

Pamana: Exploring the Philippines' Heritage through Integrating Quest-Based Item Exploration  
in a 3D Game using Dijkstra Algorithm

John Lorenz D. Briones, Reynaldo B. Goroy, John Carlo V. Ibisate, and Danica Anjielyn D.

Salenga,

College of Computer Studies, Technological Institute of the Philippines- Quezon City

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Engr. Jerry E. Borromeo

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## Abstract

The Philippines is home to an abundance of historical structures, landmarks, and artifacts that contribute to its rich cultural legacy by acting as emblems of its multicultural character. Unfortunately, a lot of Filipinos, particularly the younger generation, don't know much about their cultural heritage because of things like a lack of participation and accessibility. To bridge this gap, the Pamaña project was conceived, leveraging the innovative integration of quest-based item exploration within a 3D gaming framework, augmented by the sophisticated Dijkstra algorithm for seamless pathfinding. This amalgamation not only facilitates 3D exploration but also orchestrates captivating cutscenes upon artifact discovery, segueing seamlessly into educational quizzes to reinforce newfound knowledge. With the inclusion of a passing score system and competitive leaderboards, it fosters a dynamic learning environment while instilling a profound appreciation for the Philippines' historical narrative. By intricately blending interactive gameplay with cultural education, it emerges as a pioneering endeavor aimed at nurturing cultural awareness and fostering a deeper connection to the nation's rich tapestry of traditions and landmarks.

Based on the evaluation conducted using the ISO 25010 standards, the system received a grade of 5.10, or "agree," across the following quality categories: Functionality, Efficiency, Maintainability, Portability, Reliability, and Usability. According to the study's results, Pamaña is an effective way for Grade 5 elementary students to enhance their familiarity about history and Araling Panlipunan

**Keywords:** Philippines, Artifacts, Heritage, Dijkstra Algorithm, Cultural Education, 3D Game, Elementary

## CHAPTER 1

### Introduction

By taking advantage of the intrinsic motivation and engagement that come with games, gaming in education transforms conventional teaching approaches. By means of gamification and game-based learning, instructors have the ability to pique students' curiosity and augment their comprehension of diverse disciplines. Gamers' engagement with interactive experiences through gaming helps them develop important abilities, including flexibility, problem-solving, and teamwork. Additionally, because games are so flexible, learning experiences may be customized to meet the requirements and interests of specific students. To guarantee a well-balanced and productive learning environment, however, successful adoption necessitates careful consideration of curriculum alignment, accessibility, and screen time monitoring.

Gamification and game-based learning can be very difficult because they are largely based on memorizing rather than on true knowledge. The all-pervasive impact of technology frequently causes them to lose focus on their academic goals. Even with the use of visual aids, it is still difficult to keep students engaged. In addition, cognitive issues made worse by linguistic obstacles make the situation worse. It is essential to majorly change teaching approaches to solve these difficulties. When combined with interactive learning methodologies, placing more emphasis on conceptual understanding than rote memory can improve student comprehension.

Implementing a 3D mobile application helps struggling students provide interesting, interactive renderings of historical and cultural ideas. The software improves comprehension and performance by utilizing interactive games and simulations that enhance learning and reinforce understanding.

## Background of the Study

“Maintaining one’s culture, values, and traditions is beyond price.” (Getano Lui Jnr).

Maintaining a nation’s identity and generating a sense of pride and appreciation among its population depends heavily on the preservation of cultural heritage. The Philippines, renowned nationwide for its rich and diverse cultural legacy, is one example where it is necessary to look into creative approaches to encourage people, particularly the younger generation, to learn and appreciate their past.

People nowadays don’t appreciate or understand their roots and cultural heritage because it's not seen as something important or a topic that interests them. Video games have made a big impact on today's generation, and they offer a distinctive platform for engaging players in experiences that study and appreciate cultural heritage. This study proposes “Pamana,” a 3D single-player gaming idea that combines a sophisticated Dijkstra Algorithm with quest-based item exploration that will make learning cultural heritage fun and interesting. Societies can stay connected to their roots and maintain their identity by preserving cultural heritage and creating a profound appreciation for history.

Combining these components allows players to engage in intriguing missions, uncover important relics, and explore a digital version of the Philippines while exploring its rich cultural past. Each quest is specifically created to lead players to the recovery or discovery of culturally significant objects, such as historic antiquities and customary handicrafts. Players get a deeper comprehension of the historical setting, the cultural relevance, and the relationship to the rich tapestry of Philippine heritage by completing these tasks.

## Objectives

The goal of this project is to develop a 3D mobile game application that aims to offer an engaging experience that encourages Grade 5 students to understand more about the heritage and artifacts of Palawan, Manila, Kalinga, Cebu, and Kalinga.

### Specifically, the study aims to:

- Create an engaging and interactive 3D mobile learning game for elementary students in Araling Panlipunan that promotes conceptual understanding and allows for more effective learning.
- Utilized the Dijkstra Algorithm to find the nearest path that will be used in five locations of the game with a guide of Non-Playable Character (NPC).
- Evaluate the Mobile Application based on ISO 25010 software quality standards.

## Significance of the Study

"Pamana" has the potential to be a significant educational, cultural, and entertainment tool. With careful planning and execution, a game like this could have a positive impact on the preservation and promotion of Philippine heritage

This project will be beneficial to the following:

### Grade 5 Elementary Students in Melencio M. Castelo Elementary School

This study will benefit the grade 5 students by helping them explore and discover what embarks them on the exciting journey to uncover hidden historical artifacts in the Philippines. This comprehensive event blends education and enjoyment, allowing students to dig into the Philippines' rich cultural past. Students will improve their critical thinking, problem-solving, and decision-making skills by actively participating in missions and investigating numerous goods. They will face exciting difficulties and riddles that will require them to examine data, make

Students can develop a profound appreciation for their country's legacy while also developing a passion for studying in an entertaining and engaging manner with this study.

