Analysis

Operational, technical, and economic feasibility was conducted to prove the feasibility of developing the Management Information and Billing Systems for the Bureau of Fire Protection.

SWOT Analysis in Table 2.1 was used to determine the Operational Feasibility. It was conducted to determine the strengths and weaknesses, how capable Property Owners and Occupants can adapt to the changes that the application might bring, and the opportunities and threats that may occur in using the application.

Table 2.1 *SWOT Analysis*

Strengths	***Weakness***
Computer literate and has ICT Resources. Open to innovation and willing to support and adopt the system	Unstable power. Difficulties in preparing reports are always experienced due to unsorted data and manual data input.
Opportunities	***Threats***

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Improve transactions in the effective and efficient delivery of services. Can be introduced to the other BFP stations in the different municipalities in Marinduque.	Unsecured and unorganized data storage. Delay in the printing and submission of reports Inaccurate results of creating reports.

The Bureau of Fire Protection had information and communication technology (ICT) resources. Technically speaking, it is viable because the organization has access to ICT resources, which are crucial for developing a system. Furthermore, the feasibility analysis could benefit the system after one (1) year and one (11) months. Using the developed system, the Bureau of Fire Protection Organization will gain the Return on Investment (ROI) after the following years.

2.3 Development and Testing

The methodology that the developers used was the agile model. The developers chose Agile Methodology in developing the system and met the time required to finish the development of the system. It involves requirements analysis, design, development, testing and debugging, release, and maintenance.

The developers conducted an interview and observation to gather information regarding the transaction process in the organization, how they manage data, monitor and generate reports, and identify the user's needs to meet their expectations for the developed system.

In the system design phase, the developers designed a user-friendly graphical interface that is intended for the users. Use case diagram, entity relationship diagram, and HIPO diagram were used to visualize the concept of the system. Visual Studio 2013, the Cascading Style Sheet (CSS), and the Hypertext Preprocessor (PHP) were used in developing the system. The Xampp Server and MySQL were cast off for creating the database, whereby all the data are stored in the system. System testing was also conducted to detect errors and bugs occurring in the system. This stage is important to ensure that the system is error-free. In addition, the manifestation of alpha testing was being performed to identify bugs before its implementation into the organization, as beta testing is performed by the end users in the organization.

3. RESULTS AND DISCUSSIONS

As a result of the development process, the system was developed with the following functions and requirements.

A. Functionality

The system is suitable, accurate, interoperable, and compliant with the software requirements. It has security wherein the unauthorized person cannot access the system.

B. Reliability

The system can bring back the failure encountered in operation, including network and data connection.

C. Usability

The user can easily understand the system. It was easily operated and easily integrated into the organization's environment.

D. Efficiency

The system can easily respond to user inputs promptly.

E. Maintainability

The system encountered errors can be easily identified and be able to adopt the changes made.

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Table 3.1 *ISO Evaluation Result*

Criteria	Mean (x)	Descriptive Rating
Functionality	4.41	Very Satisfactory
Reliability	4.38	Very Satisfactory
Usability	4.64	Very Satisfactory
Efficiency	4.46	Very Satisfactory
Maintainability	4.60	Very Satisfactory
Portability	4.37	Very Satisfactory
Overall Mean(x)	**4.48**	**Very Satisfactory**

The Development of the Bureau of Fire Protection Management Information and Billing System in the Municipality of Santa Cruz Marinduque gained an overall mean of 4.48, with a descriptive rating of "Very Satisfactory." It shows that based on the evaluation, functionality, reliability, usability, efficiency, maintainability, and portability were found to be very satisfactory.

4. CONCLUSIONS

The developed system can accurately record information about the client/transaction, fire code collection fees, bank deposit information, evaluation/inspection result, and certificate details. The developed system also efficiently monitors the expiration date of the FSIC and notifies the BFP personnel five (5) days before and views the client's information. The developed system can generate monthly reports of Collection and Deposits, Fire Safety Evaluation/Inspection Activities Accomplishment on Fire Code Fees Collection, a List of approved and disapproved applications, and a Summary of Achievement reports.

5. RECOMMENDATIONS

Based on the conclusions derived from the project, the following recommendations are hereby suggested.

1. Add additional functionality, specifically in generating notice to comply, notice to correct violations, and abatement orders.
2. The user to maintain the system and preserve the functionality and efficiency of the developed system.

REFERENCES

[1] Bureau of Fire Protection, Wikipedia., 2020. https://en.wikipedia.org/wiki/Bureau_of_Fire_Protection#:~:text=The%20BFP%20was%20formed%20from,fire%20services%20under%20its%20control.

[2] "Republic Act No. 6975 | GOVPH," Republic Act No. 6975 | Official Gazette of the Republic of the Philippines. https://www.officialgazette.gov.ph/1990/12/13/republic-act-no-6975/

[3] J. Jao, R. Monterozo, R. Perilla, Development of Fire Tax Collection and Information system for the Bureau of Fire Protection in Municipality of Sta. Cruz Marinduque, 2012.

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THE DEVELOPMENT OF COMPUTERIZED COMMUNITY AFFAIRS INFORMATION MANAGEMENT SYSTEM IN THE MUNICIPALITY OF TORRIJOS

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Abstract **-** The Development of Computerized Community Affairs Information Management System aims to address the challenge of identifying eligible beneficiaries and managing records for programs in the Municipality of Torrijos' Community Affairs Office. The system focuses on four programs: DOLE-TUPAD, SPES, Livelihood, and Scholarship programs. By implementing the system, the office aims to enhance its data processing, analysis, record-keeping, and service delivery to beneficiaries.

The project follows the Agile Methodology, which enables the developers to design and develop the system based on the organization's specific needs. The Agile model guides the project through phases such as requirements analysis, design, development, testing, deployment, and review. Data gathering and interviews were conducted to thoroughly understand the existing system and its requirements.

The Computerized Community Affairs Information Management System was developed and deemed financially viable. It enables the office to add and update records, monitor beneficiary status and program progress, automate scholarship records, and generate reports. The system underwent testing and evaluation using ISO 9126, which assessed its functionality, reliability, usability, efficiency, maintainability, and portability. The system received an overall mean average of 4.59, indicating an "Excellent" rating.

The system proved to be fully functional, meeting all organizational requirements, and was recommended for adoption. The developers provided suggestions for further improvement, including building a web-based version of the system and adding features like generating disqualification letters for the scholarship program and monitoring work performance. Future enhancements may include SMS notifications to inform applicants of the approval or disapproval of their applications.

The Community Affairs Office in Torrijos is encouraged to continue using the developed system for better record keeping, updating, filtering, and monitoring. The system has the potential to improve service delivery and facilitate more efficient operations. Future developers can build upon the existing system and incorporate additional features to enhance its functionality and usability.

Keywords: *Information Management System, Agile Methodology, ISO 912*

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1. INTRODUCTION

Information systems are crucial in today's business and government operations. They are used to manage information, interact with clients, and compete in the marketplace. Government offices in the Philippines have embraced technology to provide efficient services and fulfill their responsibilities. Torrijos, a coastal municipality in Marinduque, relies on fishing and farming as its main sources of income. The Community Affairs Office in Torrijos is responsible for disseminating information, organizing programs, and partnering with organizations to improve the community's quality of life. The office offers various programs, including financial assistance, livelihood programs, scholarships, and employment programs for students. The aim is to provide equal opportunities to the community, with each household having one beneficiary per year.

Republic Act No. 11315 emphasizes poverty reduction through social services and employment opportunities. It recognizes the need for a community-based monitoring system to target beneficiaries, analyze poverty levels, design policies, and ensure data privacy and quality. However, the Community Affairs Office in Torrijos faces challenges in identifying eligible beneficiaries due to the absence of a proper system. Similarly, the Ministry of East African Community Affairs struggles with file management, resulting in misfiling and difficulties in accessing required documents.

To address these issues, the developers created a computerized system that verifies beneficiaries, updates data, and manages programs efficiently. The system streamlines record-keeping, filtering, and monitoring, improving service delivery. The Agile Methodology guided the development process, ensuring the system met organizational requirements. The system was evaluated using ISO 9126, receiving an "Excellent" rating. Recommendations for future enhancements include a web-based version, additional features like generating disqualification letters and monitoring work performance, and SMS notifications for applicants.

Overall, the Computerized Community Affairs Information Management System enables the Community Affairs Office to provide better services and fulfill its responsibilities effectively.

2. METHOD AND PROCEDURES

2.1 Requirements Analysis

A communication letter was sent to the Community Affairs Office in the Municipality of Torrijos asking permission to conduct an interview and partnership. During the face-to-face interview conducted on April 25, 2022, some questions and information were asked to be analyzed and used in developing the system. All the information given by the Community Affairs Officer I was analyzed to understand the existing problems with the manual process done by the management of the office.

2.2 Feasibility Analysis Procedures

The feasibility analysis procedure was conducted to determine whether the developed system is feasible for the organization after several years. This feasibility analysis contains a procedure that focuses on the developed system's Technical, Operational, and Economic Feasibility.

Table 1. *SWOT Analysis of Operational Capabilities of the Organization.*

Strengths	Weaknesses
· There are enough computers and other hardware requirements available in the organization.	· The system is incompatible with the computer units.
· The focal person of the organization is actively coordinating with the developers.	· The user may experience difficulty using the system, so it may consume time to familiarize the software.
· The organization has enough budget for the system development and maintenance.	· Unstable electric power supply.

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Opportunities	Threats
· The work of employees will be done faster. · Easy to track the records of the beneficiaries of every program. · Provide computer-based recording and monitoring system.	· Difficulties in learning the process of the developed system. · Inaccurate results in terms of tracking the details of the employee · Conflict in the project's implementation.

Table 1 shows the SWOT analysis conducted by the developers for operational feasibility in knowing the organization's capabilities to operate the system. The Strengths are the excellent characteristics of the organization to operate the system, while the Weaknesses are the negative characteristics that the organization may encounter when using the system. On the other hand, the Opportunities are the potential improvement for the organization while using the system, while the Threats are the possible risks that the organization may encounter in the development and implementation of the project.

Table 2. *Cost and Benefit Analysis*

Description	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Total operational Cost of the Existing System		250,166.00	13,382.60	14,720.86	16,192.92	17,812.24
Total Operational Cost of the Developed System		6,780.00	7,458.00	8,203.80	9,024.18	9,926.60
Developmental Cost	23,750.00					
Projected Cost Benefit		243,386.00	5,924.60	6,517.06	7,168.77	7,885.64
Cumulative Benefit	(23,750.00)	219,636.00	225,560.60	232,077.66	239,246.43	247,132.07

Break Even Year = 1

$$\text{Break Even Ratio} = \frac{\text{Projected Cost Benefit - Cumulative Benefits}}{\text{Project Cost Benefits}}$$

$$= \frac{243{,}386.00 - 219{,}636.00}{243{,}386.00}$$

$$= \frac{23{,}750.00}{243{,}386.00}$$

$$= 0.10$$

Break Even Point = Break-Even Year + Break Even Ratio

= 1+ 0.10

= 1.10 or 1 year and 1 month

Table 2 shows the cost and benefit analysis of the system. The total break-even year that has been already computed above is 1 year and 1 month. The result of the computation in the break-even ratio is 1.10.

2.3 Development and Testing Procedures

The developers used Agile Methodology as a model to develop the concept of the system. The developers chose Agile Methodology in developing the system and met the time required to finish the development of the system. It involves requirements analysis, design, development, testing, deployment, and review.

The developers considered the organization's needs by determining the exact source of the problem being solved and what the organization expects to achieve using the system.

In the designing phase, the developers developed a prototype by designing a user-friendly graphical user interface intended for the users with the use of Adobe Photoshop CS6. The developers used Visual Studio for coding, using C# as the programming language to develop the system. Using the C#, the developers can fully design and create the system. MySQL and XAMPP were used to create the database. These development tools were relevant to develop and design the system.

The work breakdown structure and Gantt chart were used as a guide by the developers to keep track working with the development of the

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system. Work breakdown structure serves as a guide in organizing the activities or processes needed to develop the system. A Gantt chart was used in scheduling the processes and keeping the development of the system on track.

In the testing procedure, the Alpha and Beta testing was utilized to assure the reliability, functionality, usability, and acceptability of the developed system to the end-users. The system has been tested to eliminate errors that might arise while using and to look for further improvement and to assure that the system meets the expectations of the end-users based on their requirements.

3. RESULTS AND DISCUSSIONS

The Community Affairs Information Management System was developed as part of the development process with the following features and specifications.

3.1 Requirements Specification

3.1.1 Functional Requirements

- View the list of programs
  - The system views the list of the programs (DOLE, SPES, Livelihood, and Scholarship)
- Add/Update, View, and Search Household
  - The system allows the user to add new records of household heads and household members;
  - The system allows the user to view the list of households;
  - The system allows the user to update the record in the household;
  - The system allows the user to search in the list of households.
- Add/Update, View, and Search Beneficiaries of DOLE-TUPAD
  - The system allows the users to add new records of DOLE-TUPAD beneficiaries;
  - The system allows user to view the list of beneficiaries in the DOLE-TUPAD program;
  - The system allows the user to update the record of beneficiaries in DOLE-TUPAD;
  - The system allows the user to search the beneficiaries in DOLE-TUPAD;
- Add/Update, View, and Search Beneficiaries of SPES
  - The system allows the users to add new records of SPES beneficiaries;
  - The system allows the user to view the list of beneficiaries in the SPES program;
  - The system allows the user to update the record of beneficiaries in SPES;
  - The system allows the user to search beneficiaries in SPES.
- Add/Update, View, Search, and Monitor Beneficiaries of Livelihood
  - The system allows the users to add a new record of Livelihood beneficiaries;
  - The system allows the user to view the list of beneficiaries in the Livelihood program;
  - The system allows the user to update the record of beneficiaries in Livelihood;
  - The system allows the user to search for the beneficiaries of livelihood;
  - The system allows the user to monitor the income of the livelihood beneficiaries.
- Add/Update, View, Search, and Monitor Beneficiaries of Scholarship
  - The system allows the user to add a new record of Scholarship Beneficiaries;
  - The system allows the user to view the list of beneficiaries in the scholarship program;
  - The system allows the user to update the record of beneficiaries in the scholarship;
  - The system allows the user to search for the beneficiaries of the scholarship;
  - The system monitors the record of beneficiaries of scholarships.

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➢ Generate Reports
- The system allows the user to generate a yearly report of a list of beneficiaries for DOLE-TUPAD, SPES, Livelihood, Scholarship, and Livelihood Monthly Monitoring;
- The system allows the user to print reports;

3.1.2 Non-Functional Requirements

➢ Monitoring Technology
- The system should have a monitoring system that monitors the status of each program.

➢ Record Technology
- The system has a record system that allows the recording of the households and their members, a list of beneficiaries in DOLE-TUPAD, SPES, Livelihood, and Scholarship.

➢ Performance
- The system should respond to the user's request.

➢ Security
- The system should require a username and password to access the system.

3.2 User Acceptance Test Results

User Acceptance Testing was also carried out. The Head of the Community Affairs Office was shown the system. The developed technology was tested by several IT experts. The staff, IT specialists, and the head of the community affairs office were handed ISO 9126 instruments to collect their acceptance, opinions, and attribute ratings using the Likert scale. The results of the evaluators' ratings are summarized below.

Table 3. Summary of Mean scores of the system evaluation.

Criteria	Mean (X)	Descriptive Rating
A. Functionality	4.63	Excellent
B. Reliability	4.47	Very Good
C. Usability	4.69	Excellent
D. Efficiency	4.5	Very Good
E. Maintainability	4.6	Excellent
F. Portability	4.62	Excellent
Overall Mean	4.59	Excellent

Table 3 shows the result of the systematic evaluation of the concerned beneficiaries including the Community Affairs Office head and employees which was computed using weighted mean. Based on the evaluation, the system was found "Excellent" as to its functionality, usability, maintainability, and portability while the reliability and efficiency of the system were found moderately acceptable.

4. CONCLUSION

The developed system is designed to add records and filter applicants that are not eligible to be a beneficiary of DOLE-TUPAD, monitor the progress of the beneficiary, filter, and print generated reports related to DOLE-TUPAD beneficiaries, add and filter eligible applicants to the program, update the record of the beneficiary, filter and print the generated reports related to SPES beneficiaries, add and filter eligible applicants to the program, monitor the progress of the livelihood programs, add and filter eligible applicants to the program, track and monitor the status of the beneficiaries of the program, and filter and print the generated reports related to Scholarship beneficiaries. The system was tested and evaluated using ISO 9126 instrument and was described as

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"Highly Accepted" with an overall mean rating of 4.59 in terms of its functionality, reliability, usability, efficiency, maintainability, and portability. Thus, the use of the system is highly recommended.

5. RECOMMENDATIONS

The study concluded that future developers of similar software should gain knowledge of other software options and Visual Studio 2017 programming language for the development of new relevant systems. The intended users may maintain the developed system by adding additional features, the Community Affairs Office in Torrijos may continue to use the system, future developers may add additional features like SMS notification confirming application approval/disapproval, and future developers can strengthen and improve the developed system by building a Web-based version.

REFERENCES

[1] "What is Information System?," 20 July 2022. [Online]. Available: https://emeritus.org/in/learn/informationsystem/#:~:text=An%20information%20system%20is%20a,stay%20ahead%20of%20their%20competition.. [Accessed 11 October 2022].

[2] "Torrijos: province of marinduque," 2023. [Online]. Available: https://www.philatlas.com/luzon/mimaropa/marinduque/torrijos.html. [Accessed 15 February 2023].

[3] "Results of the 2020 Census of Population and Housing (CPH) in the Municipality of Torrijos," 26 January 2023. [Online]. Available: http://rssomimaropa.psa.gov.ph/content/results-2020-census-population-and-housing-cphmunicipality-torrijos. [Accessed 15 February 2023].

[4] "Republic Act No. 11315," 17 April 2019. [Online]. Available: https://psa.gov.ph/content/community-based-monitoring-system-act. [Accessed 26 February 2023].

[5] A. Sarah, "Analysing the File Management System at the Ministry of East African Community Affairs: The Registry Department," 2017. [Online]. Available: https://asbatlibrary.s3.eu-central-1.amazonaws.com/c2bf0c08-3285-4b81-9008-d159561f9516Ankunda%20SarahAnalysing%20the%20File%20Management%20System%20at%20the%20Ministry%20of%20East%20African%20Community%20Affairs%20The%20Registry%20Department%20%282%29.. [Accessed 2022 5 May].

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Wildlife Awareness Educational Simulation Game

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Abstract - The study "WILDLIFE AWARENESS SIMULATION GAME" aims to spread awareness to the people about the current situations that the endangered animal species are experiencing. The developers aim to develop a game that will be informative and challenging for users to enjoy while learning. A pre-survey was conducted to measure their awareness and knowledge about these animals. This way it will determine whether the game will become relevant and effective to the targeted respondents. This will also initiate the developers upon developing the proposed system. A feasibility analysis was conducted to determine if the developers had the required skills and knowledge to develop the project. The project had undergone a series of development and testing to be fully functional and ready to be released and tested by the targeted users. Unity Game Engine was used to develop the game, including the map/terrain, UI, etc. Krita software was used on the game's storyboard, animation, and art content. For modeling and textures of the game, Blender and Photoshop were used for creating the characters' models and assets for the game. C# programming language was used for the back end of the system. The game had to undergo testing procedures like Alpha and beta testing to ensure the system was operating as expected. As a result of the conducted testing, all the game's functionalities work and meet its desired outcome. The testers were the developers and IT professionals. The system's functionality, usability, and portability are all very satisfactory for the software quality evaluation. Most of the testers have tested that the system was functioning correctly and the controls were easy to understand.

Keywords: Wildlife, Simulation, Endangered Animals

I. INTRODUCTION

The Philippines has rich natural resources, such as rare animals and plants found nowhere else. It contains a wide range of ecosystems and habitats that supports the country's unique biodiversity. Ecosystems such as rainforests in our country are filled with unique creatures that live and maintain the wildlife environment's beauty. Through the years, the number of individual species in our country continues to decrease due to non-stop illegal activities that humans have caused. It is an issue that has been with us for over a decade but still needs to be solved because people tend to ignore it or need more awareness of the ecosystems in our country [1].

A vast number of species had been declared critically endangered for extinction. One of these endangered is the famous monkey-eating eagle, the Philippine Eagle. The Philippine eagle is one of the world's top 9 most giant eagles and has an incredibly long wingspan [2]. Eagles are known for playing a crucial role in keeping the ecosystem's delicate balance in check. They help regulate the species' population and provide

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umbrella protection to other life forms in its territory. The Philippine eagle is not the only species that has been declared critically endangered; also, eight different animal species are prone to the extinction of their kind [3].

All of these are caused by mistreating the natural environment and overusing natural resources that the animals need to survive. Illegal human activities such as deforestation and poaching are one of the biggest causes of our country's rapid decrease in wildlife. Pollution is also one of the reasons for the decline in the wildlife population because it destroys the ecosystem and habitats of wild animals [4].

These activities have been done for years with no control and continue to destroy the country's ecosystems and natural environment. It is all due to most people's need for more awareness and knowledge of the current wildlife situation in our country. They also tend to ignore the problem and the effects that it might do on not just our country but the whole world. They need to learn how vital wildlife animals are to the future of our country's natural environment and ecosystems. In an era marked by rapid technological advancements, the world urgently needs to conserve and protect our planet's invaluable biodiversity.

As human activities continue encroaching upon fragile ecosystems, educating individuals about the importance of wildlife conservation and fostering a sense of stewardship towards the natural world is crucial. Using technology as a tool for environmental education has emerged as a promising avenue to raise awareness and inspire positive change. Technology integration into education has revolutionized how people acquire knowledge and engage with various subjects.

Through the immersive power of digital platforms, the world now can transcend physical barriers and connect with people across the globe. Harnessing the potential of technology to address wildlife awareness can thus be a game-changer, unlocking innovative approaches to inspire environmental consciousness and empower individuals to make informed decisions.

This study showcases the current situation of Philippines Wildlife animals like the Philippine Eagle, Philippine Forest Turtle, Philippine Deer, and Visayan Warty Pig. It will provide awareness and knowledge on how to prevent the loss of these species. By analyzing various technological tools and platforms, like simulation games, the developers seek to shed light on the effectiveness and limitations of these interventions. By doing so, this project hopes to provide insights into how technology can be optimally leveraged to bridge the gap between humans and nature, fostering a sustainable coexistence.

II. METHODOLOGY

2.1 Requirement Analysis Procedure

To acquire the essential information for the Wildlife Awareness Educational Game, a set of open-ended questionnaires. The questionnaires were distributed via Google Forms using a variety of referrals and distribution methods. Before distributing the surveys, the respondents were asked for their permission to answer the questionnaires. After gathering the surveys, the collected data were carefully analyzed before incorporating them into the design of the Wildlife Awareness game.

A Work Breakdown Structure was prepared to know the project's scope based on the order of the tasks that must be completed. It is a document guide for the developer to accomplish the written statement of work.

The game will educate the user about wildlife creatures and allow them to continue through the game while learning about them. A review of related literature was conducted to gather information regarding wildlife awareness. Some articles were games about maintaining and preserving wildlife animals; thus, the data acquired there was utilized to increase their

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dependability.

A Story Board was created as well to serve as a guide in the possible graphical user interface and flow of the game. The flowchart was used to design the logical flow of the game. It will help identify the subsequent flow of each phase of the game.

The operation followed the developers' planning sequence, from distributing the questionnaire to collecting comments. Everything was accomplished by the researchers, from data gathering to implementation. Because no other games existed in the region, the creators created one to provide awareness and educate people to comprehend wildlife creatures.

2.2 Feasibility Analysis Procedure

Feasibility Analysis was conducted to determine whether the project is worth pursuing or feasible. Operational feasibility was used to determine if the developers met the requirements and capabilities for the project's development. It will measure whether the game is effective, whether it solves the problem of the study, and how it satisfies the requirements of the project's development. The researchers observed to determine whether the requirements and capabilities of the project were met. The gathered data will then be evaluated and analyzed to identify whether the game's development is feasible. The researchers used SWOT analysis to determine the game's strengths, weaknesses, and the opportunities and threats that will be encountered throughout the game's development.

All of the equipment and resources that will be needed were checked for the development, such as the software and hardware parts that will be implemented and used to develop the proposed game. Technical feasibility was also used to determine whether available technical resources were needed for the game's development. GAP analysis was also used to determine if the developer has the general requirements for operating and developing the game.

Lastly, Market Feasibility was used to measure the game's marketability. It will determine if the game is thriving with the targeted audience. It will also determine if the game will sell throughout the market and be played by many users once published. A series of questions were conducted for the targeted audience to identify whether the game was practical and relevant to the respondents.

2.3 Development and Testing Procedure

The development procedures revolve around the entire process, from prototyping to game development. Lunacy, a tool identified by the developers for prototype creation, will be used to generate the prototype model. For the game's presentation, the prototype will showcase the game's design and appearance.

The game's design stage focuses on the aspects employed in the game's building. The platforms, character designs, and other in-game elements are created here. Krita, Photoshop, and Blender are the tools utilized in the design stage. The storyboard concepts and game art style were created in Krita, then improved in Photoshop and modeled in Blender. The features and events of the game will connect to the storyline, allowing the player to traverse a vast terrain while learning about the lives of many wildlife animals. The components needed to make the game's environment and models were purchased from the Unity Asset Store, with some being free to use.

The Unity Game Engine is the software to develop the game. Unity is a sophisticated cross-platform developer IDE and a 3D/2D game engine. Unity can provide many of the most significant built-in elements that make a game operate as a game engine. Physics, 3D rendering, and collision detection are examples. The Unity game engine supports the programming languages C++, C#, and Python, which have shown to be capable and appropriate for

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programmers working on the project. The elements at this level have been coded to have functions and interactions with the other aspects. Physics and constraints are applied to the created elements at various phases in the game using Unity Game Engine. Each set of pieces will have its interactive function and game logic, which will be incorporated into the programming.

Following the creation phase, the game is put through a series of tests to ensure its functioning and quality control. System testing is done to evaluate and monitor the game's performance. The Wildlife Awareness Educational game is then presented to push the game's bounds, pointing out bugs and other anomalies to suit the user's comfort. Game bugs are not necessarily unavoidable; some might arise due to programming errors.

As a result, system tests are conducted to determine the game's limitations, potential bugs, performance, and the amount of human involvement it can manage. Because the game's theme is educational wildlife awareness, all the information was ensured to be credible and accurate. The contents displayed inside the game are based on credible sources from the Philippine government to assure the legitimacy of the knowledge imparted. The game's producers ensured that the standards were followed to ensure the game's efficiency and portability.

With everything intact, the game will now be released for Alpha and Beta testing. The game is initially released for Alpha Testing, then given to the programmers working on the project as game testers. The testers played the game to determine how the game's mechanics work and identify any overlooked issues during system testing. The findings of the Alpha testing are saved for debugging purposes before the Beta test.

The Beta Test is used to evaluate the game's capabilities in the hands of the end user. The game is only available to a particular group of people. End-user feedback and views are critical for pre-release game feature improvements. The user's engagement is crucial since the players are only qualified to provide feedback on the game experience. It guarantees the game will work when exposed to a real-world user context. The information obtained from beta testers is used to make changes and adjustments if an error is discovered in the game mechanics or content.

Feedback from the Alpha and Beta tests has been received and will be considered under certain conditions in the game's final debugging phase before release. Suggested modifications from alpha and beta testers must be investigated, debated, and filtered to be considered. End-user feedback is vital and will almost always be valued to remedy concerns and prevent future difficulties in the release.

2.4 Implementation Plan

The planning and ideas led to the creation of this game. The Gantt chart indicated that it was tested and prepared for implementation through necessary planning and actions. They took into account the results of the pre-survey completed to properly introduce the game to the users before it was developed.

The game is free to play, and the gameplay and controls are easy to operate by users of any age. The project will benefit greatly when more users are willing to play the game and have more developments in the future.

The game will be mainly implemented for educational use, especially for students. It will be available for the users to play after the application's development and some test runs are finished. This game requires a large amount of storage due to the files and details it has to run, and it is necessary to run on desktop or laptop computers. For this reason, installations must be made in personal devices or school computer labs. It is anticipated that the project will be implemented in December.

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III. RESULT AND DISCUSSION

3.1 Requirement Specification

The Wildlife Awareness Educational Simulation game will mainly focus on increasing awareness regarding wildlife animals among the people in Marinduque. It will guide and educate the people, especially the students, about the importance of understanding and presenting them with different wildlife species here in the Philippines. The user has the free will to explore the vast environment of the game. The researchers meticulously picked and examined all of the material contained and utilized in the game, including a questionnaire with open-ended questions, using their previous data collection findings.

3.1.1 Functional Requirements

a) Gameplay – The system will provide players complete control over their character. The players can explore the vast area of the environment. In addition, the system must enable the player to complete the game's objectives.
b) Player Interaction – The game shall allow the users to interact with the objects and animals. It includes picking up food from the crates and feeding the animal to access their information.
c) Game Settings – The system shall allow the users to adjust game settings such as graphics, sound, and controls.
d) Inventory – The game shall allow the players to use the inventory to store food items.
e) Game Progress – The system should have a feature that shows users their game achievements and progress from the beginning to the present. It will allow the players to view their collection progress as they explore the game.

3.1.2 Non- Functional Requirement

Non-functional Requirements concentrate on the system's criteria for judging its functioning rather than specific behaviors.

a) Game Access – The system shall be free and accessible in the area location.
b) Capacity- The size of the game is large and requires a huge amount of storage due to the files and details implemented in the game.
c) Compatibility- The game can be played with minimum requirements for PC and laptop devices.
d) Usability – The system should walk a user through the features and functionalities of each icon in the User Interface the first time they use the program.

3.2 Result of the Feasibility Analysis

3.2.1 Operational Feasibility

For the Operational feasibility, the SWOT analysis results show that the targeted respondents have the strengths needed for playing the game. Most of the respondents have the required devices to perform the game and have internet access. Regarding weakness, some users might need more devices to perform and play the game. Required devices might be provided for users to test and operate the game. The users can play the game because the design and gameplay of the game are easy to perform and understand. However, power interruptions while playing the game are one of the threats that may occur while performing the activity. Game bugs are also a threat to users that will keep them from properly playing the game as it should be intended.

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Table 1: *SWOT analysis for Operational Feasibility*

Strengths	Weakness
1. The respondents have the devices for playing the game. 2. The respondents have internet connections.	1. Lack of device for performing the game.
Opportunities	**Threats**
1. The game might be proven effective to the targeted audience. 2. Satisfaction and enjoyment of the targeted audience after playing the game. 3. Such users can promote the game and expand its market.	1. Power interruption while operating the game. 2. Unexpected bugs upon playing the game

3.2.2 Technical Feasibility

For the Technical feasibility, the developers have the needed equipment and resources for the project's development, and its specification can support the developed system. Three functional desktop computers will be used to create and implement the game. The SWOT analysis reveals that the developers have the needed strength to develop the system. All of the required devices are available and have internet access for the game's development and implementation. The required knowledge is also met enough to perform the software and application necessary for the game's development. The developers are also familiar with the programming language used to develop the system. For the weakness, it shows that the developers do not have enough experience in game development. There might also be communication problems between the developers, such as relaying information and instructions since the development is done remotely. The opportunities show that the developers can utilize their skills from previous courses to develop the project and acquire knowledge while developing and improving the requirements to benefit the users and the system. However, the threat shows that power interruption and loss of internet connectivity are problems that the developers may encounter throughout the project's development. Bugs, software, and hardware failures are expected threats during game development. The developers will create a backup file when such an event happens.

Table 2. *SWOT analysis for Technical Feasibility*

Strengths	Weakness
1. The developers' resources and devices needed to develop the project 2. The developers have good internet connections. 3. The developers have enough knowledge of the software that will be used on the development of the project	1. The developers do not have enough experience in game development. 2. The developers might have enough knowledge of programming
Opportunities	**Threats**
1. The developers can utilize their skills from the previous course 2. The developers might gain knowledge along the way 3. The developers might seek improvements upon the development of the game	1. Power interruption while developing the game 2. Unexpected bugs upon the development 3. Hardware and software failures

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3.2.3 Market Feasibility

For market feasibility, a pre-survey questionnaire was conducted online to determine if there are willing users for the game system.

The survey revealed in Figure 1, that the majority of the respondents are aware, with 38% population, of their level of awareness in the current wildlife situation in Marinduque. Twelve percent (12%) are intensely mindful, and 13% are firmly not aware or less knowledgeable, 19% are not aware & 20% are neutral about the current situation of the wildlife.

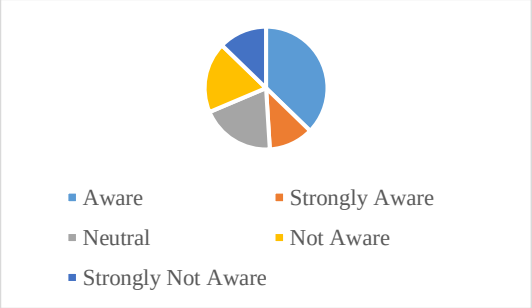

***Figure 1**: Awareness on Wildlife Situation*

Furthermore, according to Figure 2, the survey result shows that 66% of the population agree that wildlife is significant to protect, 32% think it is neither necessary nor unimportant, and 3% believe it is trivial to preserve wildlife.

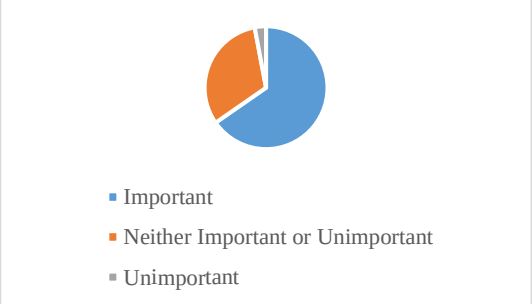

***Figure 2:** Agreement on Preserving the Wildlife*

The respondents were asked about their information sources on the current wildlife situation as presented in Figure 3. The survey found that almost half, or 30% of the population, answered that their primary sources are social media, 13% from tv, 18% from friends or family, 17% from the internet, while 21% have no idea and know almost nothing about the current state of wildlife ecosystem or any activities to preserve it.

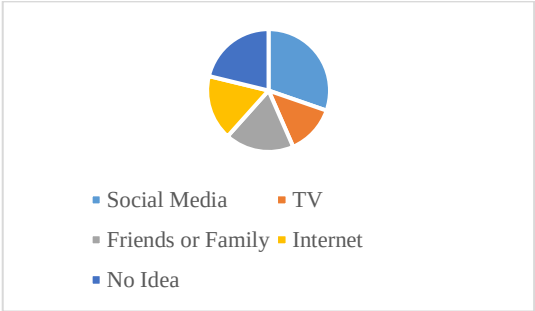

***Figure 3:** Information Sources about Wildlife*

According to the result of the study in Figure 4, 62% of respondents are familiar with and have heard about endemic species, 16% said maybe, and 23% said no.

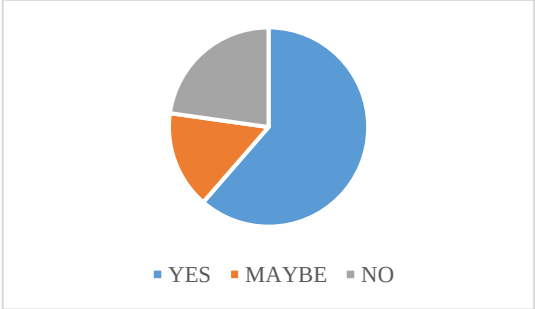

***Figure 4**: Familiarity on Endemic Species*

The majority of respondents in Figure 5, (79%) answered no, meaning that they have no problems with wildlife animals in their local area, whereas 21% have encountered difficulties with wildlife animals and do not know how to deal with them.

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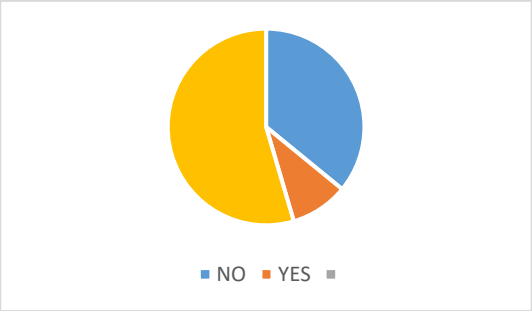

Figure 5: *Wildlife Problems on their Locality*

Lastly, respondents were asked if they would rather play a game about endangered animals in Marinduque wildlife while having fun and learning. Most respondents (68%) responded yes, 6% were against it, and 27% answered maybe.

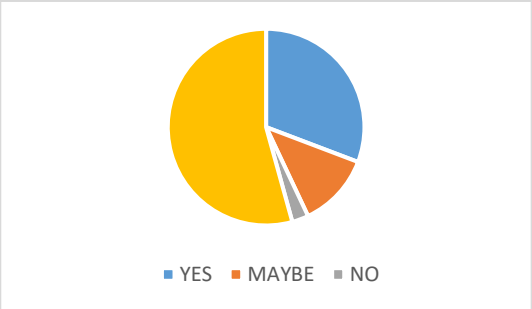

Figure 6*: Using a Game Application about Wildlife*

With these results, the game can gain some traction. It will guarantee the game's marketability and relevance to our expected users.

3.3 Description of the Project

Wildlife Awareness Educational Game is designed to inform students and spread awareness about the country's current situation of endangered animal species. The game is available to be downloaded and installed on PC/Laptop devices.

The game allows the users to explore a virtual representation of the country's ecosystem and rainforest and the unique endangered animal creatures in the environment. Each animal has unique characteristics, and players can interact with them and study their details. Players can view the behavior of each animal species according to their natural habitat. Each with its habitat, the players can spot all the habitats in different parts of the map.

The educational elements were included throughout the game. It is required to meet the project's goal of raising awareness. The unique mechanics, such as feeding/taming, will give the players some challenge and more interactive gameplay instead of instantly viewing the animal's information. Well-hidden crates with food are distributed around the map for the animals depending on what they usually eat. The food is divided into three categories: meat for carnivores, fruit for herbivores, and seeds for small birds. The animals will continuously follow players at a certain distance once fed or tame. The animals emit sounds that will also help the player find the animals and experience how they sound in the wild.

It consists of all the information, details, and appearance of every animal in the game. The game also includes a journal collection of every endangered animal species that the players will unlock as they explore the map and feed the animals. Players can collect them by exploring the environment and interacting with and feeding the animals they will encounter to obtain their information.

The game also includes in-game tutorials to help players navigate through the gameplay and controls of the game.

The players can access in-game settings to tweak some adjustments depending on their preferences. They can also pause and unpause the game at any time if they need to. The players can view the control keys of the game in the settings. The controls are set for keyboard and mouse controls on computer devices. The developers set specific graphics and audio in the game. The users can adjust those graphic tones to fit their

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preferences, and some visual effects can be overbearing for some individuals. They are given the ability to change the levels of graphical and audio effects in-game. It ensures that the game will be playable to everyone based on their preferences.

The developers are granted administrative access to modify the game's content and system. This access gives the game's system access to add, update, remove, etc. It is to ensure that the game's maintenance is consistent and to respond to any bugs or challenges that may occur in the future. The user should not be concerned because the administrative pass does not access the data of specific users.

3.4 Test Results

Tests were done to check the functionality and capability of the system.

System testing was done for the Alpha testing. A test case was used to know whether the system performs its intended functionality. The test involves interactions in the Game Menu functions and the game's mechanics. It will ensure that every function work and that there are no bugs that will cause failure in the game and the design of the game. The specified conditions and steps are followed to simulate the users' expected interaction with the system. As a result of the conducted testing, all the game's functionalities work and meet its desired outcome. The testers were the developers and IT professionals.

Recommendations and suggestions were asked from the expert's perspective to enhance the game's quality and performance. Some suggested including extra features to make the system more beneficial and practical. Some shared more helpful and efficient techniques and methods for a more furnished result.

For the Beta testing, a software quality evaluation tool based on the ISO 25010 Quality Standard was used for the software quality assessment. Randomly selected participants were asked to evaluate and test the system's features. The test was to ensure the quality and functionality of the software is good based on the user's perspective. The test includes functional sustainability, performance, compatibility, reliability, security, and maintainability to ensure the system will pass on the evaluation for software quality. According to the software quality evaluation, the system's functionality, usability, and portability are all very satisfactory. Most of the testers have tested that the system was functioning properly and the controls were easy to understand. However, some testers needed help navigating the map and identifying some game components. The system is satisfactory in terms of maintainability, security, and reliability.

Lastly, when it comes to portability, the testers have rated the software very satisfactory since the game can be installed easily using an installer and can be operated in any environment. They were then also asked to give some recommendations for improving the game. Some of them recommended enhancing additional features and qualities, like graphic improvements, map navigations, and other system features that can furthermore help the game improve more in the future.

IV. CONCLUSION

The developer's goal for this project was to develop an educational game that spreads awareness about the current situation of wildlife in the country. The developers have gathered data to support the objectives of the game and for
Based on the findings of the project, the developers have concluded the following:

The survey resulted in mixed answers from the respondents. Most respondents have less to no neutral awareness regarding the current wildlife situation in the province. The respondents were selected from people from different municipalities of the province. They were also asked if they would rather play an educational game about endangered animal

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species and have fun while learning about them. Most participants responded yes, some responded maybe, and a few were against it.

In terms of the project's feasibility, the developers utilize Operational, Technical, and Market feasibility to measure whether the game is feasible or not. The developers had concluded they had the necessary skills and resources to develop the game. The requirements of specification of devices for developing the system were met through GAP analysis.

System testing was conducted to determine whether the system works accordingly. The system's Functions and features were tested to ensure everything was working, which was done using test cases. It was also utilized to detect bugs and errors in the functions that may affect the system's performance.

In conclusion, the game has proven effective in targeting respondents since most of them need to be made aware of the current situation of the endangered animals in the country. The game can be an educational learning method for spreading information about the animals.

Any user can play the game. The gameplay and design are simple for the user to understand and play the game. This way, the users may learn and enjoy playing the game.

V. RECOMMENDATIONS

The following are the recommendations to future researchers that will help develop their game:

1. Originally, VR technology was supposed to be implemented in the project since developers lacked resources. Future developers are encouraged to apply this technology if they have the resources to support it.
2. Seek different game developer professionals on what they propose, recommend, and give tips about the game. It is beneficial to improve the game's structure, design, and functionality.
3. Future researchers/developers may include a time system wherein the game's timescale should transition from daytime to nighttime. It also adds different types of wild animals that many people don't recognize as nocturnal.
4. Add animal behavior, such as drinking, hunting other animals, and sleeping, as an animal's normal behavior. Also, the developers think improving the design, graphics, and map is good. Furthermore, improving how they interact with the animals and display the information is recommended. Instead of text, it should be graphics and show their species' evolution.

REFERENCES:

[1] N.A (2022) Endangered species in the Philippines. Retrieved April 20, 2022, from https://tinyurl.com/42v2y95y

[2] N.A (2021) Top 9 Largest Eagles in the World. Retrieved April 20, 2022, from: https://tinyurl.com/2s3edp35

[3] N.A (2019) THE PHILIPPINE EAGLE. Retrieved April 20, 2022, from https://tinyurl.com/yk9kjvr8

[4] N.A (2015) Causes of Wildlife Species Endangerment Retrieved April 20, 2022, from https://tinyurl.com/b4unvwf2

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AGRONOMY: A FARM MANAGEMENT SYSTEM FOR THE STUDENTS OF MARINDUQUE STATE COLLEGE – COLLEGE OF AGRICULTURE

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Abstract **–** As the foundation of a country`s economic system, agriculture has evolved from traditional to modern methods to maintain a productive, sustainable, resilient, and profitable practices. However, as these practices can be overwhelming to manage, several farm management systems and plant care applications have been developed to help agriculture producers increase farm productivity. With the aim of assisting students and faculty members at the Marinduque State College – College of Agriculture, this project aimed to develop a farm management system accessible via mobile phones and browsers, allowing users to acquire information, monitor crop status, be reminded of daily farming activities, and generate reports. This is to primarily minimize wastage that occurs during the planting process, as well as to maximize and optimize resources and capital through high crop yield. As this project was proven to be feasible, the prototyping model was used throughout the project's development using Figma. Various programming tools and languages, such as VS Code, Android Studio, PHP, JavaScript, Kotlin, and well-known web frameworks, were utilized to develop the project. MySQL and SQLite were also employed for database management. After the development, a series of tests was conducted to ensure its correctness, completeness, and consistency. The mobile and web application's functionalities were tested by five students and three faculty members, respectively. Based on the test results, all system features were operational, and the software quality evaluation conducted by five IT experts produced highly positive scores, resulting in an overall rating of 4.611. Although minor flaws were discovered during the testing process, it had no significant impact on the overall performance of the system. Generally, the results show that the system can be beneficial to the faculties and agriculture students considering all crop-related information, notification reminders, and crop monitoring the system offers. Hence, the users were satisfied with the system's performance.

Keyword: Farm Management System, Crop Monitoring, MSC-College of Agriculture

I. INTRODUCTION

Agriculture is the foundation of a country's economic system. It is essential for the successful sustainability of a country's economy [1]. As a food provider, it is the cornerstone of human existence [2]. Over the decades, agriculture has evolved from traditional ways based solely on yield and harvest to modern agriculture focused on profit or loss. Agriculture today deals with old and new activities and strategies to keep a farm productive, sustainable, resistant, and profitable, as it can be a source of various sectors [3]. However, as this can be overwhelming to manage, innovative farming systems were created to provide opportunities for agriculture producers to increase productivity while better managing their farms and natural resources [4].

Agricultural education is provided in the Philippines through Higher Education Institutions (HEIs) known as State Universities and Colleges (SUCs), which were all established by Acts of Congress [5]. Agricultural education is more than just an elective course. It also educates tomorrow's scientists, nutritionists, teachers, and many other professionals [6] [7]. And to improve day-to-day farming activities, several farm management systems and applications related to plant care were developed. Several studies also

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revealed that using these systems enhances the accuracy and productivity of farm operations.

Marinduque State College is a higher education institution with four branches in various municipalities in Marinduque. These branches are located in Boac, the main campus, Sta. Cruz, Gasan, and Torrijos. It offers the general population a wide range of bachelor's degrees and secondary education. Agricultural courses are available at the Torrijos branch under the College of Agriculture, founded under BOT Resolution No. 6s. 1985 and provides a Diploma in Agricultural Technology–Bachelor of Agricultural Technology (DAT-BAT) and a Certificate of Agricultural Science–Bachelor of Science in Agriculture (CAS-BSA) (CAS-SSA). The College of Agriculture aims to educate students in the scientific habit of thought and entrepreneurial skills and prepare them to become professionals with entry-level competencies in technical agriculture.

However, a short survey/interview with the students enrolled in agricultural courses revealed that one of the problems they encountered was the crops' unmonitored health. The leading cause is that students often forget or become careless about doing certain farm activities to the crops as it grows. They often overlook some farm activities and minor changes to the crop state as it grows, primarily caused by having many crop information to remember. They often need help recalling some information about specific crops or get their ideas mixed up. In addition, students also sometimes need to consider some factors before planting. They often commit errors in considering the soil type and season a crop is most suitable and when measuring the distance between the crops in the plant field. This practice leads to poor growth of the crops as they need help to grow in an unsuitable environment. The cause for this problem is that students frequently need to remember to consider the necessary factors before planting a specific crop and start producing on the available fields. In addition to this is that they also often need clarification about the appropriate crop distance between columns and rows. Aside from often neglecting some farm activities, another cause for this problem is that students sometimes also need to remember to consider practices in taking care of their crops. It includes the proper way of hoeing, watering, digging, cutting, weeding, and thinning crops and what to do when natural disasters and interfering animals occur. In other words, students needed help with the proper management of crops.

Hence, to address the identified problems, the developers proposed developing an Agronomy application for MSC – College of Agriculture students. As this would provide valuable features that are flexibly accessible, developing the Android-based mobile application will address the problems encountered in the current setting and serve as an asset for the organization.

II. METHOD AND PROCEDURE

2.1 Requirement Analysis

As the target organization, faculty members and students of Marinduque State College Torrijos Campus, specifically the College of Agriculture department, were subjected to interviews and observations. Prior to the interviews, a Formal Letter for Interview and Data Collection was submitted to the organization for approval. Subsequently, the developers prepared and utilized a constructed survey/interview questionnaire for face-to-face discussions with students and faculty members. The developers also utilized Google Forms to conduct an online survey using the same set of questionnaires with other students and faculty members of the organization, in order to gather additional data and determine the demand for implementing the system.

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After gathering all the essential information through observations and online and face-to-face interviews, the developers analyzed the data and formulated solutions to the identified problems. Based on the findings, the developers designed several essential diagrams, including the Work Breakdown Structure, Gantt Chart, Entity Relationship Diagram, Database Schema, Use Case Diagram, and User Story. These diagrams were utilized in the system development process. Furthermore, to ensure continuous user involvement, the prototyping model was employed as the system modeling method to gather user feedback and discover requirements for the completion of the application.

2.2 Feasibility Analysis

A feasibility analysis was conducted to assess the viability of developing the Agronomy Web and Mobile App. This analysis aimed to evaluate the capabilities of both the developers and the target organizations to support the envisioned system effectively. The analysis aimed to provide evidence of the project's feasibility by focusing on operational, technical, and market feasibility.

Operational feasibility was conducted to examine the school's capability to support the system's development. This undertaking involved an interview with key stakeholders as part of the project. The developers evaluated the users' computer literacy, examined the available school technological equipment and specifications, and observed students and faculty members' willingness and cooperativeness. The information acquired during the interview was then analyzed and presented using SWOT Analysis in Table 2.1. Using this tool, the developers determined the organization's strengths and weaknesses in adapting to changes the system may bring. The developers also identified the opportunities and threats the entity might encounter after implementing the system.

Table 2.1 *SWOT Analysis (Operational Feasibility)*

Strength	Weakness
• All students use smartphones and apps. • Organization keen to support system development • Faculty own laptops • Organization has internet access	• Students and faculty are unaware of the FMS
Opportunity	**Threat**
• Helps students track plant growth and improve performance • Asset for teaching plant care to students • Raise student awareness of FMS	• Malware sudden occurrence • Equipment may suddenly break • Loss of Internet/power

A technical feasibility analysis was done to identify whether the developers could meet the required technical resources in developing the system. In this deliverable, the developers inspected the available technical resources and compared them to the minimum specifications of technical resources. It was further analyzed using Gap Analysis. Using this tool, the developers specifically compared human, hardware, and software resources with the available and technical resources necessary. Moreover, the developers assessed their skills using SWOT Analysis to see if they could build the system, as presented in Table 2.2.

Table 2.2 *SWOT Analysis (Technical Feasibility)*

Strength	Weakness
• Have enough tools to develop the system • Knowledgeable in programming • Flexible for learning new technology/language • Teamwork and collaboration	• Team is working remotely • Personal matters can make a member unavailable • Schedule changes and sudden activities occur

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Opportunity	Threat
• Gain project/system development knowledge • Improve teamwork skills. • Enhance analysis and problem-solving skills	• Power shortage unexpectedly happens • Equipment/tools can fail • Changes and adjustments in the development of the project

Furthermore, market feasibility was conducted to determine the acceptance and willingness of faculty members and students to support the system. In this endeavor, the developers conducted an online survey using a Survey Questionnaire. They utilized market analysis to present the results of users' receptiveness, as well as the marketability of the mobile application. As part of assessing the potential marketability of the app, the developers also evaluated the presence of other similar applications that would compete with the app.

2.3 Development and Testing

The Prototyping Model was used in this study as the system development method on the web and mobile application. The system was partially implemented using this method, specifically partial prototyping, allowing users to view the product earlier and provide feedback. The initial prototype featured only the fundamental functionalities of the application according to user requirements.

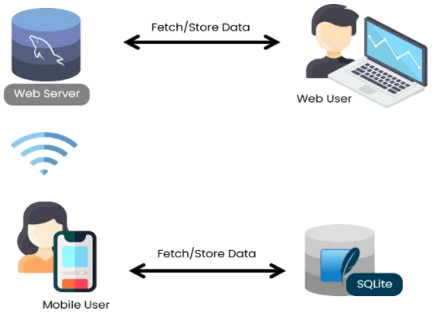

Figure 1.0 *System Architecture of the Project*

The Figure 1.0 depicts the system architecture of the farm management system, which starts from storing data from the web user's computer to the database server. These data or records stored on the database will then be fetched or used by the mobile application to perform its functions. When the mobile user changes the records, it will save or update them on the local database. Once the mobile user connects online, the application will automatically update the record(s) on the web server using the locally stored data in the mobile app's database. Only selected tables are set to be modified by the changes made throughout this process. It ensures that the records do not overlap or harm those stored in the web server's database. As a result, any database updates or changes will be retrieved by the website for record viewing.

In creating the web interface or application, Visual Code Studio was utilized as the Integrated Development Environment (IDE) for scripting and developing the web application. It was used as it supported web technologies such as Hypertext Markup Language (HTML), which was used to create and structure the website. The PHP Hypertext Pre-processor (PHP) was utilized as the programming language, and JavaScript was used to create dynamic web pages and system functionality. In addition, Cascading Style Sheet (CSS) and Bootstrap 5.0 framework were used to define the style and layout of the website. Moreover, XAMPP Server was used to manipulate and manage the database of the web system. It provided Apache, which was used to create the local webserver to access the web system.

Android Studio was used as the Integrated Development Environment (IDE) for scripting and designing the mobile application. As the programming language, Kotlin was utilized for scripting the app's functionalities and methods. On the other hand, extensive Markup

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Language (XML) was used to finalize the design, appearance, and layout of user interfaces.

Furthermore, the developers employed Figma to layout the user interface design, formats, and dimensions of all the drawable images to be used in the application.

After developing the system, a series of testing methods were conducted to identify the problems and bugs in the developed system. In the testing phase, the developers first conducted System Testing. The system's overall functionality of both web and mobile interfaces was checked to ensure that it was error-free and to determine whether the system met the specified requirements. Through Cross-Browser Compatibility Testing the project's web interface was evaluated in several browsers to ensure it was compatible with all media browsers. It was guaranteed to work with Google Chrome, Internet Explorer, and Mozilla Firefox, among other browsers.

Inter-Device Testing was also implemented to check if all app functionalities adapted or worked correctly in the specified minimum Android version and higher. Apart from this, another test was conducted through User Acceptance Testing. For the system evaluation, Software Quality Evaluation Based on ISO/IEC 25010 Software Product Quality Standard was used by the Information Technology professionals to test and evaluate the developed mobile and web application in its entirety. This standard measured the system's quality based on the expert's ratings and feedback, which were assessed according to predefined criteria. The test and evaluation results were interpreted using the Likert Scale Rating Basis in Table 2.3.

Table 2.3 *Likert Scale Rating Basis*

Weighted Mean	Verbal Interpretation
4.20 – 5.00	Strongly Agree
3.40 – 4.19	Agree
2.60 – 3.39	Neutral
1.80 – 2.59	Disagree
1.00 – 1.79	Strongly Disagree

III. RESULTS AND DISCUSSION

3.1 Requirement Definition

Agronomy is an Android-based application designed primarily for MSC – College of Agriculture students and faculty members. With the user's consent, their information will be collected and stored in a local database. Agronomy aims to be user-friendly, portable, and easy to use, providing significant assistance to students in their day-to-day planting activities. Additionally, it serves as an innovative tool for faculty members to teach students about proper crop care. The application takes advantage of the internet and can also be accessed offline, enabling students to monitor the state and progress of their plants effectively.

3.1.1 Functional Requirements

1. For the Student:
    a.) Crop Information Viewing - The application will provide a list of crops that are ideal for growing in the current month or season and those that are not. The app will present this with the use of visual media and will also allow users to view the details or facts about each crop.
    b.) Cultivation Tips and Preventive Measurements – The application shall allow students to view general crop cultivation tips and preventive measures to better manage or take care of their crops.
    c.) Crop Distance Measurement Calculator – The application shall

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allow users to calculate crop distance measurement by entering their land area and the number of seeds, allowing the system to compute its distance from each crop and display the result.

d.) Fertilizer Calculator – the application shall allow the users to compute the amount of fertilizer they need by entering the number of crops in their garden area, allowing the system to compute the needed fertilizer and display the result.

e.) Crop Progress Monitoring – The application will allow students to select crops to grow and monitor their progress. The system should display the crop's age as well as a list of daily activities that must be completed. It must display a description of the crop state in each phase, allow users to answer brief questions, and suggest alternative solutions to concerns discovered. At the end of phases, users are expected to fill out a form showing the number of crops that grew successfully, crops that were rejected, and crops that died.

f.) Crop Collection Management – The application shall allow the students to manage their crop collection and either add or delete planted crops from the collection.

g.) Notification Reminders – The application shall provide pop-up notifications to students to remind them of their daily activities that must be completed throughout the day.

h.) Daily Scheduled Activities – The program shall allow students to view daily farm activities as well as create or set their own tasks.

i.) Application Calendar – allowing users to view a calendar showing the day they started planting and the expected date of harvest.

j.) Profit Calculator – The application will allow students to input all of the accumulated expenses throughout the planting process, as well as the number of crops sold and the selling price, allowing the system to calculate and display the profit using a provided formula.

k.) Harvest Report – The application will generate a report based on the data obtained during and after harvesting. The reports must include the name of the crop, crop variety, batch name, the number of seeds, the date they started planting, the expected date of harvest, the actual date of harvest, and the harvest status if it meets the expected date. This is presented using tables and diagrams.

l.) Report of Daily Activities – Throughout their planting, the application will generate a report based on their daily farm activities. The name of the crop, crop variety, batch name, the date they started planting, the actual harvest date, list of farm activities in each phase, the activities date of execution, and status if they completed or missed the activities will all be included in the report. This is presented using the tables and diagrams.

m.) Profit Report – The application shall generate a report based on their earnings and profits. The report includes a summary of expenses, the number of seeds sold, their selling price and units sold. It will be represented in the receipt form of

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style, allowing users to view their overall accomplishments.

n.) Crop Recommendation – The application shall allow the students to recommend new crop by answering questions presented in the application.

2. For the Faculty Members and Administrators:
   a.) Application Content Management – The system shall allow the faculty and administrator to add and/or update crop information, crop variety, crop tips, cultivation tips and preventive measurements. Additionally, the system shall exclusively allow the faculties to verify crop records which will be utilized by the application.
   b.) Approval of Recommended Crops – The system shall allow faculty members and admins to accept and/or deny recommended crops.
3. For All Users:
   a.) User Account Management – The system shall allow all users; students, faculty members, and admins to manage or update their account information. Specifically, the system shall the administrator/s to verify faculty accounts and add admin accounts.

3.1.2 Non-Functional Requirements

1. Operational - The application should run on mobile smartphones with at least an Android 8.0 (Oreo) version. Any type of browser can be used to access the web interface. In addition, the application shall have a push notification reminder feature to constantly notify students about the daily plant activities they need to do.
2. Privacy/Security - All users can use their email accounts to serve as the basis of user authentication. Registered users will also be capable of updating their account information. Furthermore, the application shall be protected by Republic Act No. 10173, popularly known as the "Data Privacy Act," which aims to safeguard and secure all users' personal, private, or sensitive information.
3. Reliability – The application or system shall provide accurate data on plant information and land measurements. The application shall also have a local database for offline access to ensure that data is always available. The local database will likewise be updated when changes are made

3.2 User Acceptance Test Result

User Acceptance Testing was conducted. The system was presented and demonstrated to the faculty members and students of the College of Agriculture – Marinduque State College Torrijos Campus. After the demonstration, developers allow the users to explore the web and mobile applications for testing. A User Acceptance Form was handed to them as a tool to assess if the mobile and web system's features fulfilled the expected result, as well as whether the users were satisfied with the developed web and mobile system's functionality.

Table 3.1.1 shows the User Acceptance Testing evaluation result from participating five (5) College of Agriculture - Marinduque State College Torrijos Campus students on the Agronomy mobile application. Overall, the agriculture students found all features to be functional, with a total weighted mean of 4.496 and a verbal interpretation of a strong agreement. However, it was discovered that the Creation of Account had the lowest weighted mean of 4.0, which was still verbally interpreted as "Agree" on the Likert Scale Rating Basis. Nevertheless, it was determined that these functions require further improvement, as they lack some essential elements.

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Table 3.1.1 *User Acceptance Test Results (Mobile User)*

System Requirement	Mean	Verbal Interpretation
Creation of Account	4.000	Agree
Information Viewing	4.200	Strongly Agree
Crop Collection Management	4.360	Strongly Agree
Notification	4.800	Strongly Agree
App Calendar	4.800	Strongly Agree
Reports Generation	4.867	Strongly Agree
Crop Recommendation	4.300	Strongly Agree
Account Management	4.600	Strongly Agree
Crop calculator	4.533	Strongly Agree
Overall Rating	**4.496**	**Strongly Agree**

Four (4) faculty members of the College of Agriculture – Marinduque State College Torrijos Campus evaluated the system as they were the primary user of the web application. The results demonstrate that the mean score for each function was at least 4.0, indicating overall satisfaction among the selected faculties. Generally, the participating faculties were impressed with all the features, resulting in a weighted mean score of 4.539, which corresponds to a "Strongly Agree" verbal interpretation. Furthermore, the faculty members rated the web application's interface design positively, describing it as aesthetically pleasing and user-friendly.

Table 3.1.2 *User Acceptance Test Result (Web User)*

System Requirement	Mean	Verbal Interpretation
Creation of Account	4.433	Strongly Agree
App Content Management	4.533	Strongly Agree
Approval of Recommended Crop	4.622	Strongly Agree
User Account Management	4.667	Strongly Agree
Overall Rating	**4.539**	**Strongly Agree**

3.3 Software Quality Evaluation Results

As part of the testing and evaluation process, the mobile and web application underwent Software Quality Evaluation (SQE). The evaluation was carried out by five (5) IT experts who comprehensively assessed the project's attributes using a devised evaluation form based on the ISO 25010 Software Evaluation standard. The system attributes were rated using the Likert Scale. The system attributes were rated using the Likert Scale. Furthermore, the evaluation results of the developed mobile and web application have been documented and presented in Table 3.2.

Table 3.2 *Software Quality Evaluation Result*

System Attribute	Mean	Verbal Interpretation
Functional Suitability	4.8	Strongly Agree
Performance Efficiency	4.667	Strongly Agree
Compatibility	4.8	Strongly Agree
Usability	4.433	Strongly Agree
Reliability	4.4	Strongly Agree
Security	4.32	Strongly Agree
Maintainability	4.6	Strongly Agree
Portability	4.867	Strongly Agree
Overall Rating	**4.611**	**Strongly Agree**

After evaluating the eight (8) system attributes, it was discovered that the application demonstrated the highest mean score of 4.867 for Portability, along with ratings of 4.8 for Compatibility and Functional Stability. The evaluation also indicated mean scores of 4.667 for Performance Efficiency and 4.6 for Maintainability. Furthermore, the application received mean scores of 4.433 and 4.4 for Usability and Reliability, respectively. However, the evaluation revealed that Security received the lowest mean score of 4.32, although it was determined that this had no significant impact on the system's operation. The evaluators gave the project an overall satisfactory rating of 4.611, interpreted on the Likert Scale Rating Basis as "Strongly Agree", indicating their high level of agreement regarding the project's effectiveness and acceptability. The evaluation results confirm

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the positive performance of the mobile and web application, showing its potential for success.

IV. CONCLUSIONS

The developers assessed the system for its completeness and correctness with the different performed testing procedures. The results indicated that the system's functions are working as intended. Aside from that, it was determined that both the website and the application run smoothly on all browsers and specified Android versions. However, the results revealed a few issues and challenges: (1) the app takes a few minutes to fetch data from the XAMPP server, (2) incorrect placement of activities to be completed on the list, and (3) the app's ability to adapt to lower Android versions. These minor flaws discovered during the testing process have no significant impact on the system's output.

As a whole, the testing outcomes showed that all system features were operational. As a result, the users' satisfaction with the system's output and attaining the fundamental project/system objectives validate the project's success. It proves that the system can benefit the faculties and agriculture students considering all crop-related information, notification reminders, and crop monitoring the system offers.

V. RECOMMENDATIONS

Based on the findings, the developers recommend several enhancements to improve the system's functionality and increase user satisfaction. For future developers:

1. They can provide more information about each crop to help students make informed decisions about which crops to grow and provide information to understand the crop itself better.
2. They can incorporate a weather forecasting feature into the mobile application to help students plan their activities ahead of time in the event of bad weather. Additionally, this feature can provide notifications and reminders for users to take necessary actions, such as covering crops during a heavy downpour or watering them during a dry spell.
3. They can expand the system to include farm animals, providing students with comprehensive techniques, tips, and advice on properly caring for animals and plants.
4. Adding a plant scanner to the mobile application would be a valuable asset as it can scan the type of crop and the associated disease, providing users with a rapid diagnosis of the crop type and any associated illnesses and enabling them to administer appropriate treatment measures promptly. Thus, this would save time and money in the long run.
5. Also, thorough testing and maintenance to fix minor errors will improve system performance.

Implementing these features can provide students with a more comprehensive and user-friendly experience, making learning and applying farming techniques easier. With these enhancements, the system can become a valuable tool for agriculture students and users, helping them maximize their yields.

REFERENCES

[1] Dane, K. 2022. Why is Agriculture Important, and Its Role in Everyday Life? Retrieved April 23, 2022, from https://agriculturegoods.com/why-is-agriculture-important/

[2] Blandford, D. 2012. The Contribution of Agriculture to Green Growth. Retrieved April 23, 2022, from https://www.oecd.org/greengrowth/sustainable-agriculture/48258861.pdf

ISSN 3028-0168 (Print) | 3028-0176 (Online)
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[3] Rose, D., Sutherland W., Barnes A. 2019. Integrated Farm Management for Sustainable Agriculture: Lessons for Knowledge Exchange and Policy, Volume 81, Pages 834-842. https://doi.org/10.1016/ j.landusepol.2018.11 .001

[4] OECD. Innovation for a More Sustainable and Prosperous Agriculture. Retrieved April 23, 2022, from https://www.oecd.org/agriculture/topics/agricultural-productivity-and-innovati.on/

[5] Zamora, O. 2014. Challenges and Opportunities for Sustainable Agricultural Education in the Philippines and in the ASEAN Region. Retrieved April 23, 2022, from https://www.jstage.jst.go.jp/article/jdsa/9/1/9_29/_pdf

[6] Brescia, J. 2018. The Importance of Agricultural Education. Retrieved April 23, 2022, from https://www.slocoe.org/the-importance-of-agricultural-education/

[7] Ammirato, S. 2019. Why is Agriculture Education Important? Retrieved April 23, 2022, from https://collegeambassadors.uconn.edu/2019/03/07/why-is-agriculture-education-important/#

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SERVI-SEEK (MARINDUQUE'S MARKETPLACE OF SERVICES)

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Abstract- SERVI-SEEK is an online and mobile marketplace that matches Service Providers with local demand, allowing Service seekers to find immediate help on their needed services in the province of Marinduque. This project aimed to develop a web-based system that can be accessible for anyone who finds jobs or services allowing the user to acquire information, promote services, find job-skilled worker, supply the needs of the clients and generate reports. Fact-finding techniques such as research, surveys and interviews were applied to get the needed information for preliminary investigation. As this project was proven to be feasible, the Use Case Diagram, Work Breakdown Structure was used to analyze and utilize the system's appearance and also serves as a guide in the entire development of the project. The system was developed using PHP, JavaScript, HTML, CSS, and MySQL. After the development, a series of testing was conducted to ensure the correctness, consistency and completeness of the system. Alpha and Beta Testing for the system's functionality and suitability. Browser Testing, User Acceptance Testing and to check the system's quality standard, Software Quality Check using ISO 25010. On this project, all users had the opportunity to explore the functions and features of the entire system. Based on the test results, all system features were found to be operational, and the software quality evaluation conducted by five IT experts produced highly positive scores, resulting in an overall rating of 4.79 getting a satisfactory result. Although, minor flaws were found during testing, these had no significant impact on the system's overall performance. The results show that the users were satisfied, considering the system will be beneficial to the service provider and service seekers. In other words, it would be beneficial and make a profit in the future.