### **Teachers**

The study will provide information by exploring artifacts and engaging the Teachers with valuable opportunities for their professional growth. The application is an outstanding instructional tool, providing teachers with an innovative and interesting platform to supplement their history and cultural courses. It gives teachers a novel technique to pique students' interest and make studying more fun. Teachers can enhance their students' active learning, critical thinking, and problem-solving skills by implementing the application into their curriculum. Because of the game's interactive aspect, teachers may promote dialogues and guide students through the investigation of cultural items, promoting a deeper understanding and respect of the Philippines' legacy.

### **ICT**

This project will benefit the ICT, with its broad range of tools and technology, offers a beneficial feature for managing data, preservation, preserving, collaboration, and education. By embracing these technological developments, It may improve research procedures, increase access to cultural assets, and promote interdisciplinary collaborations, all of which will improve our awareness of the past.

### **Tourism**

The game can also be used to promote heritage tourism in the Philippines. By providing players with a virtual tour of different heritage sites, the game can encourage them to visit these sites in real life.

## Entertainment

The game can also be a fun and engaging way to learn about Philippine heritage. By integrating quest-based item exploration into the game, developers can create an experience that is both educational and entertaining.

## Future Researchers

The outcome of this study will reflect on the Future Researchers, It can be their credentials, which will help them build and enhance their knowledge to uncover the mystery of the Philippines, This study may also use the Future researchers as their guide to make progress for the development and improvements to the application

## Scope

The game "PAMANA: Exploring the Philippines' Heritage through Integrating Quest-Based Item Exploration in a 3D Game Using the Dijkstra Algorithm" is centered on investigating the cultural legacy of the Philippines through a quest-based object exploration system. The game has the following features:

- **Quest-Based Gameplay** - Players are given a variety of goals and activities linked to touring historical locations in the Philippines and gathering artifacts of historical importance as part of the game's quest system.
  - **User Interface**
    - **Loading Screen** -It notifies the player that the game is still in process, preventing them from feeling disconnected or wondering what went wrong.

- **Home Screen** - It acts as the player's starting point or base, from which they can access numerous features and settings before plunging into the game itself.
- **Settings Screen** - During the Options Screen, players are often presented with various options and tweaks that allow them to customize their experience.

- **Tutorial**

- A voiceover to the given tutorial to help the players understand the objectives of the simulation and determine the next given task.
  - This will display the provided quest item and the leaderboard

- **Level 1**

- In this challenge, players must explore the heritage of Palawan to discover artifacts made from five different materials. Students explore Palawan's Manunggul Jar through artifacts and quests, uncovering its historical and cultural significance. Each discovery and completed quest adds to their understanding, culminating in a vivid cutscene that connects the jar to ancient Filipino beliefs and burial practices. This immersive journey fosters deep learning and historical empathy among students.

- **Artifacts**

- **Manunggul Jar** - The important artifact that's been found on the Tabon Cave in Lipuun Point in the municipality of Quezon, Palawan.

- **Level 2**

- At this level, the challenge is to collaborate with and explore the heritage of Manila, The origin of the Philippines can be traced back to theory, myth, and religion.
- **Artifacts**

- **Sedula or Cedula** - One of the important things that started the revolutionary movement that was formed by Andres Bonifacio in Recto Avenue in Manila.

- **Level 3**

- In this level, players are tasked with uncovering artifacts from the heritage of Kalinga and identifying the origin of the first group of people in the Philippines

- **Artifacts**

- **Mambabatok** - a traditional form of putting a tattoo on one's body in the province of Buscalan, Kalinga.

- **Level 4**

- Players are challenged to uncover artifacts from the heritage of cebu, and identify the way of life of the Ancient Filipinos during the Pre-Colonial period that can be examined

- **Artifacts**

- **Kampilan** - This sword is used by one of the greatest heroes Lapu-Lapu on the failed attempt of the Spanish people to colonize Mactan, Cebu.

- **Level 5**

- In the last level, the players must determine the five different materials and explore the heritage of Ifugao and the economic life of Filipinos during the Pre-Colonial Period about Internal and External trade, and types of Livelihood (farming, fishing, blacksmithing, weaving, etc.)

- **Artifacts**

- **Bululs / Bul-ul** - It is a carved stone used to worship the ifugao's "Anito" meaning the rice god which represents wealth, happiness and well-being.
- **Storyline** - The game will have a plot that invites players to research the significance, history, and culture of the heritage places they visit. Engaging stories and character interactions will be required for this.
- **3D Game Environment** - The game uses a three-dimensional virtual world to allow players to navigate the environment that represents the different heritage locations in the Philippines.
- **Cultural Heritage Focus** - The game focuses on the cultural heritage of the Philippines, highlighting the important locations and artifacts.
- **Item Exploration** - Players are encouraged to thoroughly explore the environment to uncover hidden treasures or artifacts and unlock new challenges.
- **Educational Element** - The game aims to impart knowledge regarding the Philippines' heritage and historical locations.
- **Visual and Audio Design** - Features visually appealing graphics and audio design that enhance and make the heritage exploration realistic.

- **Partnerships with Academic Institutions** - Develop customized game versions in collaboration with educational institutions to be used in classrooms to advance heritage and history teaching.
- **Modules for Interactive Learning** - Include in-depth historical and cultural details about each heritage site in interactive learning modules built into the game. For a more engaging teaching experience, these modules may provide quizzes or interactive storytelling.