Keywords: Service Provider, Service Seeker, Services, Servi-Seek, Feasible, Testing, IT Experts

I. INTRODUCTION

In modern industrialized countries, services are as important as goods. They must be correctly identified and quantified if economic growth and inflation have any value for the economy as a whole. In other definition, services are just as important as goods in today's industrialized nations. Economic growth and inflation must be accurately defined and characterized if they are to be useful for the economy as a whole [1].

People utilize services every day as consumers and they are all around us. The growth of the service industry is widely acknowledged, and it is progressively helping many regions to thrive economically. This trend will likely continue to increase as more people connect to the internet and trade digitally with the rest of the world. With their increasing marketability and rising importance as inputs to traded goods and services, services are poised to play an increasingly vital role in many countries' economic growth [2].

Electronic marketplaces are virtual markets where buyers and sellers can bargain, transact business, and exchange pricing and product and service offerings. The expenses associated with acquiring and disseminating product/service information can be decreased using this approach. In other words, internet-based electronic marketplaces leverage information technology to match buyers and sellers with increased effectiveness and lower transaction costs, leading to more efficient, "friction-free" markets [3]. Web-based marketing combines marketing and web technology to

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systematically and practically drive business. Successful Web-based Marketing does not require a particular method to be followed. It is always a combination of many online and offline Web-based marketing techniques [4] [5].

However, looking for a skilled worker who provides various services is becoming increasingly common in the province of Marinduque. Unfortunately, service seekers struggle to find a service provider who can assist them in resolving a specific problem due to unfamiliarity with the service provider's location and the service provider itself. As a result, service seekers spend money, effort, and time just looking for a service provider.

Service Seekers have no basis for determining whether services are of higher quality, more reliable, and work better, especially if it is the service seeker's first time acquiring the service. Other than that, Service seekers do not know the status of their acquired service.

Furthermore, service providers have difficulties promoting and offering their services, especially if they do not have a defined workplace, which is why they are not competitive enough in promoting services.

With the abovementioned problems, the developers created a system entitled "Servi-seek (Marinduque's web-based marketplace of services)". It is a web-based platform that can be accessed via cell phones and personal computers, making it simple for service providers and service seekers to connect and negotiate over their services. Using this system, any service seekers can find a service provider they need in a very simple way; they do not need to travel to town or another place and waste money, time, and effort merely to find a service provider. In addition, the service seeker can also read all of the comments and feedback about the service provided by the skilled worker to have an idea of the quality of service offered by the service provider.

Moreover, this system will help all service providers advertise and market their services throughout the Province of Marinduque. It can also use to make transactions between the service seeker and the service provider more efficient and convenient, as well as to provide direction for the location of both the service seeker and the service provider

II. METHODS AND PROCEDURE

The developers developed the system by planning, executing, and evaluating. The procedures that will be included in the execution of the said methodology are as follows:

2.1. Requirements Analysis Procedure

A systematic investigation was carried out to obtain necessary information thru fact-finding techniques such as online surveys and face-to-face interviews.

The researchers held a group meeting for brainstorming and an in-person interview to acquaint themselves with the existing processes for how different services work and to identify potential problems that may be rectified. After analyzing the existing processes and determining the most common problem encountered by both target users, the developers better understood what led to a possible solution. Then they conducted an online survey to know the acceptability of the newly proposed ideas that might solve that problem. At the same time, the interviewed service provider and seeker had given a hardcoded survey questionnaire.

To have a clear overview of the deliverables, better monitoring of project development, and manage project schedules, costs, resources, and changes, the developers created the Work Breakdown Structure (WBS). presented in Table 2.1 and Gantt Chart. It helps

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the developers assign tasks based on their skills acquired and ensure to complete them properly and on time, considering the difficulty of each task. In addition, the actual dates of the creation are specified to check if the development is going according to plan.

Table 2.1 Work Break Down Structure

1. INITIATION
   - 1.1 Constructing
   - 1.2 Selecting of Target Area
   - 1.3 Conducting a preliminary investigation
     - **1.3.1** Prepare interview questionnaire
     - **1.3.2** Close-out interview
   - 1.4 Define problem or opportunity
     - **1.4.1** Identify the problem domain
     - **1.4.2** Identify the significance of the study

2. PLANNING
   - **2.1** Gather project requirements
     - **2.1.1** Create WBS
     - **2.1.2** Create Gantt Chart
     - **2.1.3** Create a Use Case
     - **2.1.4** Create an Entity Relationship Diagram
     - **2.1.5** Create a Database Schema

3. EXECUTING
   - 3.1 Design a website suitable for the proposed project
   - 3.2 Obtain formal approval of design project
   - **3.3** Conduct Feasibility Analysis
     - 3.3.1 Technical Feasibility
     - 3.3.2 Operational Feasibility
     - **3.3.3** Economic Feasibility
   - **3.4** Development of the Design
     - **3.4.1** Coding
     - **3.4.2** Debugging
   - **3.5** System Testing
     - **3.5.1** Alpha Testing
     - **3.5.2** Beta Testing

4. MONITORING & CONTROLLING
   - **4.1** Review design development of the project
   - **4.2** Update changes of the project
   - **4.3** Submit the final Construction Document (CD's)
   - **4.4** Implementation of the project deliverable
   - **4.5** Maintenance

5. CLOSING
   - **5.1** Project Acceptance
   - **5.2** Close-out of the project

2.2. Feasibility Analysis

To conduct the feasibility study, the developers conducted research work and studies related to the development of the system. This helps them determine if the developed system is feasible.

Table 2.2 *SWOT Analysis*

Strengths	Weaknesses
1. Both the Service Seeker and the Service Provider are computer literate and understand how to operate and manage the system. 2. Both the service seeker and the service provider have gadgets that can be used to gain access to the system. 3. The users have access to the internet. 4. User has a provision in the development of the developed system.	1. Miscommunication with the client. 2. Low communication and social skills. 3. Accessible without login but only on limited function and features. 4. Lack of ICT Maintenance Personnel.
Opportunities	**Threats**
1. The map locator feature of the system may increase service seeker and service provider satisfaction. 2. The system's comment and feedback features ensure the accuracy of information about the service provider's performance.	1. Unexpected Occurrence of Malware. 2. Power shortage while developing the system. 3. Weak Internet Connection. 4. Development tools failure.

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SWOT Analysis in Table 2.2 was used in Operational Feasibility to determine the strengths and weaknesses of the service seeker and provider, and how capable the service seeker and service provider are of adapting to the changes that the developed system may bring, as well as opportunities and threats that may occur on the developed system. The Technical Feasibility of the developed system was determined by applying GAP analysis presented in Table 2.3 by comparing the hardware, software, and peopleware requirements of the existing and needed specifications. Also, the Market Feasibility Analysis was used to determine the Market Feasibility of the developed system and how this system will benefit both the service seeker and the service provider. Conducting an online survey using google forms and interview conducted by the researchers to determine if this study is feasible.

Table 2.3 *Gap Analysis*

Needed Resources	Available Resources	Action Needed
HARDWARE		
Processor: Core i3 4Ghz or faster	Core i5 8.00 GHz	Use the available processor of the developers.
RAM: Minimum of 2GB DDR3	8.00 GB DDR3	Use the available RAM of the developers.
Hard Disk Drive Capacity: Minimum of 500 GB	1 Terabyte	Use the available Hard Disk Drive of the developers.
SOFTWARE		
Operating System: Windows 10 or higher.	Windows 11	Use the available OS of the developers.
Web Browser: Google Chrome, Microsoft Edge, Mozilla	Google Chrome (Version 55.0.2883.8), Mozilla Firefox (Version 50.1.0)	Use the available browser of the developers.
HUMAN RESOURCES		
• System Analyst • System Programmer • UI Designer • System Tester • Documentation	• System Analyst • System Programmer • UI Designer • System Tester • Documentation	Available

2.3 Development and Testing Procedures

After completing the conducted feasibility study analysis, the system's designers and programmers began designing and coding the system. To assess if the system, its functions, and its features are practicable, the following requirements are met:

The system's fundamental features and functions, as well as a prototype, are discussed in detail. The developers also provide ratings and recommendations on the system, which can be utilized to enhance the system's overall development to satisfy the client's expectations. The prototype was designed on a high-fidelity design using the Mock-Up Plus tool, and it was produced using Visual Studio Codes as a code editor and used to test the design.

The Use Case Diagram presented in Figure 2.1 serves as a guide for the development of the system, and the Work Breakdown Structure presented in Table 2.1 was used as a guide for the developers on a certain task to better monitor the progress of the project. It was determined to utilize the Database Schema in both the visual and logical architectures; the database for supporting both was created by the developer using MySQL to support both visual and logical designs, and the Database Schema was used in both the visual and logical architectures as well.

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Figure 2.1 Use Case Diagram

After the development, several evaluations were conducted to test the developed system. The developers conducted Alpha/Beta Testing to investigate and discover potential bugs and errors that might occur. The system's functionality was checked to ensure that all functionalities operated smoothly without technical glitches. The system was also tested in several browsers to ensure compatibility with all media browsers. It was tested with a variety of browsers, including Google Chrome, Microsoft Edge, and Mozilla Firefox. Then provided a bug report option on the system so that testers can notify the developers of any issues or faults they see so that they can be fixed as soon as possible. After that, the system was ready for the Software Product Quality test that was created based on ISO/IEC 25010 Software Product Quality Standard. This testing process is done by presenting the developed system to IT professionals for evaluation. The test and evaluation results were interpreted based on the Likert Scale Rating Basis presented in Table 2.4.

Table 2.4 Likert Scale Rating Basis

Weighted Mean	Verbal Interpretation
4.20 – 5.00	Strongly Agree
3.40 – 4.19	Agree
2.60 – 3.39	Neutral
1.80 – 2.59	Disagree
1.00 – 1.79	Strongly Disagree

III. RESULTS AND DISCUSSION

As a result of the development process, the Servi-Seek was developed with the following functions and requirements.

3.1 Requirements Definition

3.1.1 Functional Requirements

- Manage User Account – The system requires users to register or create an account first to access the full features. If the user already has an account, the system should allow them to access the system by logging in with their username and password.
- Apply/Avail Subscription - The system should allow the user to upgrade their account from a service seeker to a service provider. It allows allow the service provider to subscribe first to create an account as a service provider.
- Manage Services Information - The system should allow the service provider to post and update their description, such as their name, age, location, service offer, etc. on their profile, which the service seeker can access.
- Search/View Services - The system should allow the users to search for a specific type of service that they need.

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After searching for specified Services, the system should display all of the individuals that offer those services.

- Profile Sharing - The system should allow users to access their profile as well as the basic profile of the service seeker to provide an overview of the basic information of both the seeker and the provider.
- Map Locator - The system will track the location of the Service Providers and Seekers can easily locate their specific location to determine the distance between them.
- Acquire/ Provide Services - The system should allow service providers to look for and hire a service provider to fix their problem encounter by sending their approval request. This should enable the service provider to receive an application request from the service seeker.
- Manage Service Monitoring - The system should enable service providers to monitor and manage all services provided to service seekers. It allows the users to take actions such as view the status of the acquired services, update the request status, accept, decline or deleting the request.
- Messages - The system should allow both the service seeker and the service provider to send messages to one another through the system's chatbot feature.
- Manage Service Payments - The system should allow users to select a mode of payment for the services they avail.
- Manage Ratings/Feedback - The system shall allow the users to rate and submit feedback about the services they received; this will assist other service seekers in selecting the proper service provider and can also assist the service provider in determining what they need to improve in their services.
- Generate Reports - The system should generate reports on the number of service providers for each service, the number of users, the total amount of payment, and the total number of service providers from various locations in Marinduque.

3.1.2 Non-Functional Requirements

- Operational - The system should work on any smartphone that runs on the Android or iOS operating systems. Also, the system must be capable of running on a web platform.
- Performance - The system's processes must be fast and efficient. It should have a persistent server that is available at all times.
- Security - The application always requires user login authentication. Passwords are generated automatically, and registered users, such as service seekers and providers, can change or modify their passwords on the system. The password will be used to authenticate the user.

3.2 User Acceptance Test Results

User Acceptance Testing was also conducted. The system was presented to the Dean and faculty members of the College of Information and Computing Sciences and also one employee from the ICTSC and other 2 IT professionals. They were tested and examined the system by themselves. The system was made available via the local area network using XAMPP Server remote configuration. UAT forms were given to IT professionals and faculty members to gather their acceptance, views, comments, and recommendation regarding the system's functionalities. Based on the result as presented in Table 3.1, most of the retrieved forms gathered positive outcomes as most of the testers strongly agreed that the system has executed all the functions that were tested.

Table 3.1: User Acceptance Results

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System Requirements	Mean	Adjectival Interpretation
User Access Management	4.3	Strongly Agree
Search and View Services	4.4	Very Strongly Agree
Monitoring and Managing services	4.5	Very Strongly Agree
Report Visualization	4.6	Very Strongly Agree
Generate Reports	4.6	Very Strongly Agree
Grand Mean	**4.4**	**Very Strongly Agree**

As, a result the IT professionals and faculty members very strongly agree that the system met the provided requirements, with a gran mean of 4.4. Hence, the acceptance of the system's features and function are strongly agreeable. While some faculty members provided comments on some functionalities, the developer took these comments for the improvement of the functions of the whole system.

3.3 Software Quality Evaluation Results

As part of the Testing and Evaluation process, the Servi-Seek website was subjected to the Software Quality Evaluation. Five (5) IT practitioners and professionals tested and evaluated the application using a devised evaluation form based on the ISO/IEC 25010 Software Product Quality Model. In addition, system attributes were rated using the Likert Scale as discussed in the methodology. Below is the summarized result of ratings gathered from the evaluators.

Table 3.2 *Summary of Software Quality Evaluation*

System Attribute	Weighted Mean	Adjectival Rating
Functionality	4.8	Very Satisfactory
Reliability	4.55	Very Satisfactory
Usability	4.7	Very Satisfactory
Efficiency	4.93	Very Satisfactory
Maintainability	4.8	Very Satisfactory
Compatibility	4.7	Very Satisfactory
Portability	4.93	Very Satisfactory
Security	4.92	Very Satisfactory
OVERALL MEAN	**4.79**	**Very Satisfactory**

With the six (8) system attributes that were evaluated, all of them tallied a weighted mean with an equivalent rating of Very Satisfactory. Therefore, the summary of the software evaluation indicated that the application has a Very Satisfactory rating with an overall standard of 4.79. This result proves that the application has the quality that satisfies various users' stated and implied needs and thus provides value.

IV. CONCLUSION

Based on their research and study, the developers concluded that the developed system has met its goal of providing an effective and efficient system that would benefit both the service seeker and the service provider. Servi-Seek aimed to make it easier for service seekers to find a service provider to assist them in resolving a specific problem. The completion of the developed system leads to the conclusion that Servi-Seek has met all of the needs of both the service seeker and the service provider. This system allowed users to create and register their accounts and log in to the system as service seekers. Service seekers can search and view basic information about the service provider by accessing their profile. Using this system, a service provider can choose a service provider they need, and they can send a request for availing of services. Service seekers can rate and comment on the service provider profile if they avail themselves. Using this system, the service provider can promote their services conveniently; they can also accept and reject a request of a service seeker. Using the chat features of the system, both the service seeker and service provider can send their private message using the chatbot feature of the system; they can also see the location of both sides by using the map of the system. In terms of administrator privileges, the administrator can verify and review the user's registration. They can check the user's subscription payment and have the right to accept or reject it and also generate a report about the number of users.

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V. RECOMMENDATION

After a long period of analyzing the achieved objectives of the developed system, some recommendations were proposed based on the study's findings and conclusion. This will be helpful and valuable for the system improvement, providing good services for the users. Future researchers should develop and study the system for extra features that will make it easier to use, such as;

In enhancing the developed system, future developers should create a mobile application for the system that can be responsive and help to make an easier transaction to both users or customers. The system must use enhance GPS in map locator to trace the users and determine their location, velocity, and time anywhere and anytime in the province.

In terms of transactions to make a better, understandable communication between users and customers, uploading images, audio, and videos in messaging is also recommended for the system.

The system must use online payment API like Gcash, Paymaya, Coins.ph, etc. for the subscription of the service seeker.

In addition, for the improvements of ratings from the provided services, users can also upload a video to the service provider's profile if they leave a comment and rate the service provider.

REFERENCES

[1] Hill T. P. "*The review of income and wealth*," 2017. [Online]. Available: https://onlinelibrary.wiley.com/doi/abs/10.1111/j .1475-4991.1997.tb00021.x

[2] Buckley P. Majumdar R. 2018. "*The services powerhouse: Increasingly vital to world economic growth*" Article from Deloitte Insights. Google. Retrieve from: https://www2.deloitte.com/us/en/insights/economy-growth.html

[3] Ph.D. E. 2022. "*The Emerging Role of Electronic Markets*" Google. Retrieve from: https://phdessay.com/the-emerging-role-of-electronic-markets/

[4] Rajagopal, R. 2022. "*Web Marketing-Advantages and Disadvantages*." Outsource Strategies International.

[5] Shethna, J. 2022. "*Web Based Marketing*" Mumbai - 400072. EDUCBA.

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e-Counsel Portal: A Web-based Analytics Platform for Guidance and Counseling of Balanacan National High School (BNHS)

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Abstract— Counseling is a well-organized, targeted, and short-term intervention that tries to assist students in managing and resolving problems or worries that are getting in the way of their achievement. The procedure helps students understand the issues, their causes, available solutions, and benefits and drawbacks, which enables them to make decisions and take appropriate action. E-Counsel Portal is a system that will serve as a virtual exchange information and communication platform between the guidance counselors to answer questions, give proper guidance to the students in a more efficient manner, and also track red flags over time, detecting patterns, trends, and disturbances in students individual or group behavior. The developers used PHP, HTML, Javascript, and SQL to develop the front-end system. After the analysis,, the developers concluded that the system may help the admin to counsel and have easy access for students to have a portal to express their emotions. The system benefits Balanacan National High School for this provides an outlet for counseling.

Keywords: e-counsel Portal, Counseling, Guidance, Red Flags, Analytics

1. INTRODUCTION

Guidance refers to advising or assisting an individual with educational, vocational, or personal problems. It is a service a specific school provides to help young people make wise decisions and changes. The guidance assists a person in realizing and developing a person's potential, as well as achieving the highest level of individual happiness and societal usefulness. Counselors, parents, relatives, teachers, administrators, other educational specialists, and spiritual leaders are typically involved in guidance activities.

As stated in the DepEd RM NO. 651, S.2021- Counseling and Referral System for Learners of School Year 2021-2022, the Implementing Rules and Regulations of Republic Act No. 11036, otherwise known as the Mental Health Law, Section 25 stipulates that "Educational institutions such as schools, colleges, universities, and technical schools shall develop policies and programs for students, educators and other employees designed to: raise awareness on mental health issues, identify and provide support services for an individual at risks, and facilitate access, including referral mechanisms of the individual with mental health conditions to treatment and psychosocial support." [1]

Students and staff had to re-create their in-person school experiences through cyberspace instead of in person [3]. School counselors have been at the center of the problem-solving process since the arrival of the coronavirus. They have made mental health referrals for students in crisis and offered moral support to teachers, administrators, and each other. All while providing academic guidance and focusing on students' emotional and social learning [4].

Numerous benefits come with online counseling. Clients cannot see the counselor during interactions. Regarding self-disclosure,

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clients find it less challenging to disclose themselves to counselors electronically than face-to-face [10]. It is because demographic characteristics such as gender, age and name may be hidden. Studies also prove that honesty may increase; clients may feel less defensive, fearless and vulnerable [11].

One of the unique features of counseling is the use of non-verbal cues. It is known that using non-verbal cues takes about 80% of communication. It is essential in counseling to enable the counselor to understand the client's issues and assist them promptly [14]. Nevertheless, this is absent in the online counseling process [15].

Online counseling is seen as convenient and readily available because clients can access counseling services at any time of the day when they feel most in need of it and even in the comforts of their homes [19]. Counseling transcripts are easy to access and record, allowing for monitoring the client's progress, identification of counseling style, or use for other future references. Compared with face-to-face counseling, transcripts reduce the need to memorize and recall information. Rereading the transcripts could enable counselors to determine which issue needs further discussion in succeeding sessions [21]. The electronic nature of online counseling provides counselors and counselees with a permanent record of their conversations [20]. Because online counseling is a new method in counseling, it may be particularly effective in gaining the trust of adolescents who desire novelty and creativity [22].

Furthermore, client confidence regarding the confidentiality of data is essential. This is one of the crucial aspects to consider in delivering online counseling services.

Moreover, e-Counsel Portal is to support its students via an established protocol. And with that, counseling needs to move in parallel with data analytics.

Counseling using data analytics also bridges the gap between limited knowledge and endless opportunities. Data analytics considers the student's background information, demographics, interests, motivational factors, and engagements. It also tracks red flags, detecting patterns, trends, and disturbances in students' individual or group behavior.

Data analysis will help the counselor to understand the student's learning abilities and challenges that they may encounter, monitor student progress, and promote evidence-based intervention. Also, with the help of a dashboard for data visualizations, these summarize the information or the data to understand easily. Counselor dashboards include student information for all students who have connected to the counselor and identified as their counselor.

Thus, this system will help improve the process for the Guidance office and the whole institution regarding reaching out to the student's concerns, questions, and problems.

2. METHOD AND PROCEDURE

2.1 Requirements Analysis

The specifications of the system are not fully conceptualized without proper strategy. With this, preliminary interviews, gathering data, and data analysis were performed.

In determining the process of the existing system, an Interview Letter was presented and given first to the principal and handed to the guidance counselor of the institution to conduct a preliminary interview. Interview Questionnaires were asked of the guidance counselor to know the process inside the institution. A Consent letter was also handed in to ask the guidance counselor's permission to interview the BNHS students. The initial interview was conducted at Balanacan National High School, where the guidance counselor and 50% of the total student population, 228 students, answered all the needed information through the Survey Questionnaire. All the data gathered from the institution were

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analyzed to determine the problems and come up with a solution to develop a web-based system.

After conducting fact-finding techniques such as interviews and data gathering, problems were identified. Using questionnaires given to the guidance counselor, an Entity-Relationship Diagram (ERD) was made. ERD represents the relationship between different entities and the process in the institution. Data inquired from the institution was analyzed in creating a database and the needed data for each table.

Dataflow Diagram was made to determine functions and how roles interact with them. This helps in identifying, clarifying and organizing system requirements. Dataflow Diagrams ease the way how the programmer codes the system.

Furthermore, the Gantt chart was prepared to have a well-timed schedule for developing the system. This timetable was used to remind and limit the developers' manageable time during the development. Besides, for the breakdown of works, Work Breakdown Structure was made. WBS is similar to the Gantt chart created, but it only has the itemization of works.

Planning the structure and function of the project was the next stage. A prototype was made, which served as the preliminary version of the project. It was supposed to be the clone of the original system having the same functions and structure. The prototyping model was used as a software lifecycle model.

2.2 Feasibility Analysis

A feasibility analysis determined the project's economic, technical, and operational feasibility. Data gathering, interviews, and questionnaires were used to determine the institution's potential benefits and the costs associated with the development of the system.

Economic feasibility was done by identifying and listing the expenses of supplies and materials. Operational cost and benefits analysis of existing and developed systems were listed. Cost and benefits were used to determine if the developed system's development would benefit the institution and whether the Return of Investment would be incurred within five (5) years. The amount of projected benefit was also identified.

In identifying the projected cost of the supplies and materials of the existing and developed system, 10% was added to the cost in the previous years. To compute for the projected benefit, the cost of the existing system was subtracted from the cost of the developed system.

Development and installation costs were initialized as one-time and written in year zero. Cumulative benefits were calculated by adding the previous year of the cumulative benefit and the current year of the projected benefits. Lastly, the return on investment was identified using the break-even ratio and break-even point. The formula for the break-even ratio and break-even point were:

$$\text{Break Even Ratio} = \frac{\text{Projected Benefit} - \text{Cumulative Benefit}}{\text{Projected Benefit}}$$

$$\text{Break Even Point} = \text{Break-even year} + \text{Break-even Ratio}$$

Moreover, the technical feasibility and operational feasibility of the project were executed based on the functionality and specifications of the hardware, software, and network resources available in the institution as well as for the developer to know how capable of finishing the system and of determining if the resources found can meet the minimum requirements of the hardware and software that would be used in developing the system. Interviews were conducted with the institution's technical personnel or the guidance counselor. This resulted in real solutions to the issues that arose during each process. SWOT Analysis also assesses the institution's strengths, weaknesses, opportunities and threats. This tool will assist developers in determining appropriate methods of system development.

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The guidance counselor in Balanacan NHS was interviewed to know the flow of specific and overall processes in the institution. The counselor was given a questionnaire to identify the problems in conducting face-to-face counseling at the institution. It assessed the guidance counselor's capabilities and willingness to use the system.

2.3 Development and Testing

Several development tools were used in making the system. A prototyping model was made in developing the system to respond to the client's never-ending demand and proposed a solution that was used to validate the ideas and design the project. This model allows the project to be built faster according to the client's requirements and presented to them.

Database schema defined database fields, records, and relationships during the system design. The fields used in the Entity–Relationship Diagram were used in constructing the outline of the database.

Chart.js was the dashboard, a free JavaScript library for HTML-based charts. It is one of the most straightforward visualization libraries for JavaScript and comes with built-in chart types such as scatter plots, line charts, bar charts, pie charts, donut charts, bubble charts, area charts, radar char and mixed charts. Chart.js renders in HTML5 canvas and is widely covered as one of the best data visualization libraries. It is considered significantly easier to use though less customizable than the latter.

XAMPP Server was used for the database components of the system. To handle MySQL administration over the web, phpMyAdmin, an open-source PHP tool, was utilized to execute SQL statements and control users and their consents. The tools used are HTML, Javascript, MySQL, PHP and Sublime Text.

The testing procedure is helpful in pointing out the defects and errors of the system. This activity validates and verifies the client's satisfaction level with the system and has a clear and complete projection of how the client views the system.

For validation and verification, the system will undergo an ISO 9126. It is an international standard for the evaluation of software. This is the second stage of Alpha Testing conducted with the client. The quality tester, consisting of representatives from the institution or the guidance counselor and IT experts, was identified. IT experts can be faculty members or someone who knows computers.

The evaluation was divided into four parts which address the following subjects: quality model external metrics, internal metrics, and quality in-use metrics. These international technical reports provide a suggested set of software quality metrics. Quality model external metrics may be used to measure the software product's quality by measuring the system's behavior of which it is a part. It can only be used during the testing stages of the life cycle process and any operational stages. The measurement is performed when executing the software product in the system environment in which it is intended to operate. Internal metrics may be applied to non-executable software products during their development stages (such as requests for proposals, requirements definition, design specifications, or source code. Quality in-use metrics measures whether a product meets the needs of specified users to achieve specified goals with effectiveness, productivity, safety and satisfaction in a specified context. It allows the users to measure the quality of the intermediate deliverables and thereby predict the quality of the final product.

Beta testing ensures that the end users are satisfied with a software product before the developers make it generally available. Alpha testing was done on the system and within the institution. It covers two stages. The first stage is a software review committee in which the system is presented to the panels.

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3. RESULTS AND DISCUSSIONS

As a result of the development process, the e-Counsel Portal was developed with the following functions and requirements.

3.1 Requirements Definition

3.1.1 Functional Requirements

- User Sign-in and Registration- The system should allow the users to create an account first to access the systementirelyy. The system should let the user put passwords on their account for security.
- Log in/Log-out- If the user already has an account, the system should allow the user to log in first before using the system. If the user wants to log out of their account, the system will allow them to log out.
- Changing/Updating Username and Password- The system should allow users to update their username and password. The system should ask for the current password. The system should allow the user to enter a new and confirmation password. If the password is wrong, the system should allow users to recover their accounts by clicking the forgot password button.
- Request for Counseling- If the user or the student has an account, the system should allow the user to log in and access the Counseling Request form. The system should allow the user to submit the Counseling Request form for the approval of the admin or the guidance counselor.
- Schedule of Counseling- The system should allow the admin to view the list of students requesting counseling. The system should allow the admin to accept the student's request for counseling and set an appointment or schedule of when the counseling should be done.
- Notifications- The system should email the admin or guidance counselor if there is a counseling request. The system should notify the students through email if their counseling request has been approved and is scheduled.
- Dashboard- The system should allow the admin to view the dashboard that contains data visualization of students' case notes, red flags, and reports. The system should allow the admin to view any data they want in the dashboard.
- Reports- The system should allow the admin to view, add, and print reports.
- Anonymous/Not Anonymous Posting Rants- The system should allow students or users to post their rants anonymously.

3.1.2 Non-Functional Requirements

- Security/ Privacy- The system should only allow the admin to verify user registration. The system requires user login authentication.
- Availability and Accessibility- The system should be available anytime. The system should be accessible in any browser.
- Performance- The system should make guidance and counseling accessible for students and counselors and make the intervention process more effective and efficient. The system should be user-friendly, specifically to the student.

3.2 Software Quality Evaluation Results

The e-Counsel Portal was subjected to the Software Quality Evaluation as part of the Testing and Evaluation process. Two (2) school practitioners in Balanacan National High School tested and evaluated the application using a devised evaluation form based on the ISO 9126 Software Product Quality Model. In addition, system attributes were rated using the Likert Scale, as discussed in the methodology. Below is the summarized result of ratings gathered from the evaluators.

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Table 3.2 Summary of Software Quality Evaluation

System Attribute	Weighted Mean	Adjectival Rating
Functionality	5	Excellent
Reliability	5	Excellent
Usability	5	Excellent
Efficiency	4	Very Satisfactory
Maintainability	4.5	Very Satisfactory
Portability	5	Excellent
OVERALL MEAN	**4.75**	**Very Satisfactory**

Of the six (6) system attributes that were evaluated, two (2) of them tallied a weighted mean with an equivalent rating of Very Satisfactory, while four (4) were rated Excellent. Therefore, the summary of the software evaluation indicated that the application has a Very Satisfactory rating with an overall mean of 4.75. This result proves that the system has the quality that satisfies various users' stated and implied needs and thus provides value.

4. CONCLUSION

A series of interviews and data gathering was conducted in the institution to collect information and conceptualize solutions for the problems encountered. The e-Counsel portal for BNHS serves as the virtual exchange information and communication platform between the guidance counselor and the student, making the counseling intervention accessible anytime.

In addition, the feasibility analysis indicated that the developed system was technically, operationally and economically feasible. Technical feasibility assessed the functionality and specification of the hardware, software, and network resources available in the institution. It includes the technical persons in the institution and the available resources of the developers. The guidance counselor's capabilities and willingness to use the system were considered through operational feasibility. Cost and benefit analysis was used in economic feasibility to identify if the developed system would benefit the institution and whether the Return of Investment would be incurred within five (5) years. The amount of projected benefit was also identified. As a result, the e-Counsel portal for Balanacan National High School is economically feasible to use, and the institution can benefit from the developed system after two years of use.

Furthermore, the developed system is deemed beneficial to the institution regarding accessible counseling for students, monitoring student progress and visualizing the analyzed and gathered insights in the data.

Moreover, the manual process will be concluded using the developed system since the outlined objectives and requirements specifications were supported by the Alpha Testing and ISO results with a total average of 4.25. It concludes that the system is very satisfactory.

5. RECOMMENDATIONS

For a more convenient experience while using the system and establishing an internet connection before requesting a counseling schedule, users of the e-Counsel portal are advised to use Google Chrome as their standard web browser. It is also recommended that the user should have a valid email address and provide the required information when creating an account.

The institution must have a stable power supply to avoid losing data during a power interruption. The Guidance Counselor is recommended to undergo training to enhance her knowledge of managing the system and solving technical errors—some related minimal features and functions, such as updating the school year and compiling sections.

Furthermore, future developers are recommended to make the system available in every school in the province of Marinduque to cater to more students that need proper counseling.

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REFERENCES

[1] Agarao-Fernandez, E., & de Guzman, A. B. (2005). Contextual realities of teacher education in the Philippines. *Educational Research for Policy and Practice*, 4, 129-144.

[2] Gerler, E. (1995). Advancing elementary and middle school counseling through computer technology. *Elementary School Guidance & Counseling*, 30, 8-16.

[3] Hohenshil, T.H. (2000). High tech counseling. Journal of Counseling & Development, 78, 365-368.

[4] Mallen, M. J., Vogel, D. L., & Rochlen, A. B. (2005). The practical aspects of online counseling: ethics, training, technology, and competency. *The Counseling Psychologist*, 33, 776-818.

[5] McCrickard, M. P., & Butler, L. T. (2005). Cybercounseling: A new modality for counselor training and practice. *International Journal for the Advancement of Counseling*, 27, 101-110.

[6] Owen, D. W., & Weikel, W. J. (1999). Computer utilization by school counselors. Professional School Counseling, 2, 179-182.

[7] Sampson, R. P., Jr. (2000). Using the Internet to enhance testing in counseling. *Journal of Counseling & Development*, 78, 348-356.

[8] Johnson, J., Rochkind, J. and Ott, A, 2010. Special Topic/ Why Guidance Counseling Need to Change.

[9] Mallen, M. J., Vogel, D. L., & Rochlen, A. B. (2005). The practical aspects of online counseling: ethics, training, technology and competency. *The Counseling Psychologist.*

[10] Mc Carthy, J. (2004). The skills, training & qualifications of guidance workers. *International Journal for Educational & Vocational Guidance.*

[11] Offer, M., & Sampson, J. P. (1999). Quality in the content and use of information & communications technology in guidance. *British Journal of Guidance and counseling*

[12] Pope, M. (2000). A brief history of career counseling in the United States. The Career Development Quarterly, 48, 194-211.

[13] Rodrigo, M. M. T. (2001). Information and communication technology use in Philippine public and private schools. *Loyola Schools Review: School of Science and Engineering, 1, 122-139.*

[14] Tait, A. (1999). Face-to-face and at a distance: the mediation of guidance and counseling through the new technologies. *British Journal of Guidance & Counseling, 27, 113-122.*

[15] Van Horn, S. M., & Myrick, R. D. (2001). Computer technology and the 21st century school counselor. *Professional School Counseling, 5, 124-30.*

[16] Vinluan, L. R. (2002). The Internet as a resource for research and instruction in guidance and counseling. *The Guidance Journal, 31, 41-51.*

[17] Wilson, F. R. (1995). Internet information sources for counselors. *Counselor Education and Supervision.*

[18] Jacob, Mihai (2012). Good Practices in the Use of ICT in Providing Guidance and Counseling. Retrieved from www.jobtribu.eu/pdf/else2012_Jacob.pdf

[19] Vinluan, Lorelie R. (2011). The Use of ICT in School Guidance: Attitudes and Practices of Guidance Counselors in Metro Manila, the Philippines. International Journal for the Advancement of Counseling. International Journal for the Advancement of Counseling, 33 (1), 22-36.

[20] Oraegbunam, Ngozi M. (2009). Applying Information and Communication Technology in Counseling Practice.

[21] American Counseling Association (2014). ACA code of ethics and standards of practice. Retrieved from http://www.counseling.

[22] Chester, A., & Glass, C. A. (2006). A descriptive analysis of therapy services on the Internet. British Journal of Guidance & Counseling, 34(2), 145-160.

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MRHU PORTAL: A WEB-BASED ANALYTICS DASHBOARD FOR MOGPOG RURAL HEALTH UNIT PATIENTS' HEALTHCARE

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Abstract **–** Every healthcare institution implements a Patient Record Management System, whether paper-based or electronic. A Patient Record Management System helps provide accurate, up-to-date, and complete information about patients' medical records. The developers found that there is no existing system for the Mogpog Rural Health Unit and they are using the paper-based approach in recording and storing patients' medical records. Thus, a Web-based Analytics Dashboard was proposed to address the problems being faced by MRHU, such as duplicate records and too long to locate patients' records. The system was intended to assist the Mogpog Rural Health Unit in recording their patients' data, such as personal information, medical history, diagnosis, findings, prescriptions, and medications. The primary goal of the project was to create a Web-based Analytics Dashboard for the Mogpog Rural Health Unit that will be utilized as a tool to help and assist the nurses and doctors in the RHU in recording their patients' information and consultations along with the diagnosis, findings, prescriptions, and medications, allowing them to analyze, explore and gain insights from these data. The MRHU may improve and strengthen its relationship with the patients through the proposed system. The system was developed PHP, HTML5, CSS, JavaScript, and Mockplus. MySQL and XAMPP were utilized as the database of the system. After thorough analysis, the developers concluded that the system might help build and maintain the proper way of monitoring patients' records containing personal information and quickly accessing and retrieving patient data. The system is very beneficial to the MRHU for this provides an efficient way of recording patients' data.

Keywords: MHRU Portal, Analytics, Healthcare

1. INTRODUCTION

In the recent decade, increasing information and communication technology breakthroughs have significantly improved community services, particularly in the healthcare sector [1]. Technology has aided by offering storage for patient records and fast means to search for and retrieve these records [2]. The patient record is the primary storage for information about the patient's diagnosis, findings, and medications. The doctor's findings, procedures, prescriptions, and medications are documented on the patient's medical record and presented in a written report or letter to the practitioner [3]. The patient's data can be used for data analysis and exploration to identify trends and frequencies and obtain valuable insights to get evidence for improving healthcare delivery [4]. Data Analytics also helps determine hidden patterns and unknown correlations of data using business intelligence tools to visualize data [5]. Concerning the premises above, the Mogpog Rural Health Unit uses a paper-based approach to record and store patients' data, including diagnosis, findings, prescriptions, and medications.

Mogpog Rural Health Unit is a health center in Gitnang Bayan, Poblacion, Mogpog, Marinduque. Mogpog RHU is a healthcare facility that provides outpatient care. RHU offers affordable healthcare, to all residents, particularly for people with low income. When a patient goes to the RHU, the nurse will ask the patient if he is a new or old patient. After verifying the patient's status, if the patient is a new one, the nurse will

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create a record for him. While if the patient already has an existing record, the nurse will ask for his details, such as name and address, to find his record in the logbook containing his details. After that, the patient will be ready for the consultation. The patient's vital signs, such as blood pressure, pulse rate, body temperature, respiration rate, height, and weight, will be checked by the nurse and will be recorded in the logbook. Based on these vital signs, the doctor will then formulate a diagnosis once he has figured out the patient's disease or case and will also provide the findings, prescriptions, and medications. If the patient's illness or case is not yet known, the doctor will give an initial diagnosis based on the patient's symptoms and will provide a referral or lab request/test to the patient. The patient will be given a schedule to return to the center with the lab results. The lab result will be used to create findings and prescribe medications.

However, the medical center encounters problems like; duplicate records and too long to locate patients' records causing patients to wait a long period. Additionally, they are currently not using any automated system to record patients' data. With the abovementioned problem, the developers proposed "MRHU Portal: A Web-based Analytics Dashboard for Mogpog Rural Health Unit. Patients' Healthcare".

The project's primary aim is to develop a Web-based Analytics Dashboard for Mogpog Rural Health Unit that will be used as a tool to help and assist the nurses and doctors in the RHU in recording their patient information and consultation along with the diagnosis, findings, prescriptions, and medications, allowing them to analyze, explore and gain insights from these data.

2. METHOD AND PROCEDURE

2.1 Requirement Analysis

A series of interviews and observations were done to obtain the necessary information and processes of the organization. The target organization of this project is the Mogpog Rural Health Unit. A face-to-face interview was done with one of the nurses, the head of the RHU, and a doctor using the prepared open-ended questions. The client's responses were written down, and the developers requested permission to record the interview for future use before the interview. The gathered data was examined after the interview and observation to understand the organization's needs better. In addition, studies related to the project were reviewed to better understand the proposed project. A Work Breakdown Structure was prepared to know the project's scope based on the order of tasks that must be completed. The Gantt chart was used to identify the schedule of the project activities that the development team should accomplish. Data Flow Diagram was used to show the process flow of the existing and proposed system. Entity Relationship Diagram was used to show all the entities and their relationships in the system by determining all possible tables that might be included in the system's database.

2.2 Feasibility Analysis

A Feasibility Study was conducted to establish whether the project is worthy of future development. A preliminary investigation was undertaken at Mogpog Rural Health Unit to analyze the existing system.

Operational Feasibility was used to determine and ensure the organization met its development needs. A series of interviews with its employees was undertaken to learn more about the organization's business process. The employees were asked open-ended questions. The system's targeted users, nurses, and doctors undergo interview cycles. The data were reviewed to assess if the organization's operations were feasible. The developers also evaluated the company's strengths and weaknesses in responding to the changes that the system may bring through SWOT Analysis, as well as the

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opportunities and threats that the organization may face when the system is implemented.

Table 2.1 *SWOT Analysis (Operational Feasibility)*

Strength	Weakness
• The organization has five available computers and an internet connection. • The employees are responsive and cooperative. • Immediate support for the need, social equity, consistency of service, and service access to more people.	• No guidance and efficacy.
Opportunity	**Threat**
• Better follow-up patient care.	• Cyber-security threats • Privacy and Data Security • Loss of Internet/power

The SWOT Analysis was performed to determine the developers' strengths and weaknesses. The developers' opportunities and threats in developing the system were also highlighted. The developer's technical resources, which include the hardware and software required for development, were examined. Gap Analysis was used to compare the standards to the minimum technical specifications.

Table 2.2 *SWOT Analysis (Technical Feasibility)*

Strength	Weakness
• Developers have different tools and technology for the development of the project. • The developers possess resourceful characteristics. • Teamwork and collaboration	• No enough resources.
Opportunity	**Threat**
• A better understanding of the programming language used to develop the system. • Knowledge growth. • Improve their problem-solving and analytical skills.	• Power shortage while developing the system. • Budget shortage. • Weak internet connection.

Furthermore, Economic Feasibility was utilized to see whether the project's benefits outweighed the estimated cost. A list of the supplies and materials of the organization within a year was requested. Having this information, the total amount of how much the organization consumes in supplies and materials was calculated. The estimated expenses of the organization for their materials and supplies increased by 10% every year were also calculated. The supplies and materials the organization still needs if the system is implemented were also computed. The materials lessen, as the system intends to decrease the papers and other unnecessary materials used in transactions. The addition of 10% every year was also calculated. It helped the developers identify whether the system could return the investment cost if developed and implemented. In determining the project benefit, the existing cost was subtracted from the cost of the developed system and in which year the organization will get the payback.

2.3 Development and Testing

The prototype model was used to develop a solution for testing or confirming ideas and planning the project so developers could make the needed changes or revisions. The development model for this application was prototyping. Initially, Mockplus was used to create the system's prototype. The XAMPP serves as a server to manipulate and manage the database of the proposed system. It also provided an Apache used to create a local webserver to access the

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proposed system. MySQL will be used for data storage and to connect the application to the database for the system's proper function.

3. RESULTS AND DISCUSSION

3.1 Requirement Definition

3.1.1 Functional Requirement

Functional requirement defines a system or its components. It describes the functions of an MRHU Portal must perform.

a. User Account Management
- The system can add/update user accounts classified as nurse/doctor.
- The system can allow the nurse/doctor to input email and password.

b. Patient Information Management
- The system can allow the nurse/doctor to add and save new patients' information, vital signs, consultations, diagnoses, prescriptions, medications, and laboratory.
- The system can allow the nurse/doctor to view, edit and save old patients' information, vital signs, consultations, diagnoses, prescriptions, medications, and laboratory.
- The system can allow the nurse/doctor to view patient lists.
- The system can allow the nurse/doctor to view the patient's medical history.

c. Data Analysis and Exploration
- The system can allow the doctor/nurse to analyze and explore data such as:
  1. Patient's Geographic Location
  2. Patient's Volume
  3. Patient's Diagnosis and Findings
  4. Frequency of Diagnosis and Findings
  5. Volume of medication
  6. Volume of Patients according to Age
  7. Volume of Patients according to Gender
- The system can allow the doctor/nurse to interpret those data and gain insights.

3.1.2 Non-Functional Requirements

a. Security
- The system should require the authentication of users.
- The system should be accessed only by authorized users.

b. Usability
- The system should be easy to operate and control.

c. Availability and Accessibility
- The system should be available at all times.
- The system should be able to access through any browser.

d. Performance
- The system should be user-friendly.
- The system should utilize information resources efficiently.
- The system shall function in real-time; any operation on the stored information.

3.2 Software Quality Evaluation Results

The MRHU Portal used Software Quality Evaluation as part of the testing and evaluation process using the ISO 25010. One (1) nurse in the MRHU tested and evaluated the system. The developers used the Likert Scale to rate the system attributes. Below are the results of the software quality evaluation conducted.

Table 3.2 *Summary of Software Quality Evaluation*

System Attribute	Weighted Mean	Adjectival Rating
Functionality	5	Excellent
Reliability	4	Very Satisfactory
Usability	5	Excellent
Efficiency	5	Excellent
Maintainability	5	Excellent
Compatibility	5	Excellent
Portability	4.5	Very Satisfactory
OVERALL MEAN	4.7	**Excellent**

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Out of the seven attributes of the system, the functionality, usability, efficiency, maintainability, and compatibility were rated 5-Excellent, while the two, reliability were rated 4.5 – Very Satisfactory and portability were rated 4 – Very Satisfactory. As a result, the overall mean of the evaluation was 4.7. Therefore, the system satisfies the system quality standard and the intended users of the system.

IV. CONCLUSION

A portal was developed to solve the identified problem encountered by the Mogpog Rural Health Unit since no existing system has been designed for Mogpog Rural Health Unit. The system will enable the organization to conveniently monitor patient records containing personal information and quickly access and retrieve patient data. The dashboard will visually display patients' data on consultation, medication, and frequency. Therefore, the developed system will allow the MRHU to strengthen its relationship with the patients, and the system will address the problem that the rural health unit encountered in recording patients' data.

V. RECOMMENDATIONS

Based on the given findings and conclusion, the following recommendations were made: Some features could be added to the system to assist the RHU in recording, storing, and managing their patient's information. The security of the system can be improved using emerging technologies. Future developers/researchers can also add other reports the system can generate. The developers highly recommend using the required hardware and software specification to achieve a fully functional system.

REFERENCES

[1] Omankwu, Obinnaya Chinecherem, Nwagu, Chikezie Kenneth, and Inyiama, Hycient 2017. Intelligent Electronic Patient Record Management System (IEPRMS). International Journal of Computer Science and Information Security, Vol. 15, No. 8. Pp. 338-343.

[2] Sena Lee Allen. 2009. The Health Patient Record Management System. Department of Computer Science, University of Cape Town.

[3] ACOG. 2019. Seeking and Giving Consultation. American College of Obstetricians and Gynecologists.

[4] Ajit Kumar Roy 2016. Impact of Data Analytics on Healthcare and Society. Journal of Biometrics and Biostatistics. 7:3. http://dx.doi.org/10.4172/2155-6180.1000300

[5] Moody Amakobe 2016. Big Data Analytics Uses, Theories, and Techniques in Healthcare. Colorado Technical University.

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Powerline Networking: A Design and Implementation of Powerline Networking Technology as an Alternative to Ethernet Networking at the College of Information and Computing Sciences

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Abstract—The Powerline Networking Technology was used to lessen the usage of ethernet cables and have an instant and flexible installation of network access points in some areas of the College of Information and Computing Sciences building. Since the college is not using a powerline networking technology yet for providing internet connection, the powerline networking technology was designed to provide a secondary network distributed by the powerline networking technology that uses electrical wirings to transmit data at the College ground floor. It can also be used as an alternative network for computer laboratories when its primary network become unavailable. This project was considered an experimental project to test out the technology in the college's environment. The project designers used the TP-Link powerline adapter with wired Ethernet ports, wireless features, web-based configuration, and utility software from the TP-Link Company. Designers designed a network plan to visualize the powerline and existing network used by the College using Paint3D. Additionally, the designers tested the powerline network technology to ensure that the device can transmit data using the electrical wiring environment at the College building and provide an internet connection for its intended user. The testing result revealed that it could work in the College environment and provide an internet connection to its intended users, especially for multiple connected devices. However, the designers suggested using other powerline network technology with the latest feature already available in the market, which might improve the limitation of this project.

Keywords*: Powerline Networking, Powerline Adapter, PLC, Wireless, Electrical Wirings, Ethernet cable, Transmission, CICS*

1. INTRODUCTION

Nowadays, connectivity has become a part of our lives, and most homes and establishments use a wireless or ethernet wired network for their computers to access the Internet [1]. The increase of devices being used needs to be connected to the Internet. Not all areas are accessible by its connection due to some reasons like having dead zone areas, congested environments for wireless connectivity, or some devices just requiring more effort to provide internet connectivity both wired and wireless networks by running long ethernet cables.

Despite some of these problems, alternative networking technologies can be employed to eliminate the hassle of installing long ethernet cables and provide seamless network connectivity to devices in a particular location. It is the use of powerline networking technology. It works and uses the existing electrical wiring of a building to carry out data connection while using the electricity to provide electricity to other devices. Of course, internet connectivity is essential for us to communicate with each other. It will help us get our work done faster and provide a wide range of knowledge since the Internet is an open library for most information. It also allows us to entertain ourselves and interact with other people, not with us, by communicating with them through the Internet [2, 3].

Marinduque State College (MSC), located at Tanza, Boac, Marinduque, offer formal education for junior and senior high school, college, and graduate school, and it is envisioned to pursue progressive and innovative lifelong education founded on humanistic, professional, and technologically advanced programs across

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cultures and communities. One of the colleges in MSC is the College of Information and Computing Sciences. The college building has computer laboratories and offices with many computers, a router, and other devices used in their work and also for teaching BSI/T and BSIS students. They used wireless and wired connections to linked devices and provided network access to each host inside their building.

While the college's network infrastructure used ethernet networking to communicate between networking devices, using ethernet cables became crucial since it is the most common way to install access points and provide a wired connection between devices, especially in computer laboratories. Many computers out there are wired connected to the switch up to its network source from the technical room using ethernet cables. Also, there are wireless access points for the faculty on the second floor of the college building.

As the College plans for its network infrastructure to be centralized and has no secondary network yet that can also be used as a backup network when its primary network experiences a problem from its provider of internet connectivity, the designers proposed the powerline networking technology that has a secondary network source isolated from its primary source of internet connection. It will be used as their secondary network that can be used by computer laboratories as an alternative network when the primary becomes unavailable, and these will also provide a wireless access point on the ground floor of the college building for its faculty to be used. It will also test the feasibility of implementing powerline networking technology in larger areas like the College's building environment.

As the designers, it becomes their deepest desire and concern to help the College provide another way of providing internet connectivity for its devices and its faculty and design and test out other networking solutions and approaches to solving a foreseeable problem that the College might encounter to their network. By implementing powerline networking technology as an alternative to ethernet networking for its secondary network, the College can have an alternative network to be used wirelessly and a wired connection for their devices. It will also ease and save time rather than installing and configuring other networking devices that need long ethernet cables for their secondary network [2, 3, 4].

2. METHOD AND PROCEDURE

2.1 Requirements Analysis

Interviews and observations were conducted to gather the College's network infrastructure plans and processes. The target organization was the College of Information and Computing Sciences at Marinduque State College (MSC). A request letter and approval letter were obtained to investigate and use the facility for the proposed project. An interview with the IT technician and observation of the current network infrastructure were performed. The gathered data were analyzed along with relevant research.

A Work breakdown structure and a Gantt chart were prepared to outline project activities and schedule. A Designed Network Plan was created to illustrate the implementation and use of the backup network presented on Figure No.1. The college Power Auxiliary Layout was analyzed to guide the creation of the Network Floor Plan and Physical Network Diagram utilizing powerline adapters.

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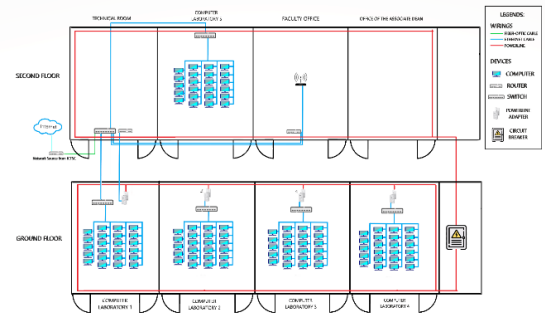

Figure No. 1: *Designed Network Plan*

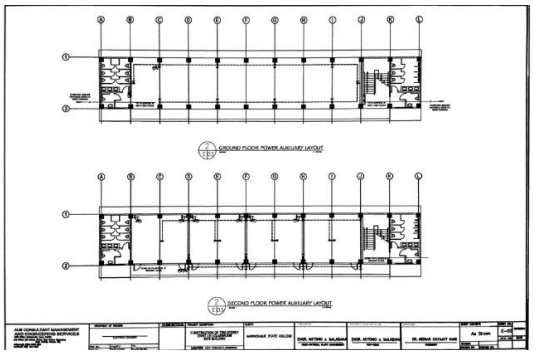

Figure No. 2*: Power Auxiliary Layout*

Based on the gathered data from the IT technician who assisted us and in observation that have conducted, opportunity to conduct and use the Powerline Network technology was seen to be feasible and fitted to apply in the CICS building based on the identified problems that have gathered.

2.2 Feasibility Analysis

Operational, technical, and economic feasibility was conducted to prove the feasibility of implementation of the Powerline Networking Technology.

SWOT Analysis in Table 2.3 was used to determine the Operational Feasibility. It was conducted to determine the strengths and weaknesses, how capable Property Owners and Occupants can adapt to the changes that the application might bring, and the opportunities and threats that may occur in using the application

Table 2.3 *SWOT Analysis*

Strength	Weaknesses
Existing network equipment Has IT technician Use one Electrical Circuit PLDT as Network Source	Limited Electrical Socket Other computer labs are not functional yet.
Opportunity	**Threats**
Introduce and test other technology. Lessen the use of ethernet cables Discover the effectiveness of powerline technology.	Power interruption Network/Signal Interruption

A GAP analysis was conducted to validate the technical feasibility of implementing the Powerline Network, identifying the hardware required for the project. Additionally, a Cost-Estimate Analysis was performed to assess the economic feasibility of the network implementation.

Table 7. *Cost Estimate of the Project Equipment*

Quan-tity	Unit	Descrip-tion	Unit Cost (Php)	Total Cost (Php)
2	Pairs	TL – WPA4220 Kit Powerline Adapter	2,500	5,000
35	meters	Ethernet Cables	500	500
2	pieces	AC Power Plug Conversion Adaptor	75	150
Total budget expenses:			**PHP**	**5,650**

2.3 Design and Testing

The designers utilized Microsoft's Paint 3D software to create the network plan design for the proposed secondary network using powerline

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networking technology. The design was based on interview data and observations conducted within the College building. For the powerline network on the ground floor, a suitable location for the powerline adapter was identified by analyzing the auxiliary power plan and estimating the wireless range for connectivity. The designers also considered the connection to a switch in computer laboratories for backup use.

The network infrastructure design incorporated various networking equipment such as ethernet cables, network switches, powerline adapters, and a modem or router as the Internet source. The TP-Link WPA4220kit served as the prototype device for the project, and a series of tests were conducted to assess its functionality, performance, and limitations within the College building. This included speed testing of both the primary ethernet network and the secondary powerline network using multiple devices.

Mathematical formulas were used to calculate the average network performance in the computer laboratories based on the sum of all computer network performances and the number of computers in each lab. The project testing followed the designed network plan and utilized the PLDT fiber router as the Internet source, as well as the tpPLC utility software from TP-Link's website for configuration and monitoring of the powerline adapters.

To gather user feedback, a user experience survey was conducted among the College's students and faculty members, specifically targeting their experience with the secondary network that employed powerline networking technology for wired and wireless access points.

3. RESULTS AND DISCUSSIONS

3.1 Requirements Definition

Functional requirements specify the functions that the powerline network technology should provide to the college network infrastructure.

For the IT technician and the Faculty members of the College.

1. Easier installation process - using the powerline adapters, this will transmit a network connection by using electrical wirings of the building from one device to another. It will also help lessen the ethernet cables being used and expand the network connectivity.
2. Plug and play – the powerline adapter doesn't need new wires and configuration. It automatically acts as an instant bridge for transmitting an internet connection between devices using electrical wirings.
3. Security feature – there's a built-in security feature in powerline technology that automatically creates an encrypted connection once a connection is established to each powerline device.
4. Secondary network - having the powerline networking technology as an alternative to ethernet networking for their secondary network can provide a wired and wireless connection since powerline adapters have the capability. It can also be used as a backup network when the primary network experiences a problem providing an internet connection.

3.2 Result of Testing

Project testing was done to check the powerline network's functionality, performance, and limitation using electrical wirings. Utility software and its web-based configuration setting of powerline devices from TP-Link were used for monitoring and controlling the powerline network while conducting the whole project testing.

For the Functionality Test, the designers used two pairs of TP-WPA4220kit, including one (1) powerline adapter source and one powerline adapter receiver with wireless features per kit. In

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the first testing phase, the designers check the connection of each powerline adapter in a different setup. It was done to ensure that the powerline adapter could be paired. The first result can be seen in Table 9, where the powerline network adapter is in a different computer laboratory room on the ground floor, and the powerline network adapters are successfully paired. It uses one (1) single electrical wiring for the distribution of electricity and to transmit an internet connection.

In the second test for its functionality, the designers test out different electrical lines that cross to the college's circuit breaker. The powerline network adapter that serves as the network source was placed in Computer Laboratory 1. The other powerline network adapter, Receiver 1, was established in Computer Laboratory 3, which has a distance of about 20 meters (The length of the computer laboratory is 8 meters each). To test the connection from the ground floor to the second floor, the other powerline network adapter that serves as Receiver 2 was placed on the second floor of the building near the Associate Dean's office. Receiver two was paired with Receiver 1, located in Computer Laboratory 3 on the ground floor, which has a distance of almost 32 meters.

As shown in Table 10, each Powerline network adapter can be paired with each other in the testing set-up. However, when the powerline adapter is being distanced, receiver two is placed farther from receiver 1. The powerline connection disappeared and became undetected, and it is because it exceeded the limit of the powerline adapter that can accommodate its connection which is only about 300 meters long.

Table 9. *Functionality Test – Single Electrical Circuit Line*

GROUND FLOOR CICS BUILDING (SINGLE ELECTRICAL CIRCUIT LINE)		
Test Scenario	**DETECTED**	**UNDETECTED**
1. Source 1 – Receiver 1	▯	
2. Source 1- Receiver 1- Receiver 2	▯	
3. Source 1- Receiver 1- Receiver 2- Source 2	▯	

Table 10. *Functionality Test – Different Electrical Lines from Circuit Breaker in CICS*

GROUND FLOOR – SECOND FLOOR CICS BUILDING (DIFFERENT ELECTRICAL LINES FROM CIRCUIT BREAKER IN IIST)		
Test Scenario	**DETECTED**	**UNDETECTED**
1. Source 1 & Receiver 1(Ground floor) – Receiver 2 (Second Floor)	▯	

Table 11. *Functionality Test – Different Electrical Circuit Breaker*

In the third and last phase of the functionality testing, the designers tested different sets up where the power line network adapter source is still located in Computer Laboratory 1 connected to the Electrical Circuit of the College Building.

The other powerline network adapter, Receiver 1, was placed on the neighbor department, the College of Accountancy Business Administration & Tourism Management. As seen in Table 11, the powerline network adapter cannot detect each other because the Neighbor College building of the CICS used a different electrical circuit breaker that managed the electricity distribution in the building. This result also proves that the security issue of the powerline adapter for unauthorized access to the College's powerline network is only possible if the neighboring college building uses a powerline network for their network infrastructure.

For the Performance test, designers conducted multiple testing phases with different set-ups. These include the Primary Network provided by the ICTSC, Secondary Network Source, the PLDT Fiber used separately by the College, and the Powerline network, which will serve as a secondary and alternative network when its primary network becomes unavailable. The designers used three (3) different speed testing tools for the initiation of testing that used the server located in Manila, Philippines, to get a fair testing result. Two computer laboratories were utilized in the performance test for each testing phase. These labs were used with multiple devices that were connected through wired connections. The other two computer labs were not used as they currently do not have functional

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computers yet, and the College is not finished setting up those laboratories on the ground floor of the college building. At first, the designers tested the primary network to analyze how fast its network source provides to the College in computer laboratory rooms and wireless access points for the faculty (Refer to Table 12 & 13 actual testing result). It will serve as the standard for whether this project could be used as an alternative to the ethernet network when its prior experience a problem. Next is the secondary network source for internet access in the powerline network, the PLDT Fiber (Refer to Table 14 for the actual testing result). Last is the Powerline network that was used to distribute internet connection from the secondary network on the ground floor of the college building. On conducting the powerline network performance test, it was tested on a different set-up.

First, it was tested in wired connection in single devices, which was executed to show how much the connection degraded while using the electrical wirings. As a result, its secondary network source obtained a speed of 311.66 Mbps download speed during the testing phase, 426.16 Mbps upload speed, and seven milliseconds in wired connection (Refer to Table 14 for the actual testing result). The powerline networking technology is only able to get 62.47 Mbps download speed, 67.02 Mbps upload speed, and 37 milliseconds of latency (Refer to Table 15 for the actual testing result), which also shows that from its network source to powerline network, it reduced up to 80% of its network speed considering that it uses the electrical wirings, its distance from the network source that has at least 30 meters, and the capabilities of the powerline network adapter that are only able to transmit a maximum of 600 Mbps to a powerline connection.

Another test the designers conducted is the Powerline network performance when using multiple devices. They tested it in a different set-up in a computer laboratory on the ground floor. First is the Wired connection with connected appliances that use electricity on the same electrical lines where the powerline adapter is installed. The second and last is a wired connection without appliances. It was conducted to show if the College's environment used different electrical wiring that distributes electricity to each device. The designers have also based the appliances used during testing on the standard device used during an actual scenario in that room. It includes Smart TV, Electric fans, and chargers.

The designer also consists of the computer units inside the computer laboratory rooms and lights. It was designed with different electrical distribution lines to determine if it would affect the powerline network. As a result, it shows (Refer to Table 16 for the actual testing result) that there is no difference in the average latency, downloads, and upload speed with and without connected appliances. It will be advantageous to the College to use power line networking technology since they have different electrical wirings used for their computer units, Air conditioners, and other appliances that consume vast amounts of electricity in the building.

For the wireless feature offered by the powerline networking technology that distributes internet connection, in the design, it was capable of broadcasting to all the computer laboratory rooms on the ground floor, and the faculty members can use these during their lectures or classes. The designers also tested it in a different setup with and without appliances. They compared the Powerline Main Network to its Guest Network to differentiate its differences in security and capabilities in providing internet connection.

As a result, (Refer to Tables 17 & 18 for the actual testing result), the comparison between each type of network offers almost the same network speed even with and without appliances used on electrical wirings where the powerline

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adapter is installed. As the designers also observed and tested, the guest network can only limit and schedule the time when the guest network is used, not its user's usage. It also prevents the user of the guest network from seeing the other connected devices and accessibility of its web-based configuration page. It proves that it can only provide an internet connection to the user but not the configuration, modification, or even monitoring of the powerline network compared to the Main network provided by its wireless feature.

Additionally, designers tested the distance provided by the powerline adapters' wireless feature in a single device. Each location where the powerline adapter wireless connection being broadcast was tested, including Computer Laboratory 1, Computer Laboratory 2, Computer Laboratory 3, and Computer Laboratory 4 on the ground floor of the college building.

As a result, (Refer to Tables 17 & 18 for the actual testing result), Computer Laboratory 2 and 3 can provide a fast internet connection with up to 68.99 Mbps- 83 Mbps download speed,67 Mbps – 64 Mbps upload speed, and ten (10) milliseconds of latency in a single device considering that there are not much obstacles and walls that can reduce the internet connection since the location of testing are also the location where the powerline network that has a wireless feature is installed.

However, as the designers also observed and based on the testing results in Computer Laboratory 1 & 4, the wireless connection of the powerline adapter network speed has been reduced to 30-60% considering that in each room, it has a wall and has at least 8 meters' distance.

For the limitation of powerline network adapters (Table 19 for the result), the designers have gathered and observed it while deploying the test in the college building. Overall, the powerline network can reach the powerline connection up to 300 meters from its network source and receivers. The powerline network needs to use the same electrical circuit. Its wireless range can only cover up to 24 meters long, providing an acceptable network speed for three (3) computer laboratories when the powerline adapter is at the center.

Each powerline network adapter with wireless features can only accommodate up to 16 users since the project used two powerline adapters with wireless features so that the network can accommodate 32 users. In contrast, for the wired connection provided by the powerline adapters and using a network switch to accommodate multiple devices, there is no limitation for the devices to be connected. The powerline network adapter's utility software only supports Windows OS and MacOS; however, other operating systems can still use the web configuration setting to manage and configure the powerline network.

After the designers' functionality and performance tests, they conducted user experience testing with at least eight questions to be answered to gather real user experience and identify areas where the project can be improved and meet users' needs. It also enables the designers to see the overall experience of the expected users of the project when it was used as an alternative network in terms of functionality, usability, and accessibility. The designers can gather a group of users for these tests, including the faculty and students of the College, with a particular task for using the powerline network.

As a result, most users are satisfied with what the network provides them, although three neutral respondents answered. In terms of ease of connection to the powerline network, most users have experienced the ease of connecting to its network in wireless features. Another is the reliability of the powerline network during use. Most users can experience a reliable speed during the testing with multiple users and using the electrical wirings.

In contrast, in terms of the speed of the powerline network during the testing, it provided

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a fast network speed capable of streaming videos and browsing the Internet. Regarding the user's perception of security when using the powerline network, some still need clarification since it uses electrical wirings. Still, most users feel secure during use considering the network issue from the powerline.

The convenience of connecting to the powerline network in different areas of the building, as the designers also observed that when in other places, the powerline adapter that has wireless feature has limited capabilities and not that powerful technology for providing wireless connection, users experienced some difficulty during the use of powerline network in other areas where the powerline network adapter is not installed.

Lastly, compared to the powerline network, it will serve as the secondary network to the primary network used by the College. Users see from their overall experience on both that the powerline network can provide better performance considering it was running on a different network source from the College. Some also answered that they experienced slightly worse and about the same experience, proving that if the powerline network is used as an alternative network to its primary, the College can still provide the needs in using the powerline network.