## **Delimitations**

### **Listed below are the delimitations of the study**

- The application will only be available in Single-player mode
- The 3D game will be applied in Offline
- The game will only be available on Mobile Phone, specifically Android that have a version of OS 12 to 14
- The game will only be available in an English language setting

## CHAPTER 2

### Theoretical Framework

A theoretical framework is a group of ideas, theories, and beliefs that serve as the cornerstone for comprehending a certain subject or issue within a certain field of study. It gives researchers an analytical framework within which to frame their research questions, create hypotheses, and analyze their findings.

### Review of Related Literature

It refers to a systematic review and analysis of current research or academic articles related to a specific research topic, study, or area of interest. It is a necessary component of research projects and academic articles, especially in the social sciences, humanities, and other research-oriented disciplines.

### User VR Experience and Motivation Study in an Immersive 3D Geovisualization

### Environment Using a Game Engine for Landscape Design Teaching

Realistic 3D geovisualization is necessary to facilitate the perception of a landscape designer in relation to the environment, which is a determining factor in decision-making in landscape planning and management. In the field of landscape design teaching and learning environments, game engines can offer an immersive 3D geovisualization mode through Virtual Reality technology, which, in addition, can be motivating for the student. Game engines allow designing the scenarios where videogames take place, but game engines can also be used for geovisualization tasks in landscape design teaching environments. In this article, we present the landscape workshop, using a Unity 3D game engine. Twenty-five architect students performed landscape design tasks and worked with an interactive 3D geovisualization low-immersive

desktop screen environment. The perception of the 3D environment during geovisualization was analyzed through the Questionnaire on User eXperience in Immersive Virtual Environments, and the motivational factor with the Intrinsic Motivation Inventory. Results showed a high perception of the 3D environment during geovisualization in the nine subcategories (sense of presence, engagement, immersion, flow, usability, emotion, judgment, experience consequence, and technology adoption) analyzed. The game engine-based teaching approach carried out has been motivating for students, with values over 5 (in a 1–7 Likert scale) in the five subscales considered.

### **Utilizing A Game Engine for Interactive 3D Topographic Data Visualization**

Developers have long used game engines for visualizing virtual worlds for players to explore. However, using real-world data in a game engine is always a challenging task, since most game engines have very little support for geospatial data. This paper presents our findings from exploring the Unity3D game engine for visualizing large-scale topographic data from mixed sources of terrestrial laser scanner models and topographic map data. Level of detail (LOD) 3 3D models of two buildings of the Universitas Gadjah Mada campus were obtained using a terrestrial laser scanner converted into the FBX format. Mapbox for Unity was used to provide georeferencing support for the 3D model. Unity3D also used road and place name layers via Mapbox for Unity based on OpenStreetMap (OSM) data. LOD1 buildings were modeled from topographic map data using Mapbox, and 3D models from the terrestrial laser scanner replaced two of these buildings. Building information and attributes, as well as visual appearances, were added to 3D features. The Unity3D game engine provides a rich set of libraries and assets for user interactions, and custom C# scripts were used to provide a bird's-eye-view mode of 3D zoom, pan, and orbital display. In addition to basic 3D navigation

PAMANA: A 3D Game for Exploring Philippines' Heritage using Dijkstra Algorithm tools, a first-person view of the scene was utilized to enable users to gain a walk-through experience while virtually inspecting the objects on the ground. For a fly-through experience, a drone view was offered to help users inspect objects from the air. The result was a multiplatform 3D visualization capable of displaying 3D models in LOD3, as well as providing user interfaces for exploring the scene using “on the ground” and “from the air” types of first person view interactions. Using the Unity3D game engine to visualize mixed sources of topographic data creates many opportunities to optimize large-scale topographic data use.

## **Towards a “Filipino” Video Game: Teaching Filipino Culture and Identity for Video Game Development**

This paper uses the author’s experiences of teaching the Filipino module of a multidisciplinary video game development class as a case study in teaching Filipino culture and identity as an element of video game development. A preliminary definition of “Filipino video game” as having Filipino narratives and subject matter, made by Filipino video game developers, and catering to a Filipino audience, is proposed. The realities and limitations of video game development and the video game market in the Philippines is also discussed to show how the dominance of Western video game industry, in terms of the dominance of outsource work for Filipino video game developers and the dominance of non-Filipino video games played by Filipino players, has hindered the development of original Filipino video games. Using four Filipino video games as primary texts discussed in class, students were exposed to Filipinomade video games, and shown how these games use Filipino history, culture, and politics as source material for their narrative and design. Issues of how video games can be used to selfexoticization, and the use of propaganda is discussed, and also how video games can be used to confront and reimagine Filipinoness. The paper ends with a discussion of a student-made

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game titled Alibatas, a game that aims to teach baybayin, a neglected native writing system in the Philippines as a demonstration of how students can make a Filipino video game. The paper then shows the importance of student-made games, and the role that the academe plays in the critical understanding of Filipino video games, and in defining Filipino culture and identity.

### **Art Scene Investigation: discovering and supporting cultural heritage conservation through Mobile AR**

The expanding influence of Information and Communication Technology (ICT) on many facets of daily life is acknowledged in the study. It highlights how the widespread adoption of ICT technology has the potential to fundamentally alter how cultural material is preserved and shared. It emphasizes how knowledge regarding cultural assets, such as artwork and historical locations, can be shared and communicated through ICT-based tactics. It makes the point that, in order to improve the tourist experience, museums and other cultural institutions currently use mobile digital guides. According to the paper, smart objects and augmented reality technologies can be extremely important in disclosing scientific insights and diagnostic assessments related to cultural artifacts and historical landmarks, even beyond just giving tourists basic information. One of the most important technologies for accomplishing the study's objectives is augmented reality. AR can provide an immersive and participatory experience for a wide range of non-specialized viewers by bridging the gap between the digital information that is already available and the actual presence of the objects. The Koguryo tombs provide as a powerful illustration of how ICT technology and augmented reality can be used to create a deeper knowledge of cultural heritage. This study lays the groundwork for this exploration. The goal of this research is to advance the field of cultural heritage preservation and distribution by using innovative digital tools.

**Manila Crossing: A Design of a Retro 2D Gamified Learning as a Solution for Educational Virtual Tour in the Pandemic Period**

Manila Crossing is a unique gaming experience that combines 2D gameplay with educational elements, aimed at enlightening players about history through the collection of relics and the exploration of historical facts. The curriculum of the school has a strong emphasis on the locations that make up Manila's cultural heritage. Since the pandemic has made it harder for pupils to engage with their own cultural history, this effort gives them the chance to learn more about the historical landmarks in neighboring communities. These instructional games were created with the idea that, in the event of a pandemic, they may provide elementary school pupils with an alternate source of information. It is also a game heavily influenced by the popular Pokémon games, adds relics as necessary elements to fulfill objectives and overcome character obstacles, adding to the entire gameplay experience. Apart from being fun, this game also helps kids get a better grasp of the various cultures and historical locations in Manila. Additionally, it seeks to uphold and advance awareness of Manila and its historical landmarks, urging travelers to the city when the pandemic passes and it is safe to venture outside.

**Improving Children's Cultural Heritage Experience Using Game-based Learning at a Living Museum**

This empirical study conducted at Sarawak Cultural Village (SCV) focused on the development and evaluation of a game-based mobile guide (GBMG) application to enhance children's cultural heritage experiences. The study employed the Interaction Design lifecycle model, involving 45 children divided into two groups – one using paper-based pamphlets and the other using the GBMG application. The Museum Experience Scale (MES) was utilized to assess

the impact of the GBMG application, with the most significant difference observed in the emotional connection dimension. However, despite the enhanced emotional connection, the study found that the GBMG application did not significantly improve overall museum experiences, challenging earlier research on technology's influence on learning in museums. The study offers valuable insights into children's behavior and technology usage in cultural heritage settings and underscores the need for further research to optimize GBMG applications for better engagement and meaningful experiences.

this study at SCV demonstrates the potential of game-based mobile guides to heighten emotional connections among children, although their overall museum experience was not significantly improved. It highlights the importance of considering the nuanced interplay between technology, engagement, and learning in the context of cultural heritage sites. The findings provide practical guidance for cultural heritage institutions and mobile guide developers, emphasizing the significance of tailored information delivery and user experiences. Further research and optimization are needed to harness the full potential of GBMG applications in enhancing children's cultural heritage experiences.

### **The Effect of Mobile Learning on Learning Performance: A Meta-Analysis Study**

The importance of mobile technologies in the educational process has directed the attention of many researchers to this field and has created an important body of academic research. The main purpose of this study is to determine the effect of mobile learning on students' learning performance. In this study, the meta-analysis method was employed. The literature was reviewed through different databases in order to access the relevant researches within the scope of the study. After reviewing the literature, study aspects and inclusion criteria were applied. The

studies to be included in the meta-analysis were examined, and 104 studies conducted between the years of 2009 and 2019 that met the inclusion criteria were subjected to a meta-analysis.

Education level, course/subject and the implementation period of the studies were determined as moderating variables. The sample of the study consists of 7,568 participants. As a result of the analysis performed according to the random effects model, the mean effect size value was calculated as 0.85 with an error of 0.07. It was determined that there was no publication bias in the meta-analysis. According to the results of the moderator analysis, it was found that the effect of mobile learning on the learning performance of the students did not change according to the education level and the implementation period, but it changed according to the course/subject. In addition to the aforementioned research results, this article also contains descriptive analysis of the results of the studies included in the meta-analysis.

### **An adaptive model for digital game based learning**

Digital Game-based Learning (DGBL) has the potential to be a more effective means of instruction than traditional methods. However meta-analyses of studies on the effectiveness of DGBL have yielded mixed results. One of the challenges faced in the design and development of effective and motivating DGBL is the integration of learning and gameplay. A game that is effective at learning transfer, yet is no fun to play, is not going to engage learners for very long. This served as the motivation to devise a systematic approach to the design, development and evaluation of effective and engaging DGBL. A comprehensive literature review examined: how games can be made engaging and how the mechanics of learning can be mapped to the mechanics of gameplay; how learning can be designed to be universal to all; how learning analytics can empower learners and educators; and how an agile approach to the development of

instructional materials leads to continuous improvement. These and other considerations led to the development of the Adaptive Model for Digital Game Based Learning (AMDGBL).

### **Designing and Analysis of a Competitive Game based Learning Application**

The paper describes Laymania, a free Game-based-learning application that embodies learning with fun with an objective to teach its users the basics of Maths, Science, Languages and General Knowledge in a competitive manner. It's designed for children of age 4 to 12 year old to get them competing with their friends in a learning game. The video games industry is a rapidly growing industry with multi-billion dollar market. Game-based-learning is becoming mainstream with Teachers adapting E-learning techniques in classrooms and using traditional games to educate students more effectively. There has been extensive research that demonstrates the potential of video games in creating a learning environment where children can achieve their educational and training goals more effectively. In this paper we study the effective implementation of multiplayer competitiveness in educational games that are built on the idea of endless run games. Multiplayer games have a huge presence in the video game industry and users are easily attracted towards games that can be played with friends and peers. Current educational games don't have a consistent user base, the plan is to create a multiplayer mode which will keep the users engaged with the game on every day basis to learn new things about the respective fields they are interested in.