PRIMARY NETWORK

Table 12. *Primary Network Source (Provided by ICTSC) Actual Internet Speed in Single Device*
**Based on speed testing tools (Ookla, Internet Health Test, and Measurement Lab)*

Connection Type	Band Frequency	Average Latency	Average Download Speed	Average Upload Speed
Wired	N/A	8 ms	71.11 Mbps	81.48 Mbps
Wireless	2.4Ghz	48 ms	24.90 Mbps	55.41 Mbps

Table 13. *Primary Network Source (Provided by ICTSC) Actual Internet Speed in Multiple Devices*
**Based on speed testing tools (Ookla, Internet Health Test, and Measurement Lab)*

Connection Type	Room	Average Latency	Average Download Speed	Average Upload Speed
Wired	CL2	38 ms	16.80 Mbps	23.58 Mbps
	CL3	37 ms	14.06 Mbps	17.85 Mbps

SECONDARY NETWORK SOURCE

Table 14. *Secondary Network Source -PLDT Fiber Actual Internet Speed in Single Device Actual Internet Speed in Single Device*
**Based on speed testing tools (Ookla, Internet Health Test, and Measurement Lab)*

Connection Type	Band Frequency	Average Latency	Average Download Speed	Average Upload Speed
Wired	N/A	7 ms	311.77 Mbps	426.16 Mbps
Wireless	2.4Ghz	9 ms	90.32 Mbps	71.07 Mbps
	5Ghz	9 ms	302.8 Mbps	287.86Mbps

POWERLINE NETWORK

Table 15. *Powerline Network connected to Secondary Network Source (PLDT Fiber) Actual Internet Speed in Single Device*
**Based on speed testing tools (Ookla, Internet Health test, and Measurements Lab)*

Connection Type	Latency	Download	Upload
Wired	37 ms	62.47 Mbps	67.02 Mbps

Table 16. *Powerline Network connected to Secondary Network Source (PLDT Fiber) Actual Internet Speed in Multiple Device*
**Based on speed testing tools (Ookla, Internet Health Test, and Measurement Lab)*

Connection Type	With Connected Appliances	Room	Average Latency	Average Download Speed	Average Upload Speed
Wired	Yes	CL2	69 ms	7.3 Mbps	9 Mbps
		CL3	77 ms	9.07 Mbps	6.69 Mbps
	No	CL2	75 ms	6.96 Mbps	10.55 Mbps
		CL3	94 ms	6.80 Mbps	9.87 Mbps

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Table 17. *Powerline Network – Wireless Feature-Main Network Actual Internet Speed in Single Device *Based on speed testing tools (Ookla, Internet Health Test, and Measurement Lab)*

Connection Type	With Connected Appliances	Room	Average Latency	Average Download Speed	Average Upload Speed
Wireless 2.4Ghz (Main Network)	Yes	CL1	29 ms	27.75 Mbps	25.56 Mbps
		CL2	10 ms	68.99 Mbps	67.67 Mbps
		CL3	11 ms	83.52 Mbps	64.44 Mbps
		CL4	25 ms	51.77 Mbps	41.49 Mbps
	No	CL1	26 ms	29.97 Mbps	33.65 Mbps
		CL2	11 ms	74.32 Mbps	64.70 Mbps
		CL3	11 ms	64.38 Mbps	57.77 Mbps
		CL4	11 ms	51.64 Mbps	29.59 Mbps

Table 18. *Powerline Network – Wireless Feature- Guess Network Actual Internet Speed in Single Device *Based on speed testing tools (Ookla, Internet Health Test, and Measurement Lab)*

Connection Type	With Connected Appliances	Room	Average Latency	Average Download Speed	Average Upload Speed
Wireless 2.4Ghz (Guess Network)	Yes	CL1	10 ms	26.85 Mbps	29.61 Mbps
		CL2	19 ms	67 Mbps	91.14 Mbps
		CL3	28 ms	79.40 Mbps	89.38 Mbps
		CL4	18 ms	45.94 Mbps	24.21 Mbps
	No	CL1	11 ms	35.93 Mbps	32.86 Mbps
		CL2	25 ms	72.16 Mbps	80.14 Mbps
		CL3	10 ms	79.91 Mbps	64.55 Mbps
		CL4	10 ms	34.79 Mbps	25.09 Mbps

Table 19. *Powerline Network Adapter Limitation Finding*

Scenario	Result
1. Powerline Network Adapter range when using the electrical wirings.	up to 300 meters (as advertised)
2. Maximum host for Wireless feature	Up to 16 client per Wireless Powerline network adapter
3. Wireless feature range	24 meters/3 Computer Laboratory per powerline network adapter
4. Utility supported Operating system	Windows Operating System, MacOS

4. CONCLUSIONS

. Based on the result, the powerline network is feasible to implement in the college environment considering that they have an advantage of using the powerline network because they use different electrical wirings for the air conditioners and computer units that consume high voltage to work. It will avoid possible electrical interference on the powerline network.

Additionally, based on the testing result, the wired connection in two (2) computer laboratories provided an excellent network speed in multiple devices. However, these will still be different when using an actual usage scenario, mainly if the College uses it at its full potential, including its wired and wireless features simultaneously, and has a lot of user load in the powerline network. However, it can still be used as a secondary network wireless access point on the ground floor for the faculty members during their stay and classes when it is not an alternative to its primary network. It can provide an acceptable network speed for the faculty members' needs. It is also important to note that the powerline network might still be affected by the electric interference if the electrical wiring line used by the powerline network has an appliance that uses a considerable amount of electricity, and this might be unavoidable since the electrical wiring was used and designed to provide electricity in electrical appliances. Also, its network performance will still depend on its network source condition and electrical wiring condition and should have a balance in powerline networking technology specifications to its network source. Hence with this, the designers also found that there is more area for further study to improve the project, including the prototype devices used as a powerline networking technology is outdated. Although it can provide good network speed, the designers found that more powerline adapter will soon be available in the Philippines and has greater specifications that might improve the network being transmitted using the electrical wiring at the College.

5. RECOMMENDATIONS

The designers found that many other areas for study and examination for this capstone project would also be advantageous. The following are some of the places where further study is needed:

1. One (1) Powerline Networking Adapter per computer laboratory room with wireless features and at least two (2) ethernet ports.

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2. Use a Gigabit powerline networking adapter with a higher frequency and transmission rate to achieve better results while using the electrical wirings.
3. Test and explore other brands that offer powerline networking technology available in the market.
4. The addition of a powerline networking adapter might be helpful for more users that the powerline network can accommodate and also to expand its network coverage.
5. Use of pass-through powerline adapter to save electrical sockets for other use.

REFERENCES

[1] Ingenia 2017. How Does That Work? Powerline Networking (March 2017) Doi: https://www.ingenia.org.uk/ingenia/issue-70/how-does-that-work-powerline-networking

[2] Dean Evans 2014. Power Networking: What You Need to Know. (January 17, 2014). doi: https://www.techradar.com/news/networking/powerline-networking-what-you-need-to-know-930691%23

[3] Andy Betts 2019. What Are Powerline Adapters? (November 28, 2019). doi: https://www.makeuseof.com/tag/8-things-powerline-adapters-need-know-first/amp/

[4] Tyler Lacoma 2021. Is Wi-Fi Too Unreliable? Powerline Networking May Be What You Need (March 22, 2021). doi: https://www.digitaltrends.com/computing/everything-you-need-to-know-about-powerline-networking/

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IOT-BASED ANTI-THEFT DETECTION DEVICE USING ARDUINO

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Abstract **-** The "IOT-Based Anti-Theft Detection Device Using Arduino" was developed to detect and prevent intrusion and theft incidents automatically and send messages as warning and call alerts regarding the present scenario to the owner/s of certain establishments. The developers used an ESP32 camera, proximity sensor, reed switch, GSM module (SIM900a), LED, Blynk App, and microcontroller (Arduino Nano) for the anti-theft detection device. The developers tested the system's correctness by checking the error percentage of the evaluated data, including the acquired data from any manual estimation. Additionally, the result taken from the evaluation of the device testing shows that the prototype of the upgraded anti-theft detection device has met all the expected technicalities required to produce the desired performance of the system. Therefore, it has been determined that the IoT-Based anti-theft detection device that serves as electronic surveillance and intrusion detection device will make people aware and prevent damage or casualties to any property if someone tries to break into an establishment. Thus, the study concludes that the IoT-Based Anti-Theft Detection Device would benefit both establishments and homeowners. However, this does not limit the system's function, and some modifications are needed to develop the project.

Keywords: *IoT, Anti-Theft Detection Device, Arduino, Blynk App, Sensors*

1. INTRODUCTION

A theft incident is one of the common problems that need immediate action. It is a crime of stealing or attempting to take important things with full intention. Closed-circuit television (CCTV) is one of the tools to prevent this incident by monitoring the event all day. Nonetheless, if no authorized person is watching, a thief can break out because there is no warning that someone is breaking in. As a result, the thief steals personal belongings, which may affect the business and owners. For example, the NCRPO or the National Capital Region Police Office said theft cases from March 1 to April 5, 2022, have slightly increased in Metro Manila. From 288 theft cases, it increased by 4.17 percent to 300 cases, which brings a significant loss for the victims [1]. The CCTV may have caught other incidents that cause destruction.

Despite that, some establishment owners or police stations cannot respond quickly because of a lack of signal warning of the incident. Due to that, providing an anti-theft detection device that can be made at home will employ sensors and IoT technologies to give early warning to the chosen organization, which is DMJJ Rovira General Merchandise, which will serve as intrusion detection and electronic surveillance. The organization can receive an SMS as a warning signal, and if the thief opens the door, they will receive a call as an alarm. If the thief enters the establishment, the owner can check it through the Blynk app installed on their smartphone to keep in touch with the current situation in their business's establishment.

A typical CCTV is just for monitoring purposes. It will improve to a much better system, composed of a microcontroller, proximity sensor, reed switch, real-time camera for real-time

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monitoring, and a GSM module that automatically sends SMS and call alerts to keep the owner aware of the possible incident using their smartphone that has telecommunication signal. Nonetheless, the success of an organization's security system program is frequently contingent on the effectiveness of each component in terms of implementation, improvement, and maintenance [2]. x

2. METHOD AND PROCEDURE

2.1 Requirement Analysis Procedure

Interviews and inspections were conducted to gather the necessary information and processes. A Letter of Interview was handed to Mr. Diomedes F. Rovira. The developers used an open-ended question to gather the requirements for developing and implementing IoT-Based-Anti-Theft Detection-Device using Arduino. Developers chose this establishment due to its history of the robbery incident and the lack of notification features of its existing electronic surveillance device.

After the interviews and inspections, the collected data were examined to understand the project further. In addition, studies relevant to this project have been analyzed to gain broader knowledge.

The developers also created several diagrams that can be helpful for developing the device, including Work Breakdown Structure, Gantt Chart, Flow Chart, Block Diagram, and Schematic Diagram. Moreover, a prototype was developed and presented to the owners to foresee the final project as it looks and performs its essential functions concretely.

2.2 Feasibility Analysis

A Feasibility Analysis was conducted to determine whether the concept merits further development. This procedure analyzes all the relevant factors of the project, including the consideration of its benefit, strength, pros, and cons, to ascertain the project's accomplishment.

Operational feasibility has been utilized to identify and guarantee that the organization satisfies the development criteria. The Operational Feasibility-SWOT Analysis presented in Table 1 allowed the developers to identify the organization's adaptability, strengths, and weaknesses. Also covered were the opportunities and threats the organization may face from implementing the technology.

Table 1 *Operational Feasibility SWOT Analysis*

Strengths	**Weakness**
Finance: The organization has financial solid capability and is willing to support the development of this device. **Expertise:** The organization is capable of using smartphones and aware of the emerging technologies we have right now.	**Outdated Equipment:** The organization has only standard CCTV and no intrusion detection.
Opportunities	**Threats**
New Technology: The organization and other establishments may consider replacing their current technology with ours.	**Service Provider:** A power outage and a weak network signal will hinder the device's functionality.

Moreover, the available technological resources were evaluated by comparing the available technical resources to the minimum technical specification which presented in Table 2 Operational Feasibility Gap Analysis.

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Table 2 *Operational Feasibility Gap Analysis*

Technical Specification needed for the Propose Device	Technical Specification of the Available Resources	Action Needed
Hardware		
Smartphone: • Android 6.0 or higher / iOS	Android and iOS	Use the available smartphone of the user
Internet Connection	PLDT Home FIBR	Use the available router of the organization
Software		
BLYNK Application	None	Install BLYNK Application from the play store or app store

Technical feasibility has evaluated whether the developers have the necessary technical resources to create the device. The developers assessed their ability to develop the device. The Technical Feasibility SWOT Analysis in Table 3 was used to determine the developers' strengths and weaknesses. In addition, the opportunities and challenges that the device's developers may face during development were outlined.

Table 3 *Technical Feasibility SWOT Analysis*

Strengths	Weakness
Management Team: Team members are networking and data security researchers with a background in computer programming; as a result, we have the necessary skills to create the project. **Time:** Developers have sufficient time to develop the project. **Marketing:** Team members have experience advertising and selling products on various social media and e-commerce platforms.	**Device Configuration:** To increase accuracy, developers must customize each device based on its placement within an organization, which requires additional resources. **Resources:** All the necessary hardware components for developing the device are unavailable at the developers' location; therefore, they must purchase it online or from a physical store. **New:** Developers still need to establish themselves as a reliable provider of security systems.

Opportunities	Threats
Partnership: With the success and potential of this project, government assistance will be possible like the DOST program or any other organizations. **Experience:** The experience and knowledge that developers obtained while creating this device will enable them to enhance the precision and reliability of this technology. **Trends:** This technology is an IoT; therefore, developers can scale up to add more features and functionalities to this device.	**Service Provider:** A power outage and a weak network signal will hinder the development of the project and the device's functionality. **Competition:** It is feasible for large firms to adapt and enhance their technology with the same capabilities as this device and sell it at a lower price. **Supply:** The shifting prices of electronic devices on the market make selling at a fixed price more challenging. Additionally, the technological equipment that developers acquire is sometimes defective.

The available technical resources of the developers, including the required hardware and software, are also evaluated. Through Technical Feasibility Gap Analysis presented in Table 4, the specifications were assessed and compared to the minimal technical specifications.

Table 4 *Technical Feasibility Gap Analysis*

Needed Resources	Available Resources	Action Needed
HARDWARE		
Microcontroller: • 16MHz or faster • 32KB Flash Memory	None	Purchase the needed specification for microcontroller
Camera Module: • OV2640 or other cameras compatible in microcontroller • 2MP or higher	None	Purchase camera module that supported by microprocessor
GSM Module • SIM900A	None	Purchase GSM module
IR Proximity Sensor • Proximity Sensing • Gesture Detection	None	Purchase IR Proximity Sensor
Reed Switch	None	Purchase Reed Switch

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Permanent Magnet • Neodymium Magnet	None	Purchase Permanent Magnet
Lithium Battery Charger Module • Type C Micro USB 5v 1A	None	Purchase Lithium Battery Charger Module
Booster Power Module • MT3608 2A Max DC-DC Step Up	None	Purchase Booster Power Module
IR LED Illuminator Board	None	Purchase Illuminator Board
DC 12V Relay 1CH Wireless Remote Control Switch Transmitter	None	Purchase Relay 1CH Wireless Remote Control Switch Transmitter
PFM Control DC-DC Converter Step-up Booster Module	None	Purchase PFM Control DC-DC Converter Step-up Booster Module
Li-ion Battery (*mAh*)	None	Purchase Li-ion Battery
Female Jack and Male Plug Adapter	None	Purchase Female Jack and Male Plug Adapter
2 Pin PCB Screw Terminal Block	None	Purchase PCB Screw Terminal Block
SOFTWARE		
Operating System • Windows 7, 8, 10, 11	Windows 10	Use the available operating system of the developers
Arduino IDE	None	Install Arduino IDE on developers computer
Blynk App	None	Install Blynk App on developers smartphone

Furthermore, the economic feasibility is calculated to assess whether the value of the project exceeds its predicted cost. The anticipated annual increase in operational maintenance costs is 10 percent, presented using Operational Cost in Table 5.

Table 5 *Operational Cost*

Particular	Year 1	Year 2	Year 3	Year 4	Year 5
IR Proximity Sensor	Php 100.00	Php 110.00	Php 120.00	Php 130.00	Php 140.00
Reed Switch	40.00	44.00	48.00	52.00	56.00
Neodymium Magnet	276.00	303.60	331.20	358.80	386.40
Li-ion Batter	100.00	110.00	120.00	130.00	140.00
IR 36 LED Illuminator Board	99.00	108.90	118.80	128.70	138.60
Total: Php	**615.00**	**676.50**	**738.00**	**799.50**	**861.00**

Moreover, the selling price and return on investment for one device with one camera are also calculated as presented in Table 6.

Table 6 *Selling Price and Return on Investment*

Total Expenses = **Php 5, 533.00**
Cost Price = **Php 5, 533.00**
Markup = **1.25** or **125% (***the 125% markup is based on the rule of thumb in selling pricing)*

Selling Price = $Cost\ Price \times Markup$
Selling Price = **Php 5, 533.00 * 1.25**
Selling Price = **Php 6, 916.25 (additional Php 500.00 per camera)**

Gross Profit = $Net\ Sales - Cost\ of\ Good\ Sold$
Gross Profit = **Php 6, 916.25 - Php 5, 533.00**
Gross Profit = **Php 1, 383.25**

ROI = $\frac{income}{capital} \times 100\%$
ROI = $\frac{\textbf{Php 1,383.25}}{\textbf{Php 5,533.00}} \times 100\%$
ROI = **25%**

Since the organization's security system consists of eleven (11) cameras, the developers also calculated the overall cost of the nine-camera device they designed. The result is compared to the cost of the organization's current security system Table 7, which determines if the project is economically feasible.

Table 7 *Comparative Analysis of the Overall Cost of the Existing Security System of the Organization and the Developed Device*

Selling Price of Developed Device
Php 6, 916.25 (additional Php 500.00 per camera)
Existing Security System of the Organization
Total Expense = **Php 50, 000.00** (with 11 cameras)

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Developed Device
Total Expense = $Selling\ Price + (Php\ 500 \times No.of\ camera)$
Total Expense = $\boldsymbol{Php\ 6,916.25 + (Php\ 500 \times 10)}$
Total Expense = $\boldsymbol{Php\ 6,916.25 + Php\ 5000.00}$
Total Expense = $\boldsymbol{Php\ 11,916.25}$ (with 11 cameras)

$Existing\ Security\ System\ of\ the\ Organization > Developed\ Device$

$$\boldsymbol{Php\ 50,000.00 > Php\ 11,916.25}$$

2.3 Development and Testing

The development model the developer used in this project is the prototyping model. In this model, the prototype of an IoT-Based anti-theft detection device was built and then tested and modified based on the feedback received from the users. The system development model represents the process of doing this project to allow the users to evaluate and try it out before the implementation.

The process started with data gathering and interviewing the store's owner. Then, the gathered data were analyzed, resulting in a requirements document. It became the basis of the initial prototype that the developers developed. This prototype model was the device to detect possible theft attempts or establishment breakers.

In developing the prototype design, Arduino Nano served as the device microcontroller. The Arduino standard API (Application Programming Interface) is used to construct the Arduino, ESP32-cam, GSM module, and sensors.

In enabling control over the system, the Blynk app was used. Blynk app will allow a user to interact with the device; this app has drag-and-drop features, enabling easy access. With the Blynk library, it is possible to control the device directly from smartphones without any code.

Every part was inspected deliberately. After the development, a series of testing procedures like Alpha testing and Beta testing was done. The developed device was examined to identify its possible issues or bugs. The system's functionality will be tested to ensure it is error-free and false-alarm-free. Another purpose of this test is to evaluate the system's compliance with the specified requirements. The actual results will be compared to the expected result.

2.4 Part-by-Part Assembly

2.4.1 ESP32-CAM Configuration

ESP32-CAM is a microcontroller that will serve as the device's primary camera. It comes with an OV2640 camera and provides an onboard TF card slot.

Step 1: Material Preparation

- ESP32-CAM
- Arduino Nano Board
- IR 36 LED Illuminator Board
- Jumper Wires
- TP4056 Lithium Battery Charger Module Micro USB 5V 1A)
- Booster Power Module (MT3608 2A Max DC-DC Step Up)
- IRF3205 MOSFET
- 32650 Li-ion Battery
- Capacitor 6.3V 1000uf
- Resistor 10k ohms

Step 2: Pin Connection

- Connect the negative power input of ESP32-CAM and IR LED illuminator board to the drain pin of n-channel MOSFET.
- Connect the positive power input of the ESP32-CAM and IR LED illuminator board to the positive output of the mt3608 power module.
- Connect the Source Pin of n-channel MOSFET to the ground
- Connect the Gate pin of the n-channel MOSFET to the D4 pin of the Arduino Nano
- Connect the Negative power input of ESP32-CAM and IR LED illuminator board to the drain pin of the n-channel MOSFET
- Connect 10k ohms resistor to the gate and collector of n-channel MOSFET.

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Step 3: Adding Library

- Add a library of ESP32-CAM to Arduino IDE by downloading it.
- Open Arduino, go to File > Preferences > and input the URL of the .json file of ESP32-CAM on the Additional Boards Manager.

Step 4: Setting Up ESP32-CAM

- Plug the ESP32-CAM into the computer using a micro-USB cable
- Wait for the red-light indicator on the ESP32-CAM board.
- Open Arduino IDE
- Go to Tools > Board > ESP32 Arduino and find AI Thinker ESP32 CAM
- Check the Port where the ESP32-CAM is inserted. Go to Tools > Port and select the correct Port
- Start inputting codes for the ESP32-CAM
- After coding, upload and compile the file.
- Open Serial monitor to generate the IP address needed in the BLYNK app. Go to Tools > Serial Monitor

2.4.2 GSM Module Configuration

GSM (Global System Mobile Communication) Module is a hardware device that connects to a remote network through GSM mobile telephone. They are substantially identical to a typical mobile phone in the eyes of the mobile phone network, including the necessity for a SIM to identify itself.

Step 1: Material Preparation

- GSM Module (SIM900A v4.0)
- Jumper Wires
- SIM Card

Step 2: Pin Connection

- Connect the negative and 5V terminal of GSM Sim900A to the output power of the mt368 power module.
- Connect the TX pin of GSM Sim900A to the D6 pin of Arduino Nano
- Connect the RX pin of GSM Sim900A to the D7 pin of Arduino Nano

Step 3: Booting Up Sim900A

- Insert SIM card into GSM module
- Power up the GSM module
- The indicator light will flash repeatedly. As soon as it connects to the network, it will stop blinking and only blink once every three seconds, indicating it is connected.
- After the connection was established, it is now ready to be programmed.

Step 4: Basic AT Command

- To change SMS sending mode: ("AT+CMGF=1")
- To read SMS in text mode: AT+CNMI=2,2,0,0,0
- Once the GSM module establishes a connection, it will send an SMS to the user stating, "Camera Security System is Ready."
- User SMS command to operate security system: (“AT+CMGD=1,4")
    - S0 = Turning off the security system
    - S1 = Turning on the security system
    - S2 = Turning off call alert
    - S3 = Activating camera
    - S4 = Turning off the camera
- Wireless Remote-Control command to operate security system: (“AT+CMGD=1,4")
- Remote control On button = Turning on the security system
- Remote control Off button = Turning off the security system

2.4.3 Reed Switch Configuration

A magnetic field-operated electromechanical switch is used to activate the call alert notification.

Step 1: Material Preparation

- Reed Switch
- Neodymium Magnet
- Electrical Cable Wire
- 2 Pin PCB Screw Terminal Block

Step 2: Pin Connection

- Connect the two terminals of the reed switch to the ground and the D6 pin of the Arduino nano

Step 3: Setting up Reed Switch

- Program the reed switch in the Arduino IDE:

```
if (SecurityStatus == 1) {
  if (CallAlert == 1) {
    if(digitalRead(ReedSwitch) == true){
    digitalWrite(CameraPower,HIGH);
    Serial.println("Reed Switch Triggered");
```

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Reply("The door has been open!");
Serial.println("Calling Number: "+PHONE);
Call();

- Attach the neodymium magnet to the door.
- Attach the reed switch near the neodymium magnet

2.4.4 IR Proximity Sensor Configuration

IR Proximity Sensor is a multipurpose infrared sensor that can be used for obstacle sensing, color detection, and line sensing. This sensor is used in this device to trigger SMS alert notifications.

Step 1: Material Preparation

- IR Proximity Sensor
- Electrical Cable Wire

Step 2: Pin Connection

- Connect IR Proximity Sensor Output Pin to Arduino Nano D2
- Connect IR Proximity Sensor GND to Arduino Nano GND
- Connect IR Proximity Sensor VCC to

Step 3: Setting up IR Proximity Sensor

- Program the IR Proximity Sensor in Arduino IDE:

```
if (digitalRead(ProximitySensor) == LOW){
        Serial.println("Proximity Sensor Triggered");
        Reply("Someone is trying to break the lock!");
```

- Place the IR Proximity Sensor near the door lock

2.4.5 Blynk Application Installation and Configuration

This system describes the connection between the Arduino Uno and the ESP32-CAM. Using the ESP32-CAM, connecting to the Blynk server and transferring data to the Blynk app is possible.

The ESP32-CAM is an ultra-compact 802.11 b/g/n Wi-Fi + Bluetooth/ BLE SoC module with a low-power dual-core 32bit CPU up to 240MHz, up to 600 DMIPS, an OV2640 camera with flash, and Wi-Fi video monitoring and Wi-Fi image upload capability. Thus, the Internet was used for communication, allowing the Blynk app to get the data.

In addition, the Blynk app creates unique interfaces for the project. This application lets developers select the specified hardware based on the used development board. To make it secure, a unique authentication token is used for every piece of a project that is made. This authentication token is a unique identifier for connecting the hardware to the user's smartphone and establishing a secure hardware connection.

2.5 Implementation Plan

After completing the system's development, a series of test procedures were done. The device will be installed inside DMJJ Rovira General Merchandise which is the pilot area of this study.

First, before setting it up, the developers will state the device's purpose to the chosen organization, including explaining each component's functions and how it will work and executing text commands that will serve as the interaction between the user and the device

The developers will verify and evaluate the requirements and all necessary technologies, including software and hardware components. Owners require at least one smartphone to receive the message and call alert notifications. Also, owners must install the Blynk App to access live viewing. Then, the developer will demonstrate to the owner how the anti-theft detecting device will be activated up to responding when it senses an attempted robbery.

In addition, the developers will provide a guide on how the user will register on the Blynk app and a printed manual for the function explaining the system's procedure. The manual also includes functional and technical documentation of the system and a detailed method to access real-time monitoring via the Blynk App. It also provides text commands (S0, S1, S2, S3, S4); these are programmed text commands for turning off and, on the system,

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stopping the message and call alert. The device can be turned off and on in two ways; it can be turned on and off using their smartphone or the remote control provided by the developers. By this, the owners will get the necessary understanding of the system and the equipment.

Furthermore, the developer is responsible for guiding the user. The developer will schedule the installation for DMJJ Rovira General Merchandise. The developer will ensure that the system function works responsively and accurately.

However, since the establishments have different structural architectures, the developers must enact a definite installation plan for each. The developers create a guideline to determine where the Anti-Theft Detection Device location should be installed.

1. The device should be placed inside the establishment and must face where the door or other entrance is located.
2. The device should be placed in a not-too-hot area or at an average temperature.
3. The proximity sensor shall be put between the door and the entrance lock. The lighting must be light and not direct sunlight.
4. The reed switch shall be placed on the target door along with the magnet.
5. The device shall be preferably placed near the outlet to charge the device's battery.

3. RESULTS AND DISCUSSION

3.1 Requirement Specification

IoT-Based Anti-Theft Detection Device Using Arduino was developed to enhance DMJJ Rovira General Merchandise's electronic surveillance security, which is the typical CCTV. It is designed to provide fast and reliable protection to reduce or prevent theft incidents. It can alert the owners through text messages and phone calls when someone attempts to enter. Moreover, an owner can see what is happening wherever they are via live monitoring.

3.1.1 Technical Features

- Wireless Connectivity
- Local and Remote Monitoring
- It can be controlled using SMS commands or a wireless remote control switch
- Supported with SMS and Call notification alert
- Built-in battery lasts up to 4 hours and 30 minutes

3.1.2 Functional Requirements

Functional requirement contains the specific function of the developed project that can provide to the business owners.

A. Monitoring real-time events– Allowed them to watch the events happening in their store.
B. Connect to the system – Allowed the user to connect to the system to keep updated on the events happening to their store.
    a. Send update via SMS – The system will send a warning message when the proximity sensor detects a movement to the store lock.
    b. Send update via Call- The system will send a call alert notification of the possible theft attempt to the user connected to the system.
    c. Control security camera – The owner can control the camera via programmed SMS commands and a wireless remote control with a maximum range of 20 meters.

4.2.3 Non-Functional Requirements

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Non-functional requirements specify criteria that can be used to judge a system's operation rather than specific behaviors.

A. Security – The system shall only allow the store owner or an authorized person with whom the owner registers an account on the Blynk app to access the device. Unauthorized access or requests must therefore be turned down. Aside from that, the device will be placed in an area where it is unnoticeable, and the LED indicator will automatically turn off once the system is activated.
B. Usability – The device must be easy to operate and understand. The device will provide wireless control over the anti-theft detection device.
C. Availability – The device must be accessible at all times and have internet connectivity.
D. Reliability- The system will ensure that the monitored events will be reliable because they will undergo analysis, and no one can easily alter data and information. In addition, during a power outage, the device still operates through its built-in battery.

3.2 Test Result

Several testing procedures examined the anti-theft detection device's functionality, accuracy, and compatibility. Alpha Testing Results as presented in Figure 1 and Figure 2 were used to determine the response time upon connecting the anti-theft detection device to the Internet using different SIM cards. As a result, the GOMO SIM provides the fastest average connecting time, 8.674 seconds.

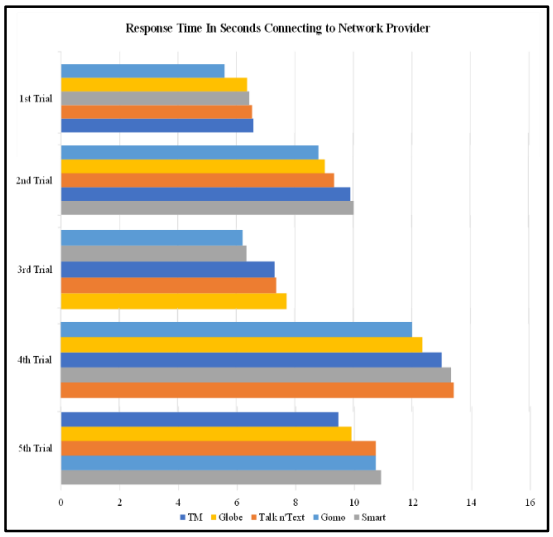

Figure 1 *Response Time in Seconds Connecting to Network Provider*

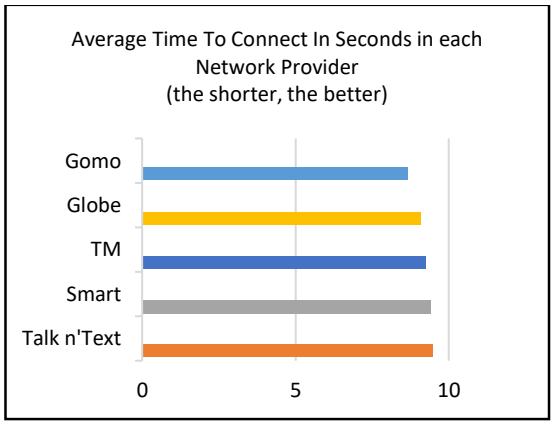

Figure 2. *Average Time to Connect in Seconds in each Network Provider (the shorter, the better)*

The test is also applied to the sensors and actuators for accuracy and responsiveness as presented to Figure 3. Hence, based on the collected data, in ten (10) tests, the reed switch, remote control, proximity sensor, camera power, LED, SMS command, and ESP32 camera performed their specified functions one hundred percent (100%) of the time. However, out of ten (10) trials conducted in call command, one test failed and received a score of ninety percent (90%) due to network traffic that delayed the call alert. This scenario can often be experienced if a

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network signal issue occurs or the cellular plan expires [3].

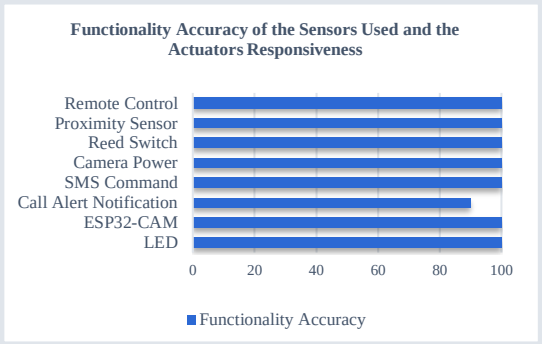

Figure 3. *Functionality Accuracy of the Sensors Used and Actuators Responsiveness*

Nonetheless, the sensor's sensitivity was so high that the alert would occasionally be triggered in direct sunlight. Therefore, the developers altered the sensor's range by twisting the potentiometer counterclockwise. The sensor's sensitivity range can be modified depending on where the theft-detection device will be positioned.

Furthermore, the Beta Testing results which presented in Figure 4 and Table 9 are the presentation used to determine how the device functions and performed the testing in DMJJ Rovira Merchandize, located in Barangay Bangbang, Gasan, which is the chosen organization. As a result, all of the main functionalities of the anti-theft detecting device returned a total of ninety-three percent (93%) successful installation results. Due to the unstable network, seven percent (7%) or two (2) out of ten (10) trials of the test failed in the ESP32 Camera trials. The developers also conduct owner evaluations for the function of the anti-theft detection device performance. As a result, most owner reviews are delighted with the functionality of each component. In contrast, the owner is only satisfied with the ESP32 camera due to personal preferences such as higher resolution and faster remote monitoring access.

Overall, the Anti-Theft Detection Device's testing results determined its functionality, accuracy, compatibility, and the fastest average time connecting it to send messages, call alerts, and access live viewing through local or remote monitoring.

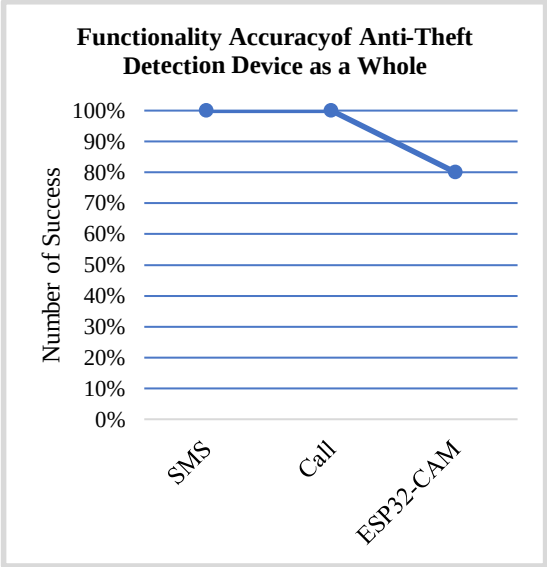

Figure 4. *Functionality Accuracy of Anti-Theft Detection Device as a Whole*

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Table 9. *Owner Evaluation of the function of the Anti- Theft Detection Device*

Rating Scale: 5- Very Satisfied, 4-Satisfied, 3-Fair, Not Satisfied, 1-Not Working

Component-Functionality	5	4	3	2	1
Reed Switch	✓				
Remote Control	✓				
Proximity Sensor	✓				
Camera Power	✓				
LED	✓				
SMS Command	✓				
Call Command	✓				
ESP32 Camera		✓			

4. CONCLUSION

The conclusion was based on the study's objectives, interviews, and the developers' evaluation results. The data gathered from answering questionnaires were checked, classified, and analyzed.

It was concluded that the establishment/store only used a typical wired CCTV as security. According to the owners, this kind of security only shows past events and will not notify them during the incident. It is based on the incident in their store where the thieves broke the entrance door lock. The CCTV installed in the area did not detect the identity of the thieves as they wore masks to hide their appearance. In introducing the upgraded form of security, the developers planned to purchase the materials needed outside the province due to availability issues. Before the project's success, the developers encounter constraints such as time, cost, and scope. The purchased material takes time to arrive, and some are also defective. As a solution, the developers ordered the same material, but this time, in another trusted store. Due to this, the time and scope of the project were affected since the reordered materials will once again take time to arrive. The project's cost is also a concern because the developers spent another money just for the same materials. The device was made and tested part by part before connecting as one and placed into a fake bullet-type enclosure. After the completion of the device is revisitation on the target establishment for testing.

Furthermore, the organization willingly participated in the testing procedure to ensure the device's accuracy and gave feedback to improve the developed system. The developers could design an IoT-based anti-theft detection device that responds to the programmed process. In addition, the developers constructed a prototype of the device to provide an actual simulation of its functionality. The developed anti-theft detection device can be availed this starting from Php 3,510.00, depending on the number of cameras. Unlike traditional CCTV, it only shows current events on a monitor and past events if they are reviewed.

Therefore, the system sends an automated warning message and call alert through GSM and can be monitored remotely using the Blynk app, boosting the chance that the owner will detect the intruders' break-out immediately, thus minimizing or preventing any potential losses. Moreover, since the alert message will be delivered to the respective owner, an immediate response will be almost, if not entirely, assured.

5. RECOMMENDATION

Based on the study and evaluation, the following recommendations are suggested for improving and enhancing the project.

1. To enhance accuracy, developers may add multiple sensors to improve accuracy, such as a buzzer and a motion sensor that reduces or eliminates the possibility of a false alert.

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2. The addition of cameras will enable monitoring all building areas.
3. To avoid a delay in alert message delivery, they may choose a network service provider that is both fast and reliable.
4. It is recommended that the anti-theft detection device be installed near an electrical outlet in case the device's internal battery drains.
5. The user may have access to reconfigure the SMS number used in the device.
6. The device may connect and communicate with the DVR of an existing security system.
7. As the device falls under the IoT, it can be upgraded to a home automation system to maximize its features and functionality.
8. They may upgrade the development board of this device into Raspberry Pi for ease in utilizing cloud storage or network-attached storage (NAS).

REFERENCES

[1] Daniza Fernandez. 2022. Theft, robbery cases ‘slightly increased’ in Metro Manila, says NCRPO. (April 2022). Retrieved May 2022 from https://tinyurl.com/5fk55rns

[2] Ekta Kapoor, Rajeev Sharma, Shri Romesh Samyal. 2019. Internet of Things (IoT) Research Initiative. (August 2019). Retrieved March 31, 2022, from https://dst.gov.in/internet-things-iot-research-

[3] Mahesh Makvana. 2022. How to Fix an Android Phone Not Receiving Calls. Smartphones. (October 2022). Retrieved December 09, 2022, from https://tinyurl.com/2wywrujm

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Utilization of Cloud Computing Concepts to Design and Implement a File Management Platform for Local Area Network

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Abstract - In many different fields, networking approaches have been extensively applied. Businesses, households, educational facilities, research facilities, the medical industry, governmental buildings, and the entertainment industry utilized it. Furthermore, anyone can access and use the internet worldwide. However, internet access is only available in some areas. This capstone project used a networking scheme and designed a file management platform applying a private cloud concept and Platform as a Service (PaaS) model. This project was dedicated to those schools and government offices who has no access to the internet and have no network infrastructure present. This project aims to provide network infrastructure and an alternative way of communication for school personnel and government employees. The designers have designed a network schema considering all the data gathered in Paciano A. Sena Memorial High School (PASMHS). The network schema covers the entire locations of all clients in the network. The Cisco Packet Tracer software was utilized to devise the network design. Installation of networking devices, server configuration, client joining, and LAN Messenger installation were done to complete this project and achieve its goal. The file management platform was developed using the Laravel Framework as its front-end, while TrueNAS software is employed as the network's back-end. The developed project undergoes a series of testing to ensure the network security and platform functionalities and to evaluate whether the project met its objective. The testing and analysis confirmed that the project is feasible in operational, technical, and economic aspects. As a result of project implementation, the developed file management platform enables users to perform various actions such as logging into their accounts, uploading files, creating folders, deleting files, and logging out. These actions are accessible to users with a designated username and password and are connected to the network. The designed project was implemented and tested at the College of Information and Computing Sciences of Boac Campus Computer Laboratories.

Keywords: *Private Cloud, Platform-as-a-Service, File Management Platform, Local Area Network*

1. INTRODUCTION

Most schools today rely on technology. Systems, programs, the Internet, and network were always present. Many rural and remote places in wealthy countries need more reliable, high-quality internet access [1]. Internet service, particularly internet connectivity, is more difficult in underdeveloped nations. Centralized record keeping allows the storage of all physical papers in one location. Centralized file management improves sharing and coordination across different buildings and promotes the effectiveness of the department's information.

Institutions that have networking framework are now limiting the paper availability due to more purchases of technological devices [2]. The lack of knowledge in technological advancement can be a hindrance in going paperless [3].

Educational institutions experience inconvenience in accessing the Internet. They have sufficient digital devices they can utilize within their school campus. Still, the need for more signal hampers communication efficiency and management of school files and data. In education, we always find ways to improve efficiency in every work we do through the adoption of technologies [4].

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Some cases resemble Paciano A. Sena Memorial Highschool (PASMHS). All industry sections require digital skills, which are crucial in many other areas of the economy. Communities with poor internet services will receive lesser advantages from the digital transition than those with quick Internet access.

To address the specific issues faced by PASMHS, a comprehensive file management platform has been developed, employing a cloud computing concept known as the Platform as a Service (PaaS) model. This innovative solution integrates a front-end interface designed to facilitate user interaction with the powerful back-end capabilities of TrueNAS software. Its primary goal of this platform is to establish a centralized storage system that ensures accessibility only to authorized individuals.

A front-end platform, a back-end platform, and cloud-based delivery are the three broad categories into which the components of cloud architecture are typically divided. The Internet is required by the system's architecture for front end and back-end connectivity. These include Platform-as-a-Service (PaaS), Software as a Service (SaaS), and Infrastructure as a Service (IaaS) [5].

To further enhance communication within the organization, the implementation also incorporates the use of LAN Messenger. This additional software solution functions as a supplementary means of communication, complementing the platform's capabilities. By installing the LAN Messenger on the users' devices, the project team ensures that employees can conveniently exchange messages, collaborate on projects, and securely send and receive files.

LAN Chat Messenger provides a reliable, secure, and low-cost means of communication among the employees in an institution. It also aids in the resolution of time and cost-related communication issues [6].

The deployment of such a platform and network infrastructure not only resolves existing issues but also lays the foundation for future scalability and adaptability. As the educational landscape and administrative requirements evolve, the platform can accommodate additional functionalities and features, ensuring its longevity and relevance in meeting the evolving needs of PASMHS and similar institutions.

2. METHODOLOGY

2.1 Requirements Analysis Procedure

PASMHS was selected as the project's data source. Interviews and surveys were conducted among the school's teaching staff to gather necessary information for project development. Additionally, a site investigation was performed to assess room distances and determine suitable locations for networking hardware installation. The findings from this investigation were used to design the network floor plan layout. A Work Breakdown Structure was presented to guide the project team and establish task order, outlining the project scope and the required tasks.

The data collected from the selected school was analyzed to develop the network layout, including the physical design, logical design, and network floor plan layout. The physical design illustrates the network design, including device connections, and was created using AutoCAD. The logical design, conceptualizing the network plan and its attributes, was developed using Cisco Packet Tracer. In this project, an AutoCAD (software) was used to design the network floor plan layout illustrating the precise device placements throughout the entire campus. This layout serves to determine the coverage range of the devices to be installed.

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2.2 Feasibility Analysis Procedure

Feasibility analysis examines a project's potential in terms of technical, operational, and economic aspects. It involves site investigation and survey to determine if the project is worth the investment, ensuring credibility with investors and lenders.

Operational feasibility assesses if the school meets the project's requirements. A SWOT analysis evaluated the school's resources and capacity to support the project. It identified strengths, weaknesses, opportunities, and threats, helping designers gauge the school's adaptability to system changes.

Technical feasibility will be assessed through a SWOT analysis to determine if the school's technological resources and the designers' capabilities align with the project requirements. The analysis will identify strengths, weaknesses, opportunities, and threats relevant to the project's technical aspects.

A comparative analysis of various software options for server installation and messaging software was conducted to identify the most suitable technology for tahe project.

Economic feasibility assessed if the project's benefits outweigh the estimated cost. It considered financial matters and the school's capability to support and cover expenses during project implementation.

2.3 Development and Testing Procedure

A variety of networking tools was used in the development of the designed project in the CICS. The networking tools are cables, switches, routers, systems, and computer units. One system unit will serve as the central storage, processor, and disseminator of data across the network. The router will serve as an IP distributor among clients and an access point that connects the devices in a network system. The switch will be of use in connecting the computer units. In the prototype of the network infrastructure, the designer used the Cisco Packet Tracer tool.

Upon the completion of the network layout is the pilot testing of the network. Before proceeding with the project pilot testing procedure, the necessary Software was prepared, such as the TrueNAS ISO file and the LAN Messenger installer.

The first task that was conducted was the server configuration through a TrueNAS software installation. Afterward, networking hardware and users' devices, such as computer units and laptops, were connected to the network. The messaging tool, which is the LAN Messenger, was also installed on the users' devices.

As for the user interface, Laravel framework and Bootstrap are used as the system's front end. These tools utilized the file storage feature to connect the UI to TrueNAS.

The network layout designed by the designer will undergo simulation testing using the tool Cisco Packet Tracer. It will assess any error in the network before proceeding with the implementation to prevent any further damage to the network.

It will undergo testing upon completing the designed platform and implemented network infrastructure. The testing series consists of Ping Test, System Testing, Stress Testing, LAN Speed Test, and LAN Messenger Test.

2.4 Pilot Testing Procedure

The designer at the Networking Laboratory in the CICS, MSC Boac Campus carried out a pilot testing.

The designer provided a separate system unit to prevent damage to the school's property. It was configured as a server by installing the TrueNAS Core ISO file.

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Upon the successful server configuration, the designer accessed the web interface and modified the server's settings. The designers created groups, users, pools, datasets, and a Windows share. An access control list was also configured to set permission on the Software.

Once the configuration of the settings in the server was done, all the remaining network hardware, such as two more routers, five computer units, and two laptops, were connected to the network. It was cabled directly to the switch for the routers and computer units to be connected to the network. The two connected routers were designed as an access point where the laptops will be connected. It is to test the actual network layout intended by the designer. The LAN Messenger installation occurs when all the user's devices are connected to the network.

Upon the successful server configuration, network hardware and users' devices connection, network design implementation, and LAN Messenger installation is the testing procedure. It is where the series of testing to be carried out in the designed platform was conducted.

3. RESULTS AND DISCUSSION

3.1 Requirement Specification

The Utilization of Cloud Computing Concepts to Design and Implement a File Management Platform for Local Area Networks with the following functions and requirements.

3.1.1 Functional Requirements

It refers to the project's unique features and functions. These are frequently related to organizational processes implemented into the project to make it easier to execute without investing excessive effort.

Network Coverage – The network layout covers the locations of the devices used by the teaching personnel.

File Management Platform Access – Users can access the platform and upload and download files.

LAN Messenger - All clients with installed LAN Messenger can communicate with others across the network.

3.1.2 Non – Functional Requirements

Non-functional requirements are a specification that describes the system's operational capabilities and constraints that enhance its functionality.

Server Management. The network administrator can control all settings in the server, such as creating groups, users, pools, datasets, and Windows share.

Restrictions. Network Administrators can restrict accounts access and set permission to files sent to the server.

Security. The administrator can set login credentials such as username and password.

Reliability. Only authorized clients shall be able to connect to the network.

Flexibility. The server can be configured as cloud storage when internet access becomes available in the school or government office's location.

Scalability. The project can be implemented in schools or government offices that encounter similar problems with PASMHS.

3.2 Result of Feasibility Analysis

3.2.1 Operational Feasibility

For the operational feasibility, the SWOT analysis shows that the school, specifically the expected users, has the strengths needed to operate the designed platform. The employees are computer literate and are ready to adopt the possible changes. Further, there is an IT coordinator who can maintain the implemented

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platform. The designers have reduced costs in implementation because of the provision. The users can become accustomed to the system. They can easily understand how the system works. Adaptability makes the user familiar with the system whenever a change is made. Maintenance is present to have a healthy working server.

As for its weaknesses, it shows that the school's current communication is through using a two-way radio transceiver. It has become its weakness as the residents near the PASMHS also used the two-way radio transceiver. Due to that, mixed frequencies always happen. As a result, residents near the school who uses this device can also hear the conversations of the employees in the PASMHS. Also, personal interaction is the only way for data transmission, and the users need more experience.

The opportunities will give numerous advantages to the school. It can provide for a better quality of service, productivity of employees in data transmission, and good communication within the organization. Quality is needed to ensure the designers' reputation and meet the user's needs. Productivity increases the efficiency of data transfer and file sharing. It eliminates the possibility of misinterpretation or message modification, reducing the likelihood of conflict. No matter what issue occurs, it minimizes downtime and ensures that productivity stays as constant as feasible. Further, it allows the organization to have a flexible network infrastructure in cases where the area might have internet access shortly.

As for the threats, the organization's networks, systems, and data are harmed when user credentials are misused, and insider attacks happen. Low physical security resources make the system vulnerable to unexpected natural disasters. It can also make the cost of the whole project high.

Table 1. *Result of Operational Feasibility*

Strength	Weaknesses
1. The school has a provision in implementingthe designed project. 2. The employees are responsive, flexible, and cooperative. 3. The employees are capable and computer literate. 4. The employees are ready to adopt possible change. 5. There is an IT coordinator who can maintain the implemented platform	1. Two-way radio transceiver in communication 2. Personal interaction for data transmission 3. User's lack of experience 4. Untrained user 5. Power interruption while implementing the project.
Opportunities	**Threats**
1. Productive employees in data transmission 2. Better quality of service 3. Good communication within the school. 4. Flexible Network Infrastructure	1. Insider Attack 2. Price Increase of Network Equipment 3. Physical Security

3.2.2 Technical Feasibility

Technical Feasibility – SWOT Analysis showed that there are particular strengths that the school and the designers possess, such as having enough IT resources for project implementation, having two IT coordinators within the school, designers knowledgeable in networking schemes, planning out networking layouts and possesses a resourceful characteristic. Further, this project can be implemented in an organization that uses desktop computers in their daily operation as it doesn't require many desktops computer to be implemented as long as there are enough computers to act as a server and client and the necessary networking equipment. Adaptability enables the designer to solve problems quickly and use obstacles as an advantage. Project planning determines the list of project goals, features, deliverables, and timeframes that are decided upon and recorded. Project and network planning includes the list of particular project goals, features, deliverables, and agreed-upon and documented timeframes.

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For the weaknesses, the lack of network signal delays the progress of the implementation. A lack of network infrastructure can break down the whole project. Miscommunication can result in poor productivity, teamwork, morale, and decreased revenues.

No access to data can hinder the efficiency of learning. Lack of experience can lead to unattainable knowledge. Untrained users can lead to them to damage the system from within. Power failure can slow the progress of the implementation since the network and system architecture is run on electricity. As for the opportunities, it gives way to the availability of offline communication, and it will also provide efficient data transmission and fast access to corporate data. Moreover, it will also provide a helpful experience to the designers regarding networking processes and enhance their skills in adapting to changes.

As for the threats, it showed a sudden crashing of the server, lack of networking equipment, and power interruption during project implementation. A lack of networking equipment can lead to the network's functionality failing. A crash of the server leads to data loss and damage to the system.

Table 2. *Result of Technical Feasibility*

Strength	Weaknesses	Opportunities	Threats
1. Adequate IT resources.	1. Lack of network signal.	**1.** Availability of offline communication.	1. Crashing of Server.
2. Have two IT coordinators in the school.	2. Lack of network infrastructure.	**2.** Efficient data transmission.	2. Lack of networking equipment.
3. The designers have enough knowledge of networking processes.	3. Miscommunication between the designers and the client.	**3.** Fast access to corporate data.	
4. The designers have already planned out the entire project implementation process.		**4.** Will serve as a valuable experience for the designers regarding networking schemes.	
5. The designers have a planned network design for the networking infrastructure in the school.		**5.** Enhances the designers' skills in adapting to changes	
6. The designers possess resourceful characteristics.			
7. It Does not require many desktop computers.			

➢ *Comparative Analysis of TrueNAS with Other Software*

TrueNAS and Open Media Vault

An open-source NAS operating system based on Debian Linux is called OpenMediaVault. In addition to having all the functionality that one would anticipate from a NAS operating system, OpenMediaVault offers a user-friendly interface compatible with various devices. OpenMediaVault is an excellent NAS operating system to learn about because of how simple it is to use.

The file systems that OpenMediaVault and TrueNAS utilize are different. OpenMediaVault users can configure a volume as any other file system, the most popular of which are Ext4, XFS, and BTRFS. TrueNAS natively supports ZFS, unlike OpenMediaVault's requirement to install a plugin. The OpenMediaVault filesystems that can be installed are all very distinct. If the client wants native ZFS compatibility, clients will have to use TrueNAS instead of OpenMediaVault and won't be able to utilize any other plugins. When adding and deleting data from NAS, OpenMediaVault, and TrueNAS, operate similarly. It will produce shared folders for both operating systems that may be accessed via a network using SMB, NFS, etc.

Although the setup procedure varies according to the operating system, you'll be using,

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this is the most crucial feature of any NAS, and the functionality and end-user experience will be comparable. Overall, the two NAS operating systems are both excellent. OpenMediaVault may be the finest NAS operating system the client can use if the device has limited system resources. However, it is preferable to have the native ZFS functionality that TrueNAS provides if the customer has a fully equipped home server with ECC memory. TrueNAS offers two versions, so users can select the one that functions best on TrueNAS Core or TrueNAS Scale, which is advantageous from a functionality standpoint. A comparative analysis between the two Software is displayed in Technical Feasibility – Comparative Analysis.

Table 3. *Result of Comparative Analysis of TrueNAS and Open Media Vault*

	TrueNAS Software	Open Media Vault	
Features	• Permission Management • File Locking • Data corruption protection • Object data storage over a centralized network • Metadata on Flash • Dataset Encryption • Two Factor Authentication • Faster ZFS Boot Platform	• Based on Debian Linux • Web based administration • Multilanguage support	
Protocol		• CIFS • FTP • NFS • SSH • iSCSI • AFP	• TFTP

Table 3. *Result of Comparative Analysis of TrueNAS and Open Media Vault*

	TrueNAS Software	Open Media Vault
Security	• Backups • Disk-level encryption • Low percentage of malware infection • One Time Password • Native encryption • API Keys • Secure Shell	• Control Login Group • Secure Shell
Partition	• Multiple	• Single
Flexibility	• Can be promoted as Cloud Storage • Storage with high-performance all-flash datastores or lower-cost hybrid datastores via iSCSI, Fibre Channel, or NFS	• RAID (redundant array expansion of inexpensive disk) expansion
Availability	• Free and via subscription	• Free

TrueNAS and Unraid

A Linux distribution called Unraid is designed to give you total control over your devices. It is primarily intended for heavy data users who desire complete control over their media, apps, and data. Performance is improved by RAID (redundant array of independent disks) since it reads and writes data from several drives. RAID provides some safety as well. RAID6 can handle the loss of two drives, while RAID5 can handle the loss of just one disk. An operating system for network-attached storage that is proprietary is called Unraid. Unraid enables the server to run various apps and build and manage shared folders and Docker containers if you'd like.

Despite not being a conventional hypervisor, Unraid allows the host to construct virtual machines. The file systems that TrueNAS and Unraid employ are their primary and most prominent point of distinction. Refrain from using XFS or BTRFS by default. TrueNAS, on the other hand, uses ZFS, which has a lot of excellent advantages. Installing hard disks and choosing one or two drives to be used as the parity drive while configuring Unraid is advised. The array will be safeguarded against data loss by the parity disks chosen. The parity bits are utilized to create a new hard disk if any drive on the NAS fails. In its most basic form, one hard drive can die without erasing data if the user has one parity drive.

When it comes to adding or deleting data from NAS, Unraid, and TrueNAS are remarkably

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comparable. It will generate shared folders in both operating systems that may be accessible through your network using protocols like SMB, NFS, iSCSI, etc. It is the most crucial feature of a NAS, and even if the configuration will vary depending on the model, the overall functionality and user interface will be the same.

TrueNAS permits the client to create snapshots by default, which is a minor distinction. Shared folders on NAS will be frozen by photos at a particular moment, allowing the user to recover them in the event of data loss, corruption, or even ransomware assaults. The ZFS filesystem in TrueNAS makes setting up snapshots simple. A comparative analysis between the two Software is displayed in Technical Feasibility – Comparative Analysis).

Table 4. *Result of Comparative Analysis of TrueNAS and Unraid*

	TrueNAS Software	Unraid
Security	• Backups • Disk-level encryption • Low percentage of malware infection • One Time Password • Native encryption • API Keys • Secure Shell	• Root password • Sharing restrictions • Ransomware protection • Email notifications • One Time Password
Orientation	• Enterprise-oriented	• Focuses on home use
Flexibility	• Can be promoted as Cloud Storage • Storage with high-performance all-flash datastores or lower-cost hybrid datastores via iSCSI, Fibre Channel, or NFS	• Plenty of third-party applications and plugins
Availability	• Free and via subscription	• Via subscription
Features	• Permission Management • File Locking • Data corruption protection • Object data storage over a centralized network • Metadata on Flash • Dataset Encryption • Two Factor Authentication • Faster ZFS Boot	• Flexible server expansion • One-click parity setup • Docker container management • Virtual machine support • Hardware passthrough
Protocol	• SMB • SNMP • SSH •TFTP • UPS •WebDAV • NFS • iSCS • FTP • AFP • SFTP	• AFP • NFS • SMB • FTP

	TrueNAS Software	Unraid

➢ *Comparative Analysis of LAN Messenger with Other Software*

LAN Messenger and MyChat

MyChat is a chat program for connecting the Internet and corporate networks. The program offers simple text messaging, file sharing, text formatting, construction of bulletin boards, etc. MyChat allows users to configure a server to customize the rights system and tailor the chat to their specific requirements. The program enables the user to make crystal-clear voice and video calls. MyChat uses an encrypted connection type, which offers trustworthy security.

The Software uses a small amount of system resources and features a well-designed user interface. MyChat Software is incredibly adaptable and straightforward, making integrating into a school or government office simple. How to connect other clients, such as automatic Linux scripts, to deliver some reports straight to the right users is an exciting thing to learn. It has wiretap protection because the server is in the users' hands rather than being located online, ensuring your staff meetings' security. The server, which is part of its own network, houses all previous correspondence data. The TLS 1.2 protocol encrypts all messages using dynamic session keys for security. MyChat

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makes use of OpenSSL. As a result, users can securely connect staff members to the company server online.

All past correspondence is kept on the company server rather than a public server on the Internet, like Skype, ICQ, Viber, or Slack. The correspondence history can only be accessed if the user database is in the right hands, like on a stolen laptop or flash drive carrying the portable version. The IP and MAC addresses of the users who connect to the server can be filtered. Additional security is also offered for MyChat servers employees from external corporate departments use to access the Internet. A comparative analysis between the two Software is displayed on technical feasibility – Comparative Analysis.

Table 5. *Result of Comparative Analysis of LAN Messenger and MyChat*

	LAN Messenger	MyChat
Features	• Instant messaging • Secure messaging for privacy • Broadcast messages • Send notifications to all users or specified users. • File transfer • Organized contacts • Message logging • Past conversations are logged and can be retrieved at any time. • Serverless architecture • A server does not need to be set up on the network for LAN Messenger to work. • No internet connection required	• Client-server architecture • Active Directory Integration • All the messages are delivered, even if the person isn't online • Kanban board controlling the process from any device • Bulletin board • Recent contact list
Security	• All messages are protected by AES encryption with RSA as the key exchange mechanism.	• Data transfer is reliably protected by OpenSSL.
Orientation	• Enterprise-oriented	• Enterprise-oriented
Availability	• Free	• Free

LAN Messenger and Winpopup

Windows has an intranet messaging tool called Winpopup LAN Messenger. The user doesn't need to have the PC online for this program to perform flawlessly. Two or more users can connect without knowing each other's IP addresses. Because of its DCHP features, communicating with others on the same network is a breeze. File transfer functionality enables peer-to-peer file transmission. As a result, files are secure since they never leave the network. The messenger is simple to install. Users can start chatting immediately by simply installing the client application on each computer in the network. There are two operating modes that Winpopup LAN Messenger supports: one with a server and one without. Winpopup Server is set up in server mode on a specific message server in your network. All communication, including offline messaging and support for multi-segment

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networks, is handled by the Winpopup Server, which adds an extra layer of protection by managing user authorization. Without a dedicated message server, Winpopup LAN Messenger operates flawlessly, instantly identifying Winpopup users on the corporate network. No dedicated server or administration is needed in this configuration. It's as easy as launching Winpopup LAN Messenger on a PC to use Winpopup LAN Messenger in serverless mode.

Information is kept from the local network when using Winpopup LAN Messenger. LAN Chat is entirely secure because all communications are secured with robust RC4 encryption. It has extended group messaging and conference functionality in its multi-user LAN chat. A conference is nothing more than a multi-user LAN conversation in terms of Winpopup LAN Messenger.

Table 6. *Result of Comparative Analysis of LAN Messenger and MyChat*

	LAN Messenger	**Winpop LAN Messenger**
Features	● Instant messaging ● Secure messaging for privacy ● Broadcast messages ● Send notifications to all users or specified users. ● File transfer ● Organized contacts ● Message logging ● Past conversations are logged and can be retrieved at any time. ● Serverless architecture	● On-Line and Off-Line Messaging ● Serverless Messaging ● Group Messaging and Online Conferences ● No Internet Connection and No IP Address Required ● ·Command Line and DLL Interfaces
Security	● All messages are protected by AES encryption with RSA as the key exchange mechanism.	● All communication is encrypted with RC4, making messages transmitted over the LAN impossible to intercept.
Orientation	● Enterprise-oriented	● Enterprise-oriented
Availability	● Free	● Free

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3.2.3 Economic Feasibility

➢ *Project Cost*

An estimated cost was presented for the economic feasibility. In particular, our equipment includes CAT-6 cable, router switch, RJ45, hard disk drive, nail-type table clip, PVC Corrugated Flexible Pipe, and labor costs.

Table 7. Result of Economic Feasibility (Project Cost)

Particulars	Unit Cost	Quantity	Unit	Total Cost
CAT-6 Cable	Php21.00	100	Meters	Php2,100.00
Wireless/ Wired Router	2,250.00	3	Pieces	6, 750.00
Switch	1, 740.00	1	Pieces	1, 740.00
RJ45	5.00	20	Pieces	100.00
Hard Disk Drive	2,500.00	1	Piece	2, 500.00
Nail Type Cable Clip	90.00	3	Box	270.00
PVC Corrugated Flexible Pipe	6.8	100	Meters	680.00
Labor Cost	-	-	-	Php1, 500.00
			TOTAL:	Php15, 640.00

For every item's unit cost, the needed quantity of each unit was also listed. The total cost for each item base on the amount was also present, giving us a total estimated cost of ₱15,640.00. The project can be implemented if the school or government offices can provide the financial assistance needed.

The school has a finite amount of money to invest in the project's growth. Because most technologies were accessible, the designed system was within the budget—only the personalized item needed to be bought. The offices and schools that will purchase the project can afford the anticipated cost of the items. These products have an estimated lifespan of five years. The schools or offices can afford to replace the equipment five years after the aforementioned due date. As a result, it is financially sustainable.

3.3 Description of the Project

3.3.1 System Architecture

System Architecture of Utilization of Cloud Computing Concept to Design and Implement a File Management Platform in LAN describes the tasks (processes and threads) involved in the system's execution and its interactions and configurations. In contrast, the admin and user are the system's clients. The admin can grant the user access to the central database by interacting with the user interface. There is a login page where the user fills in the login credentials given by the admin to access the file storage. The user can upload, download, create, and delete folders in the web system. The TrueNAS server will serve as the database where the configurations and restrictions of the server are located.

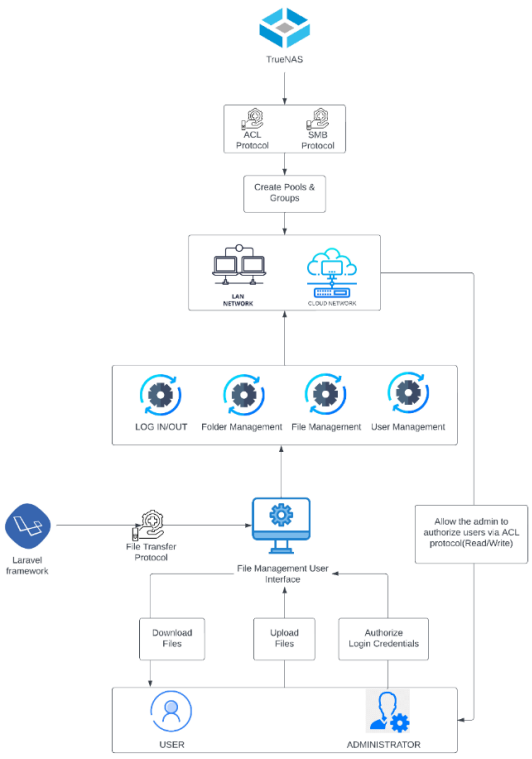

Figure 1. *System architecture of the Designed File Management Platform*

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3.3.2 Conceptual Framework

The concept framework of the entire project and system is being presented by the designers through this design. It was created using a literature review on the study's current topic.

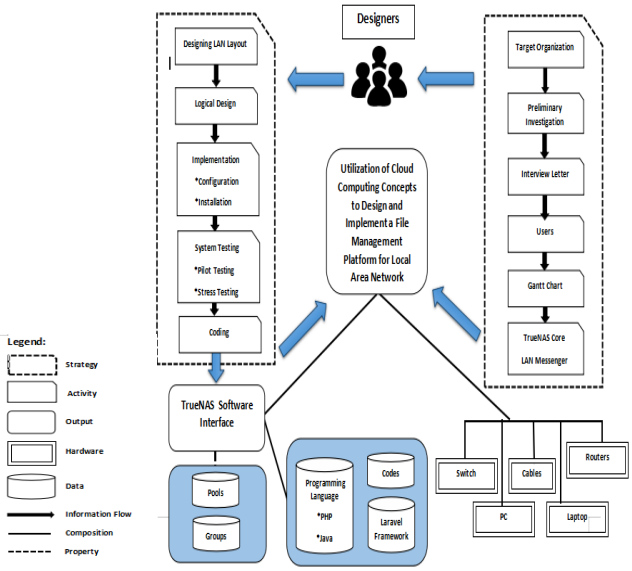

Figure 2. *Conceptual Framework of the Project*

3.4 Testing Result

3.4.1 Simulation Testing

Simulation testing was carried out in the specified network to demonstrate the operation of a real-world process and the flow of packets from one node to another or from one user to another. In illustrating this testing phase, packets were sent among the devices included in the network design. A visual simulation tool known as Cisco Packet Tracer was utilized in the testing procedure.

Table 8. *Result of Simulation Testing in Cisco Packet Tracer*

Sender	Receiver	Remarks
SHS Multipoint 3	All clients	Successful
Server	All clients	Successful
Office of Head Teacher PC	All clients	Successful
Grade 11 Laptop	All clients	Successful
Grade 12 laptop	All clients	Successful
Library Laptop	All clients	Successful
Grade 7 Laptop	All clients	Successful
Grade 8 Laptop	All clients	Successful
Grade 9 Laptop	All clients	Successful
Grade 10 Laptop	All clients	Successful
Faculty Laptop	All clients	Successful
JHS Lab PC	All clients	Successful
JHS lab Multipoint 1	All clients	Successful
JHS lab Multipoint 2	All clients	Successful
JHS lab Multipoint 3	All clients	Successful
SHS Multipoint 1	All clients	Successful
SHS Multipoint 2	All clients	Successful
SHS Lab PC	All clients	Successful

3.4.2 Ping Test

A ping test was conducted to see the connection between the clients in the network; the ping test aimed to check a particular host's status on the IP network. Additionally, it measures the connected clients' connectivity and response times.

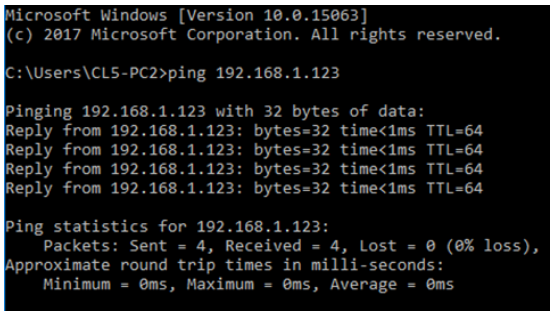

Figure 3. *Result of pinging a wired client using a wireless client.*

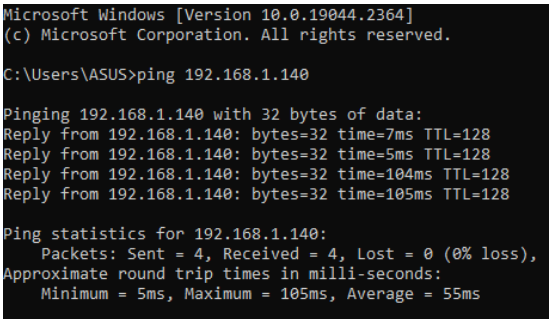

Figure 4. *Result of pinging a wireless client while utilizing a wired client.*

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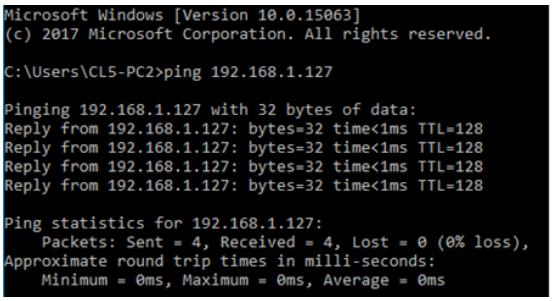

Figure 5. *Result of pinging another client with a wired client.*

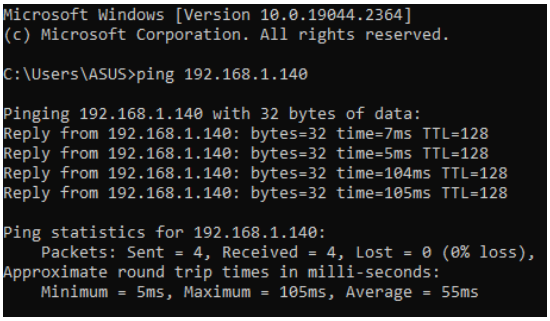

Figure 6. *Result of pinging server using wired client.*

3.4.3 System Testing

System testing is the stage at which the entire network is examined. It is carried out by designers involved in the system's creation.