## Conceptual Framework

**Figure 1**

*Research Paradigm*

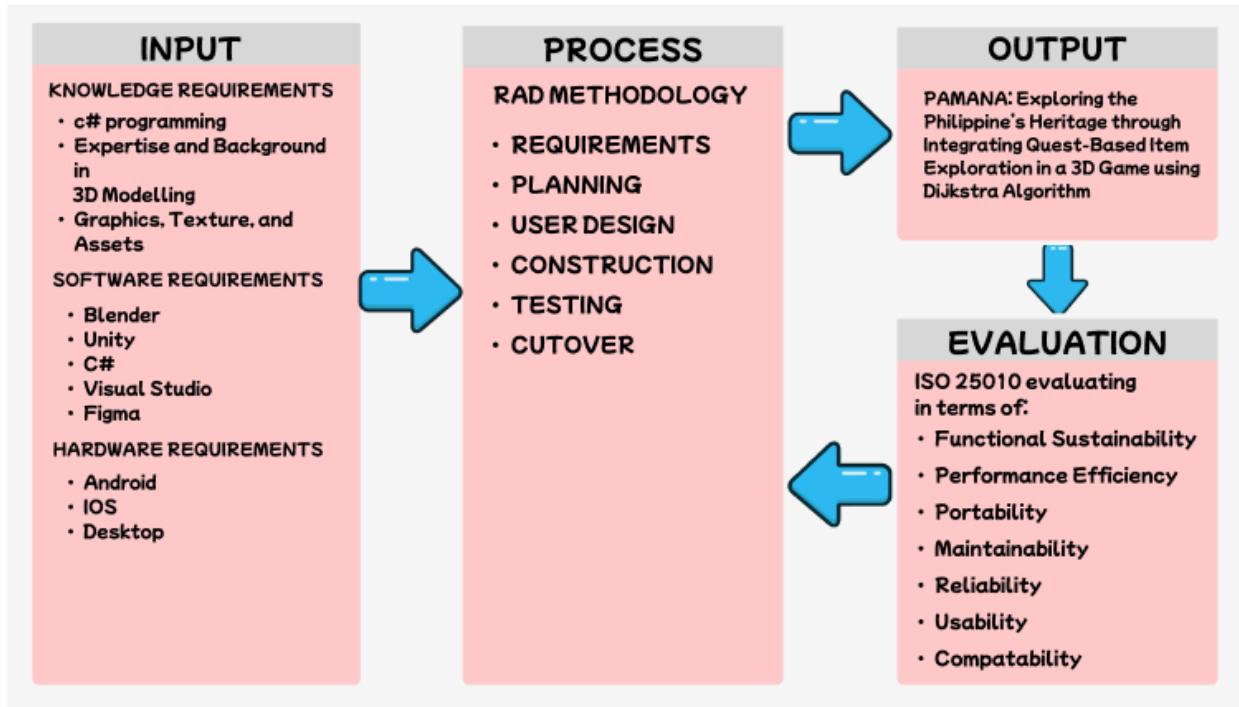
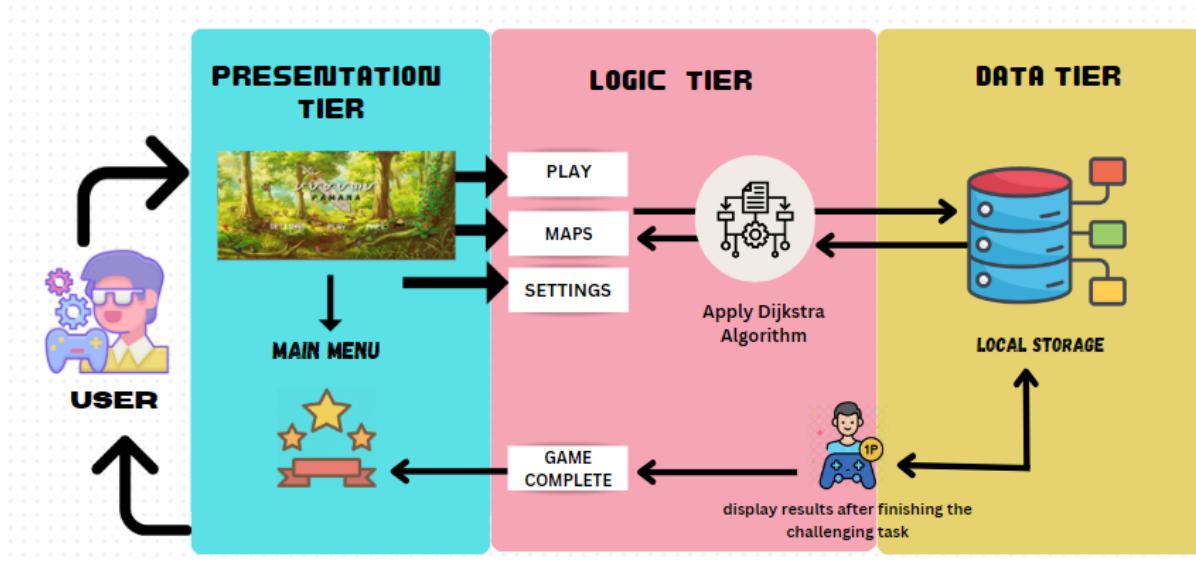


Figure 1 shows the development structure of the application, which includes the Knowledge, Software, and Hardware Requirements. The Process method represents the development of the application. The Output will be directed at “Pamana: Exploring the Philippines' Heritage through Integrating Quest-Based Item Exploration in a 3D Game using the Dijkstra Algorithm”, and the Evaluation will be the reference of the application based on: Functionality, Efficiency, Reliability, Portability, Maintainability, and Usability

## System Architecture

**Figure 2**

*System Architecture*



The provided illustration above represents the proposed 3D Game Application, called “Pamana”, which focuses on exploring Cultural Heritage sites and artifacts through the 3D game. The system architecture is divided into three tiers: the Presentation Tier, Logic Tier, and Database Tier.