The designers have tested the upload and download speed of files from 5MB to 1GB using the TrueNAS web interface. As mentioned earlier, the designers used a desktop to figure out the tests. The designers use a line graph to present the flow of the upload and download speed. The files that have been uploaded have the classification of small files, medium files, and large files.

Table 9. *Result of Upload and Download Speed*.

	Upload Speed	Download Speed
5 MB (Extra Small File)	4	4.64
10 MB (Small File)	8	7.47
20 MB (Small File)	14	16.45
50 MB (Medium File)	34	37.18
100 MB (Medium File)	66	32.82
200 MB (Large File)	143	44.76
500 MB (Large File)	364	125.57

3.4.4 LAN Speed Test

During the testing phase, the LAN speed test tool was utilized to measure the upload and download speeds. The testing results, presented in the TrueNAS Speed Test, were obtained from 11 clients.

Table 10. *Result of LAN Speed Test*

	Upload	Download
Test 1	118.78	716.19
Test 2	89.42	643.95
Test 3	108.05	644.52
Test 4	75.56	573.41
Test 5	103.59	527.69
Test 6	105	602.93
Test 7	100.43	615.51
Test 8	51.11	25.66
Test 9	151.68	666.43
Test 10	120.94	708.07
Test 11	26.88	63.43

3.4.5 LAN Messenger Result

Each client's device successfully installed the LAN Chat program, which served as a communication tool for users connected to the network and having LAN Chat installed on their computers. The program allowed users to exchange messages and share files with each other. Upon opening the LAN messenger, users were greeted with the LAN Messenger Interface which displayed a list of all active users on the network who had the software installed.

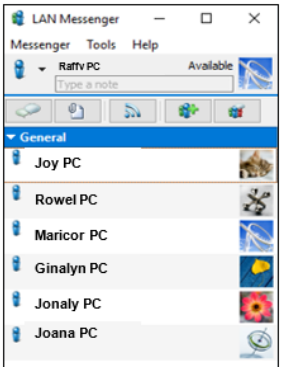

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Figure 7. *Wired Device (Computer Unit) installed with LAN Messenger*

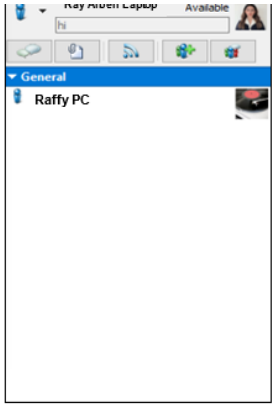

Figure 8. *Wireless Device (Laptop) installed with LAN Messenger*

The LAN Messenger result showcased the message exchange that occurred among users within the network. Additionally, users were able to receive a broadcast message from another user. This broadcast message was composed by a user and was accessible to all selected active users of the software.

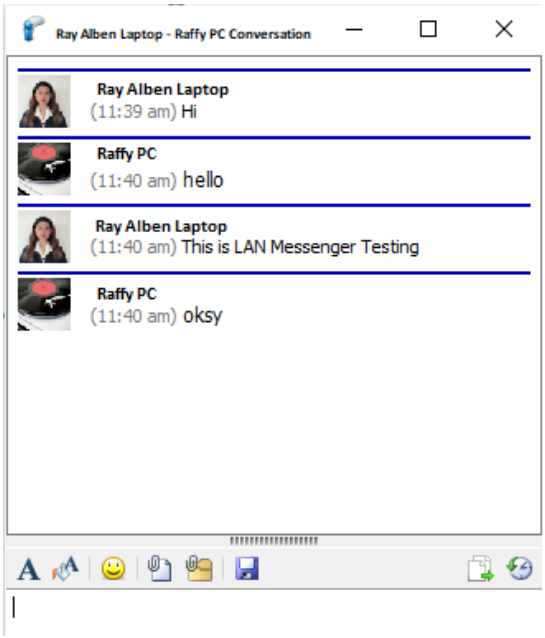

Figure 9. *Exchange of messages among two users of LAN Messenger*

4. CONCLUSION

Following the project's findings, the following conclusions were reached:

Due to limited internet access, organizations often experience inefficiencies in file transfer and communication, negatively impacting their daily operations. To address these challenges, this project was developed as a solution to aid the organization in overcoming these obstacles.

This project was initially intended to be implemented at PASMHS. Still, when the school suddenly had to focus its budget on the new face-to-face classes, this initiative had to halt abruptly. As a result, the designers and the panel committee decided to move through with the project as a pilot test. As an outcome, the designers have concluded that to avoid any problems and ensure project transparency, all project-related concerns must be agreed upon by both parties. Financial issues must be resolved and mutually agreed upon before the project's implementation.

A school faculty member or a government worker with knowledge of the project's field should be assigned the network administrator once it has been completed successfully. This conclusion was drawn because it was already clear that government entities, such as schools, had IT coordinators, and it would be easy to teach them to operate and maintain the deployed project.

The users of the designed project should be trained on using the platform for data transmission, which is also significant to data privacy. They should know what they should and should not do while using the platform. As mentioned earlier, all the findings show that the project has reached its objectives.

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5. RECOMMENDATION

The following recommendations are suggested based on the presented findings and conclusion.

The designers recommended that:

1. The IT Coordinator of the school must be oriented on how to operate and maintain the implemented project.
2. The IT Coordinator must be the network administrator.
3. The IT Coordinator must reserve an IP Address for the server. It will allow the IT coordinator to access the installed web interface at the same IP Address.
4. The designers must train the IT Coordinator to operate and maintain the designed project.
5. The users must be trained on how to use the platform in file transmission and exchange of information.
6. The school or government offices must negotiate and deal with Financial matters for the project cost beforehand to prevent delays during the project implementation.
7. The designers and the person in charge of the school must negotiate to deal with any matters regarding the project implementation for transparency to prevent any issues.
8. It is recommended that future researchers explore more features of the TrueNAS software. As the network and Software are flexible, more features can be utilized in scenarios where there can be internet access in the area soon.
9. Future researchers are advised to expand the project and fully implement the designed platform in a school or government office where it would benefit its operations.

REFERENCES

[1] Kadir Beycioglu. 2012. Current issues in educational management and leadership. Journal of Management Development, vol. 3. Retrieved on March 12, 2022, from bit.ly/3BK4HXk.

[2] Jhon Choi, Joo Won Cho, Dong Hwa Kim and Chang Hum Yoo. 2012. A novel scheme of government information sharing system for implementing paperless government in Korea. Pages 452 – 453. Retrieved on April 11, 2022, from https://bit.ly/3FAdqN1.

[3] Gloria Maite Msiza, Khashane Stephen Malatji, and Lydia Kgomotson Mphahlele. 2020. Implementation of an e-Learning Project in Tshwane South District: Towards a Paperless Classroom in South African Secondary Schools. Vol. 18 No. 4. Retrieved on February 15, 2022, from bit.ly/3uTRsjf.

[4] Valéria Farinazzo Martins, Paulo M. Sampaio, Antônio José A. Cordeiro, and Bruno Ferreira Viana. 2018. Implementing a Data Network Infrastructure Course using a Problem-based Learning Methodology. Journal of Information Systems Engineering & Management, 3(2). Retrieved on February 12, 2022, from bit.ly/3BKBX0S.

[5] Anirudh V. Karnamanirudh. 2022. "What Is Cloud Computing Architecture: Front-End & Back-End Explained". Retrieved on December 30, 2022 from https://bit.ly/3GteUKM.

[6] Jhon Choi, Joo Won Cho, Dong Hwa Kim and Chang Hum Yoo. 2012. A novel scheme of government information sharing system for implementing paperless government in Korea. Pages 452 – 453. Retrieved on April 11, 2022, from https://bit.ly/3FAdqN1.

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Mayari: Philippine History, A Story-based 3D Game for Filipinos

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Abstract- Philippine history is essential to building future generations' knowledge. Recently studying Philippine History has become more of a process to comply with the subject rather than retaining that information. It is shown and observed even on public and social media; people mainly need to improve students' knowledge about history and are easily influenced by unreliable information. This study is entitled "Mayari: Philippine History, A Story-based 3D Game for Filipinos" This study aims to create an alternative way of learning Philippine history. It is done through the concepts of gamification. By implementing the ideas of history into a game, the game was created through Unity, hoping to gather the students' interest and help them effectively retain historical information. And also, identify the ideal preference of the users when it comes to catering to their needs and providing information effectively. This project is implemented to provide an alternative way of teaching Philippine history that will help the students and open up opportunities for this method to be adopted by learners and instructors alike in the future. This study is conducted at Marinduque State College. Tests have been undertaken so the user will have no problems accessing and playing the game while respecting the systems-built functions, game scripts, and appropriate user interface design.

Keywords: Gamification, User Interface Design, Game Scripts

1. INTRODUCTION

The Philippines today was made by history. Awareness of history helps individuals compose their own beliefs, opinions, judgments, and values based on written records, analysis, interpretation, and documentation that existed in the previous time. Filipinos identify themselves based on their experiences in different eras, affecting the country's cultures, economics, society, and politics.

The history of the Philippines has come a long way since it was discovered in 1521 by the Spanish expedition led by Ferdinand Magellan [1]. For all generations, Filipinos experienced numerous yet notable historical events that helped the people to shape their view of the world today, including the Spanish Colonization, the Philippine Revolution, American Colonization, the Independence of the Philippines, of the Philippines, and The Marcos Administration [2, 3]. History is a disciplined inquiry that satisfies human curiosity and familiarizes itself with the world [4]. Knowing our history helps us establish our opinions, judgments, values, and identities and better understand the world [3].

The Philippines incorporates the teaching of Filipino history into its curriculum. It includes, among other things, the Araling Panlipunan (AP) of the K-12 curriculum, which covers various Filipino historical topics at all grade levels, [5] Readings in Philippine History which is under the Commission on Higher Education (CHED), which is a study of Philippine

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History together with various aspects of a Philippine life including political, economic, social and cultural through the lens of first-hand witnesses, [6] and the teachings of the Life, Works, and Writings of Jose Rizal mandated by Republic Act 1425 or also known as Rizal Bill, which goal is to recognize and appreciate the contribution of Dr. Jose Rizal to the society, as well as promote patriotism [7]. In previous years, Philippine history teachers usually used secondary sources such as textbooks to teach students about the topics. However, it was observed with the educational system that the supposed primary sources needed to include something interesting, which tends to make the students less attracted to the subject matter resulting in a lack of knowledge and awareness of history. However, in the curriculum of CHED, Readings on Philippine History will use primary sources, including oral, visual, and audio-visual, covering the aspects of life in that time [6].

Concurrently, as technology rapidly overwhelms the world, most traditional means are also affected, especially in education. Since history is also part of the educational system, the quality of learning about historical events will also get affected. As the generation passes by, digital natives and learners, like students who are born in a technological and digital environment, become less interested in reading books, and up to 26% under the age of 18 spend time reading [8]. In other words, most students use fewer books or reading materials to get references for their works.

With another health crisis starting around 2019, a virus called COVID-19, the world was forced to adapt to 'The New Normal.' Most people, even students, were forced to stay at home due to the lockdown implemented by the government to protect its citizens from the coronavirus outbreak. The pandemic made schools utilize various learning methods, such as modular and online learning, using the internet and other technological tools [9]. Although students can virtually learn anything online, this method may be less optimal, meaning this shows less effectiveness since many problems were encountered by the students, including dropouts and psychological issues due to different circumstances in this new learning method in the country [10]. Meanwhile, more than the digital era alone affects the students' interest in learning more about Philippine history.

With the statements mentioned above, learning history nowadays can be very tough. With fewer learning materials, students' interest in the subject matter is becoming somewhat concerning. On the other hand, another concern must be raised, including the controversial historical events in Philippine history. The issues can be found in the curriculum of Readings in Philippine History, such as The First Mass of Limawasa, Cry of Pugad Lawin, Cavite Mutiny, and other known issues. However, these mentioned issues are used to practice and exercise students' skills when it comes to research and analysis. The minimizing of confusion, if allowed, is needed.

The research's target users are mainly students capable of adapting a new modern approach to learning. Since games are proven effective as learning tools across different learning areas, this project relates to Philippine history [11]. It opened an opportunity of developing a game to tackle the topic of Philippine History. The current content available about the Philippines' history can be built through concepts, solid storylines, and game structures. The project titled “Mayari: Philippine History, A story-based 3D game for Filipinos” was proposed that will yield a deliverable in the form of a game to tackle the deliberation of historical facts.

2. METHODOLOGY

2.1 Requirement Analysis Procedure

The researcher conducted an interview with History Teachers can gather information. A review of Related Literature and studies was conducted to broaden the knowledge and consider possible technological innovations that can help preserve our history. Textbooks and other learning materials were also reviewed and analyzed to craft the game flow.

After analyzing traditional teaching and deciding to offer a new way and opportunity to teach the topic using a computer game, different techniques, and diagrams were used to prepare documents, establish structures, building blocks,

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gameplay, and project flow. In addition, the applied methods aid the game in improving and maintaining its processes.

A Work Breakdown Structure (WBS) was prepared to determine the list of works necessary and all of the deliverables to guide the performance tasks needed and define the project's scope.

The Gantt chart was created to identify and estimate the schedule of specific works identified in WBS to help plan and schedule project activities.

Storyboarding was created to illustrate the game scene so the viewer could visualize how the game will work and flow. The camera positions and characters will be staged, ensuring the best possible result.

A Flow Chart has been added to define the flow of the system. It will help indicate if the system follows the necessary flow required. It will also help with the needed verifications during the testing process. The flowchart was created to visualize the project's flow and sequence of processes.

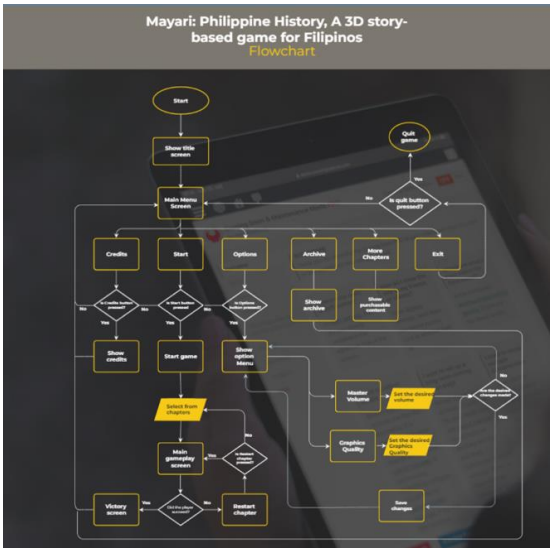

Figure 1: *Flowchart of the Application*

Following the planning sequence, as they completed the partial portion of the game, beta testers were tasked to gather feedback about the proposed match's contents, design, functionality, and effectiveness.

The beta test results are applied to verify if the game is feasible for the market and continuation of development with the implementation of feedback from the testers. The results are interpreted later on. The Beta test is also conducted with the ISO 25010 to measure if the game meets the requirements to complete the development.

2.2 Feasibility Analysis Procedure

The Feasibility Analysis was conducted to determine whether the project is worth pursuing further or is possible for implementation.

A series of prior research on any present existence of a game for historical purposes was conducted to measure its potential for new projects to take root. A study showed that there are possibilities for users to adapt to this new method of learning through games. It will show if the game will effectively put any advantage and opportunity to use while staying on track with the project's purpose concerning the project development requirement. With those in mind, the analysis was completed to ensure the project was feasible. An Operational Feasibility analysis was conducted to tell if the organization possesses the capabilities of developing the game project and has met the requirements for the project. The SWOT analysis identified the organization's strengths and weaknesses in its ability to support the game project and its operation. This analysis will also find out possible opportunities and threats that can be encountered amidst developing the game, also on use.

Technical Feasibility Analysis was conducted in order to determine whether the technical resources required to develop the game are met. Assessments like this are a must to decide whether the capabilities and skills needed to create the game are possessed. A GAP analysis was utilized to present the developer's available resources to develop the project. The GAP analysis specified the technical specifications required for the project and the general technical help for the development, from its hardware to the software needed. The results were measured to use on the SWOT analysis were the strengths, weaknesses, opportunities, and threats for the

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technical aspects of development. The SWOT analysis results are based on the GAP analysis.

Table 1. *Result of SWOT Analysis for Operational Feasibility*

Strength	Weakness
• The developers have the necessary tools to develop the game. • The developers have enough confidence and determination the game development. • The developers have the needed software and alternatives for developing the game. • The developers are knowledgeable with the related programming language for the game. • The developers possess the needed skills and flexible to meet the requirements for the game. • The developers possess the needed resources (computers) required to run the game • The users are capable of running and operating the game development. • The users have internet connections. • The users are familiar with the programming language to be used in the development. • The users are able to follow the game flow. • The developers can financially capable to source needed materials effectively and immediately.	• Lack of needed practice in some areas of development • Development requires an unfamiliar logic. • Lack of communication in development. • Lack of needed practice in some areas of development • Development requires an unfamiliar logic. • Lack of communication in development.
Opportunity	**Threats**
• Enhance knowledge and experience of the developers upon developing the game. • Equip the necessary skills and adaptability to solve development related problems amidst developing the game • The game development can utilize the skills of the developers to possible resources needed to advance. • Further development may improve the competency of the developers about the required programming for the game. • The development process may open options for the developers to adjust the requirements to further fit the user's capabilities.	• Budget shortage • Lack of available alternatives • Interruptions on the software while developing such as software updates. • Weak internet connection. • Power interruption while running the game. • Unexpected bugs upon playing the game. • Internet connection is interrupted while running the game • Development software editor failure and errors. • Sudden problems with the hardware used by the developers like storage shortage.

Table 2. *Result of SWOT Analysis for Technical Feasibility*

Strength	Weakness

Lastly, A Market Feasibility Analysis was used to measure the Mayari's marketability. The analysis is done by looking at the existing game market within or near the same genre. The market opportunities for this project are high to gather market traction. After using the game, a

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survey questionnaire is distributed to the target organization to identify the potential marketability engagement for the game and its relevance to potential market consumers. They used Slovin's formula to calculate the confidence sample size necessary for the project.

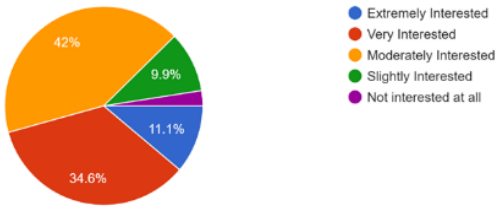

Figure 2. *Rating on how interested are they at playing a game about Philippine History*

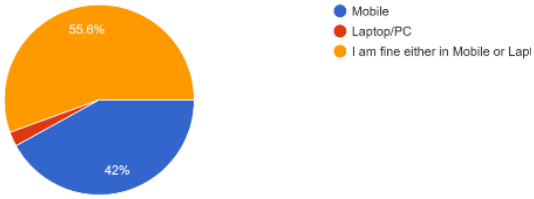

Figure 3. *Preferred medium for playing*

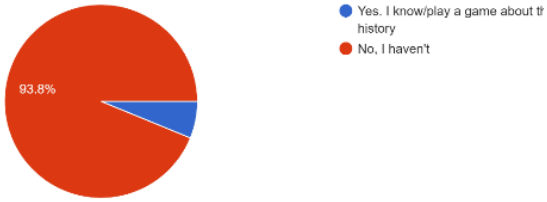

Figure 4. *Encountered a game relating to the Philippine History*

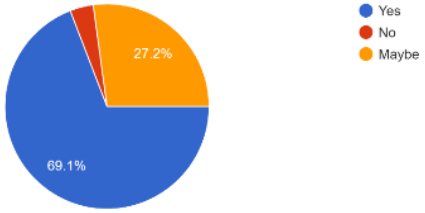

Figure 5. *Playing a game about the Philippine History*

2.3 Development and Testing Procedures

Prototyping and Game development were utilized in this project to create the game. The early developed game features the game interface and the game itself where the player can play a designated character and play based on relativity to some parts of the Philippines' history or, in this case, Ferdinand Magellan in the Philippines, was the chosen history topic that the game will be based on. This model will partially implement the game, allowing the required testers to view some parts of the game early.

The development stage is composed based on the compiled components and elements from the pre-production stage, such as the storyboard, game design, features, and game architecture. MediBang and Photoshop were used to illustrate sketches, concept art, and the final outputs, including storyboards, character designs, and terrain.

After creating the elements, the drawings were transferred to 3D computer graphics software for sculpting and modeling. Blender 3D was used for this process because it offers a convenient and easy way of modeling 3D objects. Also, considering this software's current expertise and use experience, it is proven to be more manageable than other 3D software.

Unity Game Engine was used to create the source codes of the game. Unity's game engine is supported by the C++, C#, and Python programming languages, which are familiar and easy to work on for the developers. The 3d models created on the 3d software Blender will be used and imported to Unity to add the scripts and codes on how each of the objects would function in the game and how the player's character would

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interact with it. There's some issue regarding importing 3D models to Unity because some textures cannot be imported with the 3d models. Because of that, some textures must be applied as assets after the 3d models are imported to Unity and added using Unity to avoid further problems. The assets are then implemented with various physics (how an object or model reacts to collisions, gravity, or other forces). Online assets were also gathered during pre-production and added to the game according to the project's needs.

The game was tested to identify bugs and issues following the development process. Various testing strategies were used to further identify any defects. Functional testing was required to manually test the game by first testing each navigation button from the main menu screen to see if it does what it was intended to do, like; navigating through the menu through the specific controls. Another kind of testing to be applied is exploratory testing, which refers to gameplay that is not a planned approach to testing but occurs naturally in the game. By exploring the game environment, it will identify any bugs upon use.

The primary goal of Alpha testing is to improve the game product by identifying and fixing bugs that were not discovered previously. This test will be performed solely by the development, tasked to simulate a real-world user environment by completing all the steps that actual users might take. Any bugs or issues during this stage will also be fixed and appropriately tuned right away to scrutinize unknown glitches or bugs that may arise before progressing to the Beta stage. Testers will have complete control over the character in Mayari: Philippine History, A story-based 3D game for Filipinos, and they can either follow the objectives or explore the game freely or do both simultaneously as to what real players might do.

The last stage of testing is beta testing, where a larger audience of real players have to play the game in a real-time user environment to test the game through user experience and to gather feedback to be considered for application in the final pre-release changes. The players will have to try the game for themselves and play it usually like in other games. This test contributes to the testing process by having each player report bugs, glitches, or suggestions affecting gameplay. This stage is crucial because only the group of testers within the development team is involved with the previous testing stage, and some bugs might've been overlooked. Beta testing requires more people to try and play games. Testers will be selected composed of individuals playing the Beta version, which will be done by actual testing. Feedback and suggestions will be examined, discussed, and considered after a careful process. All of those will be taken highly as valuable contributions to the game's betterment and to prevent recurrence in future releases.

2.4 Implementation Plan

This game results from the thorough planning and concepts of the development process. With considerations of the pre-survey conducted to give the users a proper introduction to the game before its development, the Gantt chart shows that necessary planning and activities are conducted to ensure that the game is refurbished, tested, and ready for implementation.

This game will be free since most of the expected users are students and would be living on a budget. It will be beneficial for the project to be this way to gain more users rather than locking it behind as a purchasable copy. The game is designed to be easy enough to be played and yet still has the challenge to be entertaining.

After completing the development of the application and a series of test runs, the game will be released for the students' use. If permitted, the game shall be implemented for educational use. As a first, it will be implemented for student use in Marinduque State College. This game requires an amount of storage space due to the details implemented in it. It is necessary to be played on desktop devices. That is why this is installed on personal devices or in school computer laboratories. The project implementation is projected to be implemented in December.

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3. RESULTS AND DISCUSSIONS

3.1 Requirement Specification

The game called Mayari: Philippine History, A story-based 3D game for Filipinos, mainly focuses on developing the game with reliable information as a new educational tool for the current educational system. It will be a guide to educate the students about the importance of Philippine history to the new generations that will be more engaging gameplay. This gameplay develops utilizing 3D game concepts that will provide various Philippine historical events. All information included and used in the game was carefully selected and analyzed from the results of past data-gathering, including interviews and research.

3.2.1 Functional Requirements

Functional Requirements define how the system works and functions based on different inputs.

a) Game Execution and Gameplay – The system shall allow the players to have full control of the character in the game to make the story progress. The system shall also allow the player to reach the game's objectives.
b) Game Settings – The system shall allow the players to access the setting function to be able to change the master volume through a slider button and change the graphics quality ranging from Low graphics quality to Very high graphics quality
c) Game Flow and Story – The system shall have its story well-written to depict the history well.
d) Game Data – The system shall allow the players to save their game data and load those data in the events of use. The system can also automatically save when exiting the game.

Stating the possible and essential functions of the system will enable the users to find educational information, be conscious of the importance of Philippine history, and engage in meaningful interaction within the game. While the story progress, all the main goals of the system will be automatically achieved as the game flow will be the main gear for picking and assisting the students to their current game status.

4.2.2 Non-functional Requirements

Non-functional Requirements focus on the system's criteria to judge its operation, not specific behaviors.

a) Game Access – The system shall be free and accessible in the area location.
b) Privacy/Security – The system shall protect all sensitive data from users from unauthorized access.
c) Bug-free – The system must be free from bugs and errors.
d) Usability – The system shall guide the user upon using the application for the first time, including introducing the parts and function of each icon in the User Interface.
e) Reliability – The system shall provide an engaging interaction and serve its purpose as an educational tool for learners.
f) Feedback – The system shall have the feedback to see the progress of the gameplay

3.2 Test Results

These tests were done to check the functionality and capability of the system. For system testing and a part of the alpha testing, the test case was conducted to simulate possible scenarios used to test the system. The test involves in-game interactions with the system from Menu functions, game mechanics, data management, and content projection. Possible scenarios that the user might interact with are tested to ensure no bugs in the system and the game design. Functions like systems triggers and boundaries were tested to ensure that the game would run smoothly and according to the desired flow of the game. The specified conditions and steps are followed to simulate the expected interaction of the users with the system. As a result of the conducted test, all functionalities are working, and the system met the desired results.

With the Beta Test concluded, the results returned promising potential for the game. Most of the results came back with positive feedbacks from the beta testers. Within them, 50% of the testers found the game just right in terms of difficulty and with a minority of 4.5% of the

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testers found the game challenging.

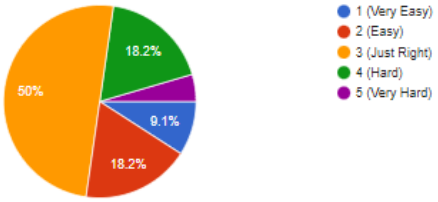

Figure 6. *Scale of difficulty of the game*

In terms of catering historical information to the users, 90.9% of the testers agreed that the game is adequate for that purpose.

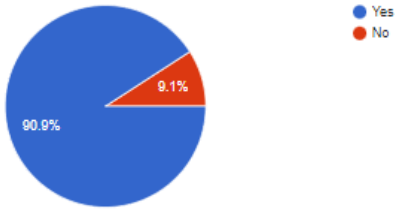

Figure 7. *Effectivity of the game on catering basic information about the history of the Phillipines specifically the Spanish Era*

Figure 8 shows that all of the testers (100%) found the game suitable for casual gameplay, proving that it fits a mass market audience.

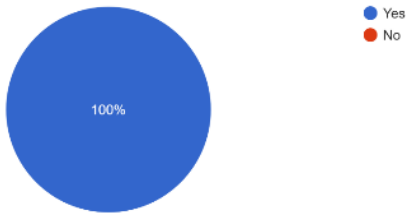

Figure 8. *Suitability of in-game questions for casual gameplay*

In Figure 9, 86.4% of the testers did not observe any significant or game-breaking bugs during the testing, and in figure 10, 95.5% did not find it an important concern.

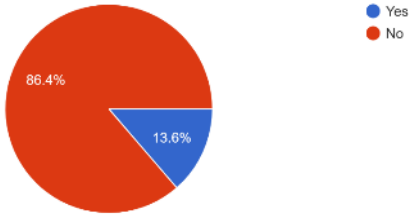

Figure 9. *Discovered difficulties or bugs in the game*

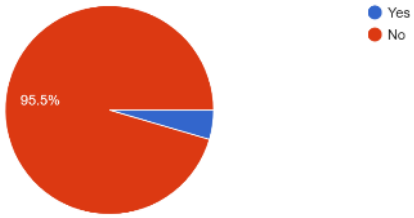

Figure 10. *Discovered bugs in the game that resulted to the game crashing*

On a scale of 1-5, the testers rated the game based on their experience during the testing process, 45.5% rated 5, 36.4% rated 4, and 18.2% rated 3. It shows that the testers were satisfied with the game, with those rating on the three scales being involved in game development based on their profile which will not be disclosed upon the agreement before the test. They are expected to review the game intensively, which will be taken as constructive and valuable information for further development.

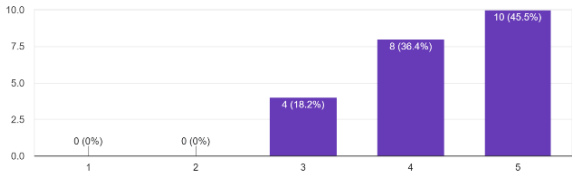

Figure 11. *Rating the game on a scale of 1-5*

In terms of building a community for the game to support the development to its completion correctly, all of the beta testers agreed to be part of the Mayari Game Development Community. As for their individual suggestions, some quotes from this part of the beta test results

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are selected. These are just some of the recommendations made by the testers:

- *"More kind of enemies that has different capabilities and are terrifying..."*
- *"..Include too a boost item and make it random so it would be more challenging..."*
- *"Hopefully, next time, there will be different types of maps that can be interacted with power-ups for the player to fight off the one-eyed monster even for at least 15 sec…."*
- *"Add sounds for the "frog man" whenever he speaks..."*
- *"I know the game is currently in development and is just the beta version. But you could add different types of monsters with their own different personalities and weaknesses.*
- *"Increasing the duration of the chase and polishing the pathfinding of the AI towards the character would be cool."*

Those are just some of the suggestions that were taken from the testers. Some are more systematic and deal with the existing system and concepts. All of these suggestions will be taken into consideration for other renditions of the game and as well as tips for future developers.

After several beta testers tested the developed game, the results for the ISO 25010 Quality Model of the game were also, and the results were as follows:

The game's operational sustainability, including functional completeness, correctness, and appropriateness, is satisfactory. The data found that 77.7% of the beta testers were satisfied with the game's user objective, while the other 27.3% found it neutral.

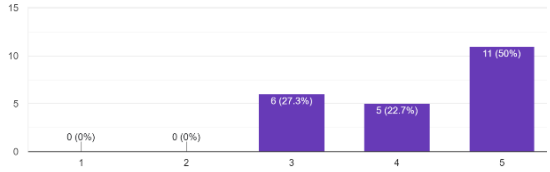

Figure 12. *Functional completeness*

Regarding the game's functional correctness, 77.3% of the beta tester agreed that the game provides correct results with the needed degree of precision, while 22.7% found it neutral.

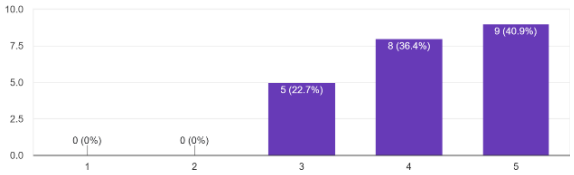

Figure 13. *Functional correctness*

The functional appropriateness of the game involving the facilitation of accomplishment of objectives scores the same as the previous data, with 77.3% being satisfied and 22.7% being neutral.

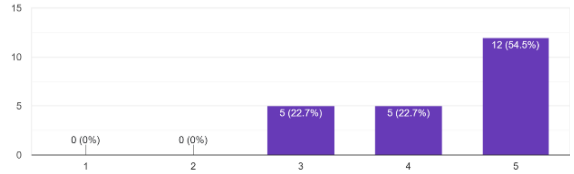

Figure 14. *Functional appropriateness*

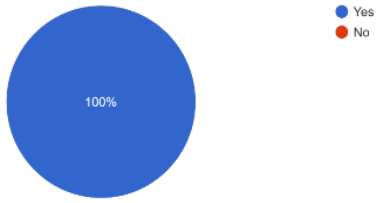

Figure 15. *Chance of supporting the game*

The game's performance efficiency, including time behavior, resource utilization, and capacity, is satisfactory. The data gathered found that 68.2% of the testers found the time behavior, which demands the system's fast processing, acceptable. While 22.7% found the case neutral, the remaining 9.1% of the tester disagrees.

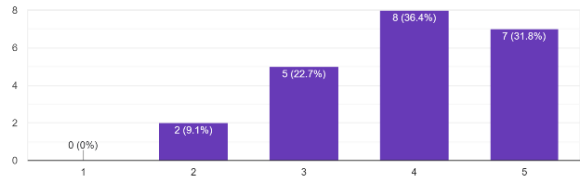

Figure 16. *Time behaviour*

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Regarding resource utilization, in which the system utilizes the information resources efficiently, 81.9% are satisfactory, while 18.2% found it neutral.

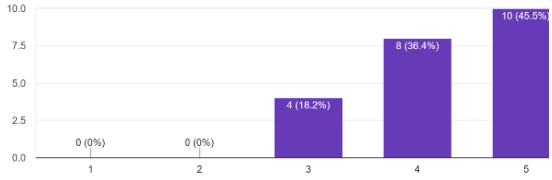

Figure 17. *Resource utilization*

On the other hand, the game's capacity, in which the system parameters meet their system requirements, shows that 81.8% are satisfied, while 18.2% found it neutral.