The **Presentation Tier** serves as the client-side interface where users, including individuals accessing the application on desktop computers, laptops, or personal computers, can interact with the software to access relevant and valuable information.

The **Logic Tier** handles the application's business logic based on user-submitted requests. It acts as an intermediary between the Presentation Tier and the Database Tier. This tier utilizes an interface to communicate with the database, storing and retrieving the necessary information required for the presentation layer. Within this tier, the facial expression recognition algorithm is

implemented to process the user's request and generate an appropriate response, considering the mental health implications.

Lastly, the **Database tier** is where processed and calculated data is stored and retrieved. It is a component of a system architecture that is responsible for storing, managing, and retrieving data. It is the tier where data is persisted and accessed by the application or system.

**Definition of Terms**

<b>Adobe Photoshop</b>	Software is extensively used for raster image editing, graphic design, and digital art
<b>Algorithm</b>	It is a method or set of rules that is used to solve a particular problem or carry out a certain task.
<b>Art</b>	It is widely understood to be the manifestation or application of creative ideas and expertise, resulting in creations that are valued for their aesthetic beauty, emotional impact, or intellectual stimulation.
<b>Artifacts</b>	An item invented by a human creature, usually one with cultural or historical significance.
<b>Blender</b>	It is an open-source application that is used to develop 3D designs, animations, and modeling
<b>Culture</b>	All of the culture, traditions, and practices of a people are passed down from one generation to the next.
<b>Cultural Heritage</b>	Is a concept that bridges the gap between past events and the future via the use of specific methods in the present.
<b>Dijkstra</b>	A widely used method in computer science and graph theory for finding the shortest paths between nodes in a weighted graph.

<b>Quest</b>	A search or quest undertaken in order to discover or benefit something
<b>Single-Player</b>	A game that is designed to be played by one person at a time.
<b>Unity</b>	Import and construct assets, execute codes to interact with your objects, build or acquire animations for use with an advanced animation engine, and much more.

## CHAPTER 3

### Research Methodology

This chapter contains the systematic and structured set of ideas, practices, processes, and techniques that will guide the researchers in developing, conducting, and analyzing studies. This is referred to as research methodology. It includes the tactics and procedures researchers use to collect relevant information, develop, knowledge, and address research questions or hypotheses. It aims to ensure the validity, dependability, and ethical integrity of the research process and its results.

### Project Design

The initial conceptualization, planning, and execution of numerous components are all part of the project design for "Pamana," a 3D game. It all starts with creating the basic concept of the game, as well as the target audience, and conducting market research. A Game Design Document (GDD) is a blueprint that details the gameplay mechanics, story, art style, and technical requirements. The developers will be assembled, budgets have been assigned, and timelines have been determined. Following asset creation, level design, and audio integration, prototyping and pre-production enhance important gameplay components. Bugs will be found and fixed through rigorous testing. Marketing methods build excitement for the debut, while post-launch support, community interaction, and data analytics help to fine-tune the game. Legal issues and monetization tactics will be discussed.

## Design Discussion

*Design 1.*



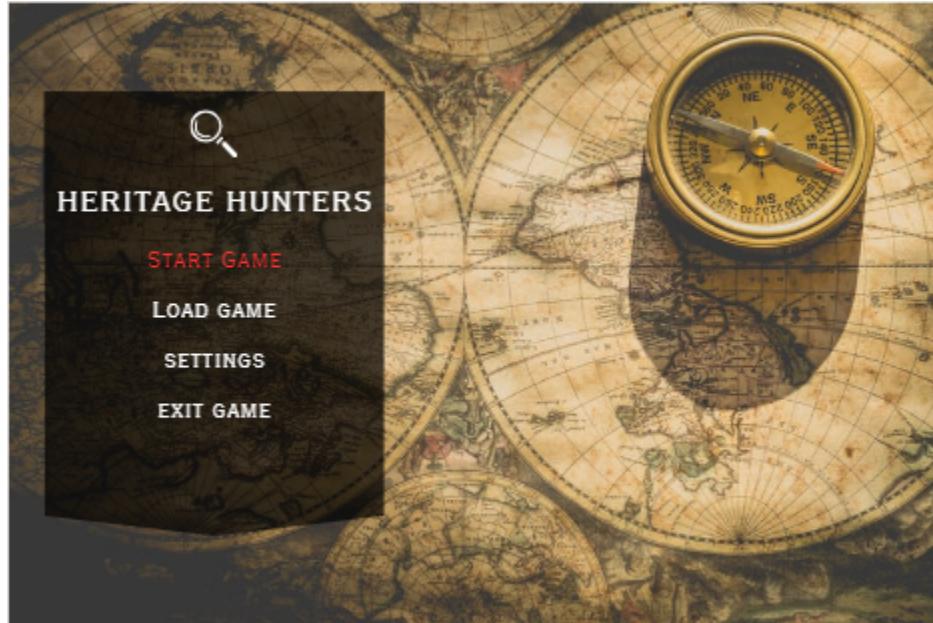
The Game PAMANA has a (3) component design that focuses on the difference among the other design. The design (1) consist of buttons the "Start Game, Load Game, Settings, and Exit Game". The main menu screen will be focused on simplicity.

**Table 1**

*Design 1 Constraints*

Render Time	Memory Usage	File Size
5.33 secs	37.3 MB	1,253 KB

Design 2.



Design (2) also includes buttons that are the same as those in design 1, but design 2 itself features a distinct design. The main menu design will be a Turn-of-the-Century War Game Design Map, with a design closely related to that of a PAMANA. The main menu design, embodying the map and theme of PAMANA, invites you to immerse yourself in the experience it evokes, providing a tangible sense of what's to come.

**Table 2**

*Design 2 Constraints*

Render Time	Memory Usage	File Size
4.49 secs	42.8 MB	1,122 KB

*Design 3*

Design (3) showcases a unique set of buttons compared to Designs 1 and 2. In contrast to the common buttons in the previous designs, Design 3 exclusively features "Start, Settings, and Exit" buttons. The central theme of Design 3 is an old island that serves as a symbol of heritage, evoking a sense of nostalgia and history.

**Table 3***Design 3 Constraints*

Render Time	Memory Usage	File Size
4.73 secs	46.2 MB	1,024 KB

**Table 4**

*Summary of Design Constraints*

Design Constraints			
Design	Render Time	Memory Usage	File Size
Design 1	5.33 sec	37.3 MB	1,253 KB
Design 2	4.49 sec	42.8 MB	1,122 KB
Design 3	4.73 sec	46.2 MB	1,024 KB

### Design Trade-Offs

A design trade-off is a decision or choice between two or more competitive choices for layout or features, where improving one often comes at the expense of another. It entails finding the correct balance or compromise between competing requirements or objectives.

Where:

#### Equation 1

*Percentage Difference*

**% difference of MIN**

$$= \frac{(Higher\ Value - Lower\ Value)}{Higher\ Value}$$

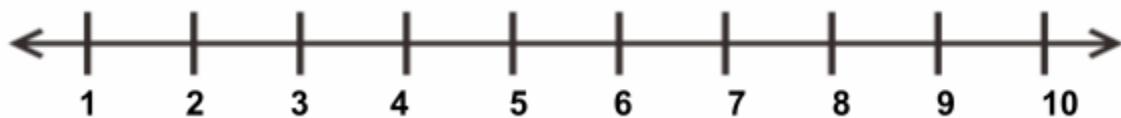
**% difference of MAX**

$$= \frac{(Higher\ Value - Lower\ Value)}{Higher\ Value}$$

**Equation 2***Subordinate Rank*

$$= GR - [(\%difference) * 10]$$

Equation 1 shows the calculation method for each percentage difference, according to the design's criteria. Equation 2 shows the process used to predict the result of Analyzing the three (3) designs' subordinate rankings in comparison.

**Figure 3.***Performance Ranking Scale***Trade-Off 1: Render Time**

The table offers a comprehensive comparison of render times for each scene across three different designs. Render time criteria denote the duration required for the programmed image to complete its conversion into a .png file format. Design 1 stands out with a score of 10, signifying the quickest render time at 5.33 seconds and thus establishing itself as the benchmark ranking.

**Table 5***Design Trade-Off 1*

Design	Render Time
Design 1	5.33 sec
Design 2	<b>4.49 sec</b>
Design 3	4.73 sec

**Computation of Ranking for Trade-Off 1 between Design 1 and Design 2:**

$$\% \text{ difference of MIN} = (\frac{5.33 - 4.49}{5.33})$$

$$\% \text{difference} = 0.157$$

$$\text{Subordinate Rank} = 10 - [(0.157) * 10]$$

$$\text{Subordinate Rank} = 8.43$$

**Figure 4.***Performance Ranking Scale of Design 2 Render Time*

Figure 4 displays a plot of Design 2 Render Time with a value of 8.43 plotted against Design 2 Render Time with a value of 10.

**Computation of Ranking for Trade-Off 1 between Design 1 and Design 3:**

$$\% \text{ difference of MIN} = \left( \frac{5.33 - 4.73}{5.33} \right)$$

$$\% \text{difference} = 0.112$$

$$\text{Subordinate Rank} = 10 - [(0.112) * 10]$$

$$\text{Subordinate Rank} = 8.88$$

**Figure 5.**

*Performance Ranking Scale of Design 3 Render Time*



Figure 5 displays a plot of Design 3 Render Time with a value of 8.88 plotted against Design 2 Render Time with a value of 10

**Trade-Off 2**

Table 6 presents a comparison of memory usage for each scene across three different designs. The memory consumption criterion quantifies the amount of memory employed by each design during its execution. Design 3 is awarded a score of 10, signifying the minimal memory utilization.

**Table 6***Design Trade-Off 2*

Design	Memory Usage
Design 1	37.3 MB
Design 2	42.8 MB
Design 3	46.2 MB

**Computation of Ranking for Trade-Off 2 between Design 3 and Design 1:**

$$\% \text{ difference of MIN} = \left( \frac{46.2 - 37.3}{46.2} \right)$$

$$\% \text{ difference} = 0.192$$

$$\text{Subordinate Rank} = 10 - [(0.192) * 10]$$

$$\text{Subordinate Rank} = 8.08$$

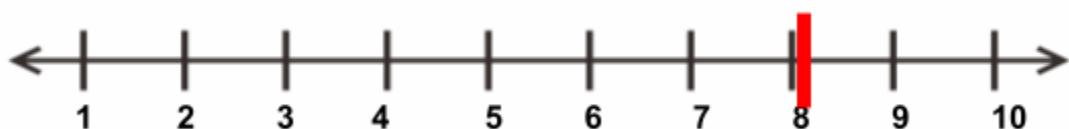
**Figure 6.***Performance Ranking Scale of Design 1 Memory Usage*

Figure 6 displays a plot of Design 1 Memory Usage with a value of 8.08 plotted against Design 3 Memory Usage with a value of 10

**Computation of Ranking for Trade-Off 2 between Design 3 and Design 2:**

$$\% \text{ difference of MIN} = \left( \frac{46.2 - 42.8}{46.2} \right)$$

$$\% \text{ difference} = 0.073$$

$$\text{Subordinate Rank} = 10 - [(0.073) * 10]$$

$$\text{Subordinate Rank} = 9.27$$

**Figure 7.**

*Performance Ranking Scale of Design 2 Memory Usage*



*Note:*

Figure 7 displays a plot of Design 2 with a value of 9.27 against Design 3 Memory Usage with a value of 10

### Trade-Off 3: File Size

**Table 7**

Table 7 presents a comparison of the file size for each scene across three designs. In this criterion, the file size refers to the storage capacity occupied by the file or image, measured in seconds. Design 2 is assigned a score of 10, indicating the smallest file size (1,122 KB), which establishes it as the benchmark rank in terms of file size consumption.