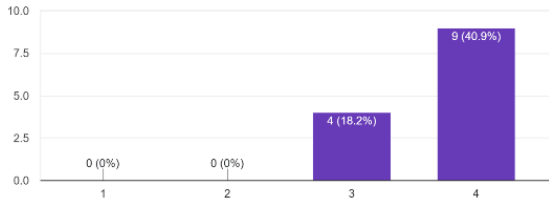

Figure 18. *Capacity*

The compatibility of the system, including co-existence and interoperability, is satisfactory. According to the gathered data, 86.4% of the tester found that the system can perform while sharing its environment with other systems, while the remaining 13.6% found it neutral.

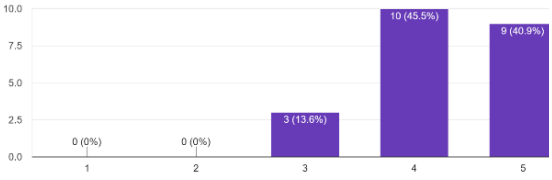

Figure 19. *Co-existence*

The system's interoperability, which can interact with another system, has 72.7% satisfaction, while the 27.3% found it neutral.

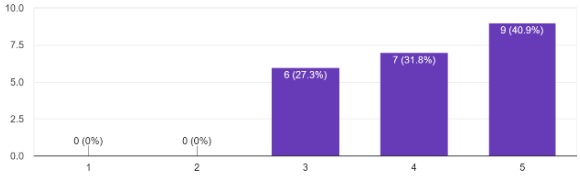

Figure 20. *Interopability*

The system's usability, including appropriateness recognizability, learnability, operability, user error protection, user interface aesthetics, and accessibility, is satisfactory. The recognizability of the system, which allows the user to recognize the system as the product to solve their needs, found that 91% of the tester agrees, while 9% found it neutral.

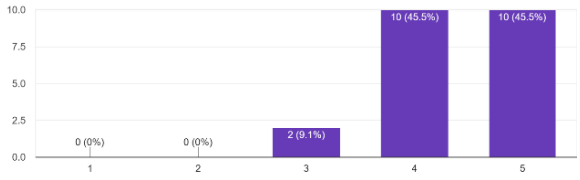

Figure 21. *Appropriateness recognizability*

95.5% of the testers agree that the system can be learned more efficiently, while the other 4.5% found it neutral.

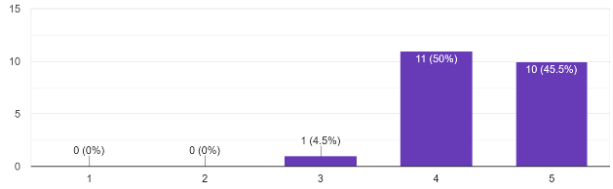

Figure 22. *Learnability*

Based on Figure 23, the system's operability has a 95.4% rating meaning that the game can be easily controlled and operated.

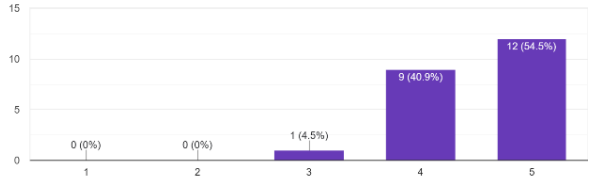

Figure 23. *Operability*

On the other hand, the user error protection has a rating of 90.9%, signifying that most of the

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testers are satisfied.

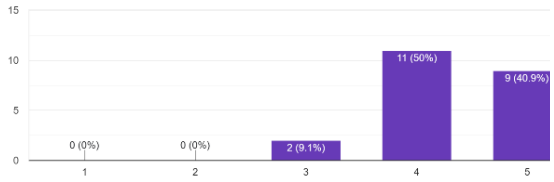

Figure 23. *User error protection*

Regarding the user interface aesthetics, which involves the system's pleasant user interface, 86.4% are satisfied with the developed interface, while the other 13.6% found it neutral.

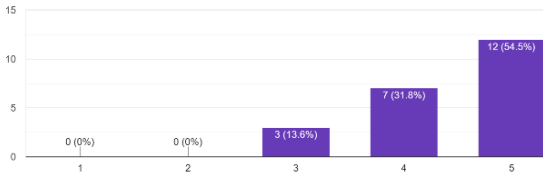

Figure 24. *User interface aesthetics*

Regarding the accessibility of the system, which tackles if the system can be accessed by specified users under specified conditions, 90.9% are satisfied, while 9.1% found it neutral.

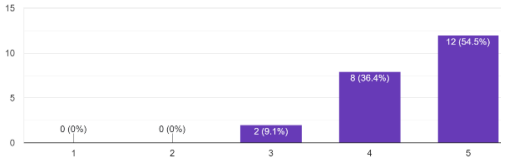

Figure 25. *Accessibility*

The system's reliability, including maturity, availability, fault tolerance, and recoverability, is satisfactory. The maturity of the system, which the system does meet the need of the user under normal operations, and the availability of the system, which tackles the operational and accessibility of the system when needed for use, has a rating of 90.9% of satisfaction, while the 9.1% found it neutral.

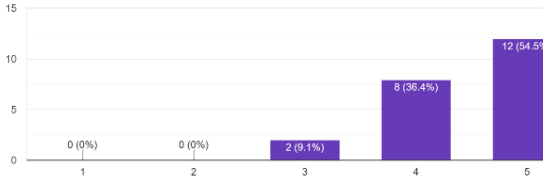

Figure 26. *Maturity*

On the other hand, 81.8% are satisfied with the system's fault tolerance and recoverability during a disaster, while 18.2% found it neutral.

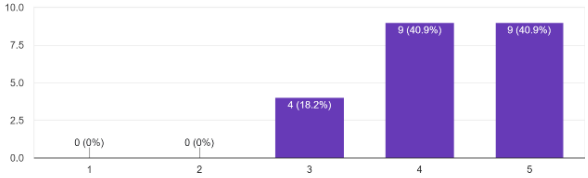

Figure 27. *Fault tolerance*

The system's security, confidentiality, integrity, non-repudiation, authenticity, and accountability are satisfactory. According to the data gathered from the beta testing, the testers answered that the system's authenticity is satisfactory, with a rating of 81.9% and 18.2% neutrality.

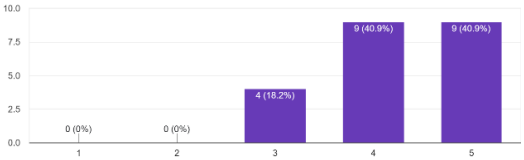

Figure 28. *Recoverability*

The confidentiality of the system, which ensures that the data are accessible only to those who have authorized access, and the integrity of the system, which involves the modification of data, has a rating of 77.3% satisfaction while 22.7% neutral rating.

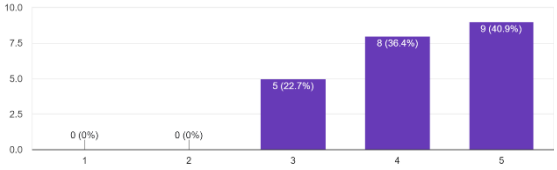

Figure 29. *Confidentiality*

The non-repudiation of the system has a rating of 86.3% of satisfaction, while 13.6% is neutral.

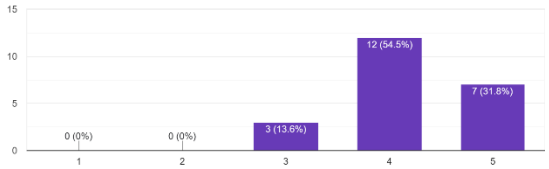

Figure 30. *Non- repudiation*

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The system's accountability, which detects if the system can trace an action or event of an entity, has a 72.7% satisfaction rating, while the other 31.8% found it neutral.

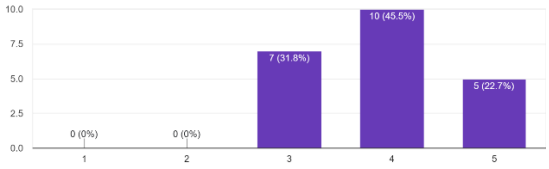

Figure 31. *Accountability*

The system's maintainability, including modularity, reusability, analysability, modifiability, and testability, is satisfactory. The system's modularity, reusability, and analysability have a rating of 77.3% of satisfaction, while the 22.7% have a rating of neutrality.

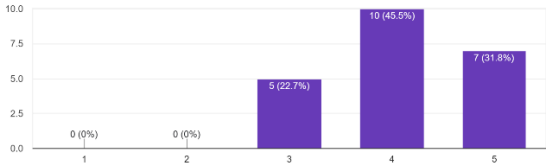

Figure 32. *Modularity*

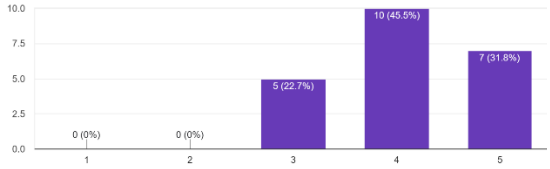

Figure 32. *Reusability*

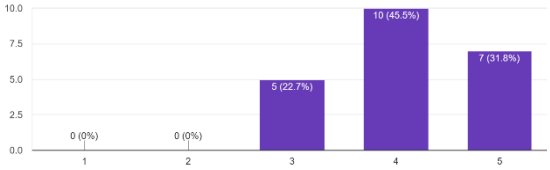

Figure 33. *Analysability*

The modifiability of the system, which covers if the system can be easily modified, has a rating of 63.6% satisfaction, 31.8% neutral, and 4.5% dissatisfaction.

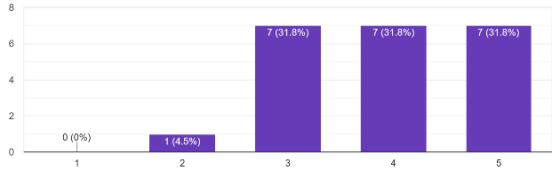

Figure 34. *Modifiability*

In Figure 35, the testability of the system has a rating of 90.1% satisfaction, while the other 9.1% is neutrality.

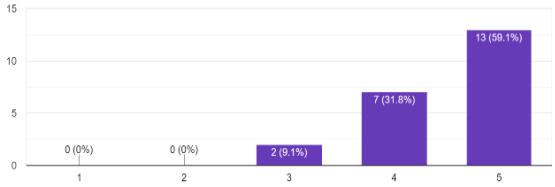

Figure 35. *Testability*

The system's portability, including adaptability, installability, and replaceability, is satisfactory. Regarding the system's adaptability, which is if the system can be moved to other environments, 86.4% are satisfied, while 13.6% are neutral.

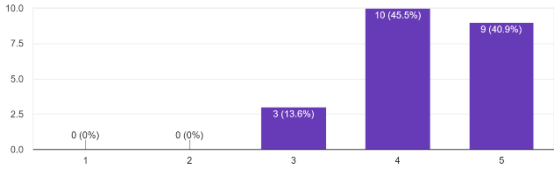

Figure 36. *Adaptability*

The installability of the system which if the system can be installed easily. 95.5% of the beta testers are satisfied or agrees with it, while 4.5% found it neutral.

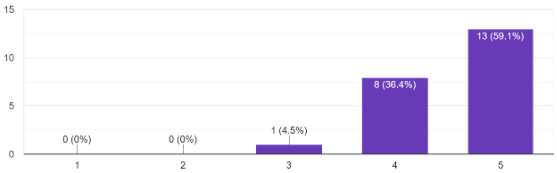

Figure 37. *Installability*

Lastly, in figure 38 it shows that 63.7% agree the system can replace other systems,

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31.8% are neutral, and 4.5% are dissatisfied.

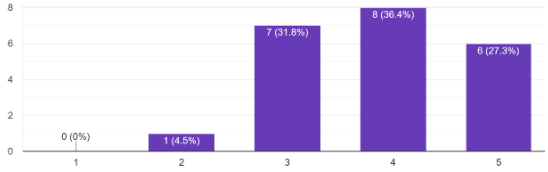

Figure 38. *Replaceability*

5. CONCLUSION

The duration of the development yielded results about the possibilities and potentials of games as a method of teaching Philippine History. Given that the respondents are students of Marinduque State College, they gathered data through surveys that can support the project objectives and serve as the basis for the project's initiation.

Based on the surveys conducted, some of the feedback and suggestions of the students regarding the methods used to teach Philippine history were met with mixed responses. The opinions of the students reflect their reactions toward the techniques, with some expressing discontent. It may have also been affected by the remote methods of teaching implemented due to the pandemic. Although this does not directly involve the purpose and objectives of the game, it is still essential to consider their feedback on the surveys.

In terms of interests, it yielded that people are interested in this type of game. The level of interest from the majority of respondents ranged from moderately interested, very interested, and highly interested. Their mixed reactions regarding interest reflect their knowledge about existing games related to these topics since they showed that most hadn't played them before. Even so, they showed promising results on the number of respondents that would like to try and play the game.

In development, various tools were used to create the story flow of the game, and they used Medibang, Photoshop, and Canva. These storyboards are used to see the possible look and functions of the system. The system's functions are built to relate to each other's purpose and tagged ID for data purposes. It will help support the claim of games as an alternative method to teaching.

Unity has been the chosen most applicable editor used to develop and program the game. These involved creating the script, engaging art style, and original concepts while still keeping the reference of the topic as the main relevant element. Since the game is purposed to serve as a tool of teaching while being interesting, it is required to have an exciting flow of the story to follow through.

In terms of the feasibility of the project, it yielded that the project is feasible regarding Technicalities, Operational, and Marketability. The desired requirements were met by developing the system and the availability of the necessary tools and skills. The technical resources available also met the GAP Analysis's standards.

System testing and Alpha testing are critical to be conducted to ensure the system is working accordingly. All of the possible scenarios had been met. Since results were not known on how the players would play their game, simulations of different scenarios, even those outside the box, were conducted to ensure that the player could avoid any problems or bugs. Although bugs are not impossible to eradicate, adjustments and contingency plans are prepared in the future to adjust the programming scripts and game objects involved with the bug.

In conclusion, a complete replacement tool for teaching Philippine history is not possible since even if the methods of the traditional teachings are outdated, they still yield great results and have been the more familiar way of learning. These methods need more people to be familiarized with them to understand and accept them entirely. As an Alternative teaching tool, games such as Mayari can be a possible alternative for teaching since the students showed great interest in it and are willing to try it.

6. RECOMMENDATIONS

In the project's development, things encountered, observed, and gathered information regarding this type of project. For future developers of Historical games, these recommendations are suggested.

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1. Ensure that the respondents are willing to cooperate. Cooperation from the users is essential to advance the development and may take time, depending on the development situation the developers are in.
2. Enlist the help of Game Development personnel. Tips from experienced professionals are helpful in the improvement of the structure of the development team, game design look, and system structure.
3. Adjust the scale of the game's future contents according to the given development time available.
4. Source more materials and propose more chapters for the game. The game has yet to tackle different eras, site more information about historical events, and use them as valuable resources for future content. Please put them in a different version of the game.
5. Apply more options for player customization of the game.
6. The game is flexible, and the current developers recommend that future developers improve the recent game's structure. The game may still need some elements that future developers would have access to, such as more assets and capable people in different areas such as sound production, animations, post-processing, arts and design, and programming.

REFERENCES

[1] Emma Jackson. 2020. Ferdinand Magellan's Voyage and its Legacy in the Philippines. (March 2020). Retrieved April 20, 2022, from *https://tinyurl.com/mu92k4hs*

[2] Kathleen Nadeu. 2020. The History of the Philippines (2nd Edition). Retrieved April 20, 2022, from *https://tinyurl.com/483s33ek*

[3] Why is it important to study history? (July 2020) Retrieved April 20, 2022, from *https://tinyurl.com/yzpxpcc3*

[4] Wilhelm Dilthey. 1961. Pattern & Meaning in History: Thoughts on History & Society (H.P. Rickman, Ed.) (1st ed.). Routledge. (July 2020). Retrieved April 20, 2022, from *https://doi.org/10.4324/9781003074434*

[5] OFFICIAL STATEMENT: On Philippine history in basic education. (January 2022). Retrieved April 20, 2022, from *https://depedcalabarzon.ph/?p=1687*

[6] READINGS IN PHILIPPINE HISTORY. Retrieved April 20, 2022, from *https://tinyurl.com/4yp36hvu*

[7] Rizal's Life and Work (Modular Approach). Retrieved April 20, 2022, from *https://tinyurl.com/2p93t2t7*

[8] Donna Ferguson. 2020. Children are reading less than ever before, research reveals. (February 2020). Retrieved April 20, 2022, from *https://tinyurl.com/3cphmvvc*

[9] Jose Z. Tria. 2020. The COVID-19 Pandemic through the Lens of Education in the Philippines: The New Normal. International Journal of Pedagogical Development and Lifelong Learning, 1(1), ep2001. Retrieved April 19, 2022, from *https://doi.org/10.30935/ijpdll/8311*

[10] Jessie Barrot, Ian Llenares, & Leo del Rosario. 2021. Students' online learning challenges during the pandemic and how they cope with them: The case of the Philippines. Educ Inf Technol 26, 7321–7338. (May 2021). Retrieved April 19, 2022, from *https://doi.org/10.1007/s10639-021-10589-x*

[11] Lea Martinez, Manuel Gimenes & Eric Lambert. 2022. Entertainment Video Games for Academic Learning: A Systematic Review. (January 2022) Retrieved April 20, 2022, from *https://tinyurl.com/bdhayurx*

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Spiderby: Clash of Spiders

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Abstract--The game Spiderby: Clash of spiders is a 2D with attached 3D fighting game that brings back the traditional game in our childhood. The game has fighting feature mechanics such as blocking, dashing, attacking and special attacks. It has very challenging levels and ranking that makes you enjoy playing. It is also having a cool sound effect during the fight in the battle field when using their different skills. Find and fight another spider. Get energy by winning the game. If you lose the game, you lost your spider. So be sure to survive. Bringing back the Filipino game now on mobile. This paper presents the development of a mobile game that aims not only for entertainment purposes but also to give information and introduce different types of spiders and its origin. The proponents used a survey questionnaire to obtain the needed information. After analyzing the data, a feasibility analysis was conducted by the developer to see if the project would be feasible. The developed project used a prototyping model that initially showed the design of the interface and the storyboard of the mobile game. The Unity 3d game engine was used in the development of the game, for things like designing and for real-time 3d content. The C# programming language was used for the back end, along with MS Visual Studio. For modeling and texturing of the game objects, Blender and Adobe Photoshop were used. The results obtained from the respondents were understood and interpreted for the betterment of the game. From the conducted User Acceptance Test, the 10 randomly participants accepted the functions of the application without crossing to a single problem during the testing.

KEYWORDS*:* Spiderby: Clash of spiders, 2D,3D fighting game, Traditional game, Spiders

1. INTRODUCTION

1.1 Project Context

Today, technology plays an important and most impact and the popular activity among young children is the use of mobile devices and apps. The impact of mobile devices on learning and development is rather underexplored. Mobile devices have become an integral part of everyday lives of modern students. Many teenagers like to play mobile games on their smartphones [1]. Using this application may strengthen your socializing skills and give entertainment. The game application is offline, although it can't connect player to player, they can still have fun playing together by staining collected spiders and comparing their ranks. Despite the fact that your opponent is A.I it acts intelligently, as if controlled by a human game-player. For instance, AI becomes increasingly inclined to select more robust playing methods [6]. It is also having a cool sound effect during the battle in the battle field when using their different skills. So, demanding that our screen heroes and heroines are constantly making sounds of strife, struggle, or victory while conducting

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surrogate labor for us running, fighting, saving worlds [7]. Users can enjoy playing without going outside to search for spiders, including deadly one. This application helps the user capture spiders and also duel and swap with other players. The modern-day games become more advanced and are laden with graphics and become a favorite pastime [8]. With its simplicity, spider fighting matches can be set up almost anywhere. Most matches happen around schools, playgrounds, and other places where gamers normally congregate. The spiders used in this sport are collected from trees and Branches that pervade the rural landscape of the Philippines. Spiders in the Philippines are collected and prepared to fight with one another on a stick until one is either dead or deprived of strength. This betting game is considered as one of the traditional pastimes in the country and the game makes many Filipinos interested. This is a Filipino-inspired spider fighting culture from an idea to virtual battle [5].

The sport of spider fighting occurs in different forms across the many islands of the country. Spider fighting in the Philippine Islands has many names. In Tagalog-speaking Island it is called "*sabong ng gagamba"*. In Hiligaynon, it is termed as "*pahibagsang damang*" while in Cebuano, the practice is called "*paaway"* [2]. In the game that we implement, it is called spiderby because of the two spiders that are fighting on sticks.

3. METHODOLOGY

3.1 Data Gathering Procedure

The proponents used data gathering procedures and conducted a preliminary investigation to get the needed information for the system through fact finding techniques such as survey and research.

Upon the preliminary investigation, the proponents made a closed-ended questionnaire to conduct the survey. Using Random Sampling Technique to gather information.

Moreover, the target user for the project is randomly selected 155 people using Slovin's formula $\boxed{n = \frac{N}{1 + Ne^2}}$ to conduct a survey questionnaire through Google form and messenger chat during a global pandemic. The gathered data was analyzed, and it resulted in requirements documents. Here is the formula for measuring the sample in this research.

Furthermore, after the survey, the gathered data was analyzed. The proponents also gather research related studies and related systems to the project to widen the knowledge about the study. The Work Breakdown Structure created by the proponents easily understands and determines the process of initiating, planning, analysis, design and testing on the game development.

Along with the WBS is the Gantt chart that is used by the proponents for planning and scheduling projects. Also, this will help determine the needed resources to complete the Project. Scripting and Storyboarding will be used to pertain to the game play and Flowchart to further understand the project.

Scripting and Storyboarding were used to refer to the game play or how the game will be played, and Flowchart were used to further understand the project.

3.2 Feasibility Analysis Procedure

In the Feasibility Analysis Procedure, it will be determined whether this study is worthy or beneficial to continue.

The procedure focuses on the Operational, Technical and Market Feasibility.

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The Operational feasibility is used to determine and satisfy the user meets the prerequisites. Operational feasibility includes SWOT Analysis in which it has the strength, weaknesses, opportunities and threats of the user. A sequence of evaluation with the user was conducted to obtain knowledge about the respondents. The gathered data was evaluated to know if the development of the game is feasible.

Through conducting technical feasibility, the proponents assessed themselves if they have the capability of developing the system. Through SWOT Analysis the developers distinguish the user's strengths and weakness in altering that the system might lead, and the opportunities and threats that the user may encounter when the system contrive in the user were preferable.

The proponent's existing technical resources and the required technical resources of the project will be compared through Gap Analysis that determines if the technical resources of the proponents have the ability to support the proposed project.

Furthermore, the Market Feasibility and Appraisal was used to determine the needs of the current market for a development of this type of system. Using the Survey Questionnaire that has been conducted to the randomly selected clients, it has been analyzed to determine the current state of the market and if there is a real need for this development.

3.3 Development and Testing Procedure

The initial prototype features serve as the basic functionality according to the client's requirements. The process started in gathering data done using Survey Questionnaire through Google form and messenger chats. Then the gathered data has been analyzed and become the basis of the initial prototype that the developers present to its client. It has been tested by the developer and it will improve using the user's feedback from the gathered data from Beta testing of the game. Photoshop, Unity and Blender is the software used by the researcher in developing the application, this was picked by the developer since these were the closest familiar for them to use, and it was currently available as their developing materials. Photoshop was used to show improvements in the interface of the application. Blender was used to model and render the spider in the game. Unity was used to create the environment of the application's interface.

The C# Language was used to create a useful and functional system to manipulate materials inside the application. The Blender Application was used to model all the entities or material that can be found inside the application.

3.4 Implementation Plan

After completing the project's development and performing tests, the developers created a user manual as a guide for the users. It includes all the parts and features of the game with its descriptions. In addition, the user manual has a step-by-step guide on how to play the game application after installing it on their phone.

4. RESULTS AND DISCUSSION

4.1 Requirement Specification

The Clash of Spiders is a 2D/3D type of game wherein players can play different types of spiders. Spiders have fangs that inject poison into their prey and most kinds spin webs in which to capture opponents. Other spiders have thick skins that provide armor yet slow in movement and the others have mobility but no armor.

Users can have additional knowledge regarding the spider's name and origin. The game can be played by a single player

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(opponent is artificial intelligence given by the game).

4.1.1 Functional Requirements

Functional requirements specify the functions that the system should react to particular input and behave in specific situations.

A. For Users;
1. Start the game
   a. The game application will allow all users to start the application;
   b. It allows all users to view home screen;
   c. It will allow all users to view guides on how to play the game.
2. Find Spiders

a. The game application allows the user to find spiders in their habitat.

b. It allows the users to directly put the spiders they found on the matchbox.

3. Campaign mode

a. The game application will allow users to play by levels.

b. It allows the users to choose your spider that you want to engage in the battle.

c. It will allow the users to control the left and right buttons on the left side of the screen.

d. It will also allow the users to control they're spider skill button on the right side of the screen.

e. The game application will allow the users to cancel and return to the main menu after losing the game.

f. It will allow the users to go to the next level after winning the game.

g. It will allow the users to cancel and return to the main menu after winning the game.

4. Rank Mode

a. The game application allows users to play hard opponents.

b. It allows you to choose the spider that you want to engage in the battle.

c. It allows the users to control the left and right button on the left side of the screen.

d. It allows the users to control their spider skill button on the right side of the screen.

e. The game application will allow the users to cancel and return to the main menu after losing the game.

f. It will allow the users to go to the next level after winning the game.

g. It will allow the users to cancel and return to the main menu after winning the game.

5. Shop

a. The game application allows the users to buy spiders on the shop.

b. It allows the users to buy matchboxes in the shop.

c. It allows the users to buy some insects that can be fed to their spiders in the shop.

6. Predatory

a. The game application will allow the users to feed their spiders.

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b. It allows the users to view the information of their spider.

c. It allows users to release their spider in the matchbox.

7. Daily Quest

a. The game application will allow the users to claim the chest box daily.

b. It allows the users to get coins or energy every time they open the chest box.

8. Ranking

a. The game application allows the users to get rank every win they have done on the rank mode.

9. Settings

a. It allow the users to mute and unmute to audio of the game

b. It allows the users to quit or exit the game.

B. For Developers;

Operational

a. The game application should run on different android devices from Android 8 to 12;
b. The game application should be user-friendly in terms of its interface and buttons;
c. The game application should operate its end to job; and
d. The game application should operate as intended as if it resumes from the lock screen.

Performance

a. The game application should run on Android 8 to 12 devices;
b. The game application should not crash while playing;
c. The game application should not stop functioning; and
d. The game application should not load too long upon opening it.

4.1.2 Non- Functional Requirement

Non-functional requirements specify criteria that can be used to judge a system's operation rather than specific behaviors.

a. *Usability* - The game is for fun and for the pastime. It should be nice and easy to use so as not to get bored and not immediately disgusted by the player or user. To ensure that those who will use it will not be bored, we will put different battlefields and add other types of spiders that can be found not only in the Philippines. So, the player will enjoy playing.
b. *Reliability* - the game must be debugged properly. Our game is offline and many people can play it. The game should also be evaluated in many aspects so as not to cause much trouble to the end user.

4.2 Description of the Developed Project

The developed system will give additional knowledge regarding spiders' origin, name and traits. It will give users a good combat between spiders on phones.

As the game load completely, it will show the second phase of the game which is the menu phase wherein the following aspects are present;

The *Guide*, for the first-time user, you see the guide or navigation for playing the game.

The *find button*, you must press this button to find a spider that you can use in a fight.

The *shop is* where you can buy the spiders, matchbox and insects.

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The *inventory*, it is where you can see the information of your spider. You can also feed your spider and keep your spider in good health. You can also release your spider there.

The *settings*, in this button you can mute and unmute the sound of the game.

The *matchbox*, in this box can see the collection of the spider. You can open and close it whenever you want.

The *campaign button*, this is one of the game modes where you fight a random spider by levels.

The *Rank Button*, this is the second game mode where you can fight random spiders with a challenging opponent.

The *Fighting Buttons*, that can be used to fight with the opponent.

The *Round Button*, used to perform a basic attack of your spider.

The *Projectile Button*, used to perform special attacks on the spider. This special attack is like a shooting star that moves to its opponent that can be damaged when it hits.

The *AOE Button*, this is the Area of attack button where the spider performs a range of attack affecting damage to its opponent.

The *Dash Button*, used to dash to the other side of the opponent to avoid its attacks and to perform other special attacks.

The *Shield Button*, used to block the attacks of the enemy for a few seconds.

The *Right Arrow Button*, used to move right close to your opponent to start fighting.

The *Left arrow button*, used to move left close or away to your opponent.

The *Timer*, to see how many seconds or minutes the fight ends.

The *Health Bar is* the life bar of the spider. There are two life bars for the spider in the game.

The *X button used* to go back in the main menu.

The *Exit Button*, this is if you want to exit from the game.

4.3 Result of Feasibility Analysis

4.3.1 Operational Feasibility

For the operational feasibility, the SWOT analysis conducted shows that the clients have the strengths needed to implement the game. The users have internet connections and devices to download and install it. The game is free to download on an Android phone. Clients have the provision in the development of the game. Because of the opportunities, the number of users who can play the game will increase because of new advances in technology. Client's satisfaction may increase due to the unique and improved interface of the game. However, the client's devices have low graphics, which is its weakness. And if a client does not embrace the game style, there is a threat.

4.3.2 Technical Feasibility

For the technical feasibility, the developers have the needed ICT resources and the needed specification that can support the developed system. Furthermore, the conducted SWOT analysis shows that the developers have the needed strength for the development of the game. The developers have enough time to complete the developed project. The developers possess resourceful characteristics and are knowledgeable in using different programming languages. For opportunities, the sudden changes in the requirements and other recommendations may help the developers better analyze the game. However, the weaknesses of the developers are lack of resources like codes for the project, low

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graphics of technologies, changes in game design and game flow, and the availability of the game for only the Android phone, unlike any other game. The threats include the failure of the development tools, power shortage while developing the system, weak internet connection, and lack of equipment or tools essential for the development of the system.

4.3.3 Market Feasibility

For market analysis, the developers identified the market competition and whether the game is feasible in the market. The market evaluation of spider fighting games is also included to support that fighting games are quite popular nowadays in the market.

As a result, the game is marketable, especially the game which has its own version of Spider Fighting game. The target customers are from age 12-17 years old because it is the age gap with the most percentage playing the game. Fully 97% of teens ages 12-17 play computer, web, portable, or console games [8]. Aside from that, survey data from survey questionnaire was applied in the game in order to attain the feedback of the users.

4.4 Result of Testing

Indicator	Weighted mean	Adjectival Interpretation
Functionality	2.5	Satisfactory
Reliability	1.74	Satisfactory
Usability	1.68	Excellent
Efficiency	1.64	Excellent
Portability	2.7	Satisfactory
OVERALL MEAN	**2.052**	**Satisfactory**

After conducting User Acceptance tests, it was evaluated that the game application for the market meets the user feedback given during the data gathering. Some of the acceptance requirements were rejected by the user and it is expected to have some adjustments for the developers. The game application was tested for the Inner Device Test on an android as the platform and it was assessed to work in any SDK version.

Moreover, the software Quality Evaluation test based on the ISO 9126 that was evaluated by IT Professionals was prepared in order to ensure that the developed game application is reliable, functional and usable. The sum up and divided results was summarized and resulted with an overall mean of 2.052 with very satisfactory as adjectival interpretation.

5. CONCLUSION

The developers tested the Spiderby: Clash of spiders concluded that it is effective and entertaining in terms of gaming experience, as well as providing information about the spiders and challenging gameplay.

In general, it can be concluded that the Unity platform supports efficient development of the fighting game. Using the new components of Unity, the developer was able to implement the game more effectively.

6. RECOMMENDATION

Based on the findings and conclusion presented the following recommendations were drawn:

- Put some food that can be found where the user searches for spiders.
- Should put a reward when the player is releasing the spider in its habitat.
- Put some videos to give information to the users about spiders.

The above recommendations will be added and improved by the researchers.

Some enhancements, such as additional features to include and improving its capability, are permitted for the future developers in order to make it more productive for the user. Future

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work is allowed to incorporate other fact-finding techniques to become more entertaining and enjoyable to play with.

REFERENCES

[1] Stan Kurkovsky. 2009.March 01. Engaging students through mobile game development. Retrieved May 08, 2021, from https://dl.acm.org/doi/abs/10.1145/1539024.1508881

[2] Ty Matejowsky. 2003. Spider Wrestling and Gambling Culture in the Rural Philippines. Philippine Studies,51(1):147-163.

[3] **"**Gagambattle". [Online]. Available:https://play.google.com/store/apps/details?id=com.JarmelaProduction.Gagamgirls_Spider_Gagambattle_MVG

[4] Michael Dimock. February 5,2008. Teens Video Games and Civics. Retrieved September 9, 2022 from: https://www.pewresearch.org/internet/2008/09/16/teens-video-games-and-civics/#:~:text=Almost%20all%20teens%20play%20games.&text=Fully%2097%25 %20of%20teens%20ages,%2C%20portabl e%2C%20or%20console%20games.

[5] "SpiderFightSimulatorEarning".[Online]. Available:https://play.google.com/store/apps/details?id=com.ricreator.Gagamba.Fight

[6] Hai Liang and Jiaqi Li. 31 July 2022. A Study on the Agent in Fighting Games Based on Deep Reinforcement Learning. Faculty of Humanities and Arts, Macau University of Science and Technology, Taipa, Macau, China.

[7] Milena Droumeva. 20 December 2019. Audible Efforts: Gender and Battle Cries in Classic Arcade Fighting Games. School of Communication, Simon Fraser University, Burnaby, BC V5A 1S6, Canada.

[8] Riad Chikhani. October 31, 2015. Audible Efforts: Gender and Battle Cries in Classic Arcade Fighting Games. Retrieved September 10, 2022 from: https://techcrunch.com/2015/10/31/the-history-of-gaming-an-evolving-community/

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