**Table 7.**

*Design Trade-Off 3*

Design	File Size
Design 1	1,122 KB
Design 2	1,253 KB
Design 3	1,024 KB

**Computation of Ranking for Trade-Off 2 between Design 2 and Design 1:**

$$\% \text{ difference of MIN} = \left( \frac{1,253 - 1,122}{1,253} \right)$$

$$\% \text{difference} = 0.9981$$

$$\text{Subordinate Rank} = 10 - [(0.9981) * 10]$$

$$\text{Subordinate Rank} = 8.96$$

**Figure 8.**

*Performance Ranking Scale of Design 1 File Size*



Figure 8 displays a plot of Design 2 File Size with a value of 8.96 plotted against of Design 1 File Size with a value of 10

**Computation of Ranking for Trade-Off 2 between Design 2 and Design 3:**

$$\% \text{ difference of MIN} = \left( \frac{1,253 - 2.3}{1,253} \right)$$

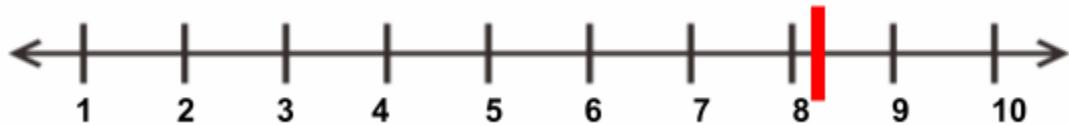
$$\% \text{ difference} = 0.182$$

$$\text{Subordinate Rank} = 10 - [(0.182) * 10]$$

$$\text{Subordinate Rank} = 8.18$$

**Figure 9.**

*Performance Ranking Scale of Design 3 File Size*



*Note:*

Figure 9. Displays a plot of Design 3 File Size with a value of 8.18 plotted against of Design 2 Response Time with a value of 10

### **Criterion's Performance**

Following a comprehensive review of the three distinct designs that take into consideration a variety of restrictions carefully studied by the researcher, the next stage is to undertake an analysis of the relevance of each criterion. This analysis will be critical in determining the best design for the intended application. Furthermore, it will assist in making informed judgments and prioritizing the criteria that are most closely aligned with the project's goals and needs, finally directing the selection of the best design solution. (Table 8)

**Table 8.***Criterion Performance Table*

Decision Criteria	Criterion's Importance	Ability to satisfy the criterion (-10 to 10)		
		Design 1	Design 2	Design 3
Render Time	8	10	8.43	8.88
Memory Usage	10	8.08	9.27	10
File Size	9	8.96	10	8.18
<b>Overall Rank</b>		241.44	250.14	244.66

### Influence of Design Trade-Offs in Final Design

The goal of implementing design trade-offs into the final design of an item or system is to get the best possible outcome by striking a delicate balance amongst opposing aspects. Design trade-offs entail making choices between competing attributes or parameters in order to achieve many essential objectives. These include optimizing the design by finding an optimal compromise, utilizing limited resources such as time and budget efficiently, achieving critical needs, minimizing risks, pleasing varied stakeholders, and controlling expenses. Furthermore, the iterative nature of trade-off analysis allows for continual development and innovation.

- **Design Criterion 1: Render Time** - This criterion determines how long it takes to generate a single frame of the game's display. It is influenced by a number of factors, including the complexity of the graphics. This can use a variety of techniques to optimize render time, such as using simple graphics, reducing the number of objects on screen, and using efficient rendering algorithms.

- **Design Criterion 2: Memory Usage-** Memory Usage affects the performance of the game when it comes to the required significant amount of memory to store assets such as 3D models, textures, audio files, animations, and level designs.
- **Design Criterion 3: File Size-** This criterion when it comes to File Size. The game needs to store all the data that the game needs to run. It is important since it will affect the download time and storage requirements of the game.

### Sensitivity Analysis

Sensitivity analysis evaluates the impact of independent variables on a dependent value while taking into account established assumptions. It evaluates the influence of each criterion and decides whether the overall ranking changes based on the importance assigned to each criterion. Sensitivity analysis provides insights into how changes in these parameters affect the outcome by adjusting the values of the independent variables. It assists decision-makers in evaluating the relative importance of criteria and determining whether changes to the variables might affect the final ranking.

#### 1st Combination for Sensitivity Analysis

**Table 9.**

*Sensitivity Analysis Using 8-9-10 Criterion Rank*

<b>Decision Criteria</b>	<b>Criterion's Importance</b>	<b>Ability to satisfy the criterion (-10 to 10)</b>		
		<b>Design 1</b>	<b>Design 2</b>	<b>Design 3</b>
<b>Render Time</b>	8	<b>10</b>	8.43	8.88
<b>Memory Usage</b>	9	8.08	9.27	<b>10</b>
<b>File Size</b>	10	8.96	<b>10</b>	8.18
<b>Overall Rank</b>		242.32	<b>250.87</b>	242.84

The combination of 8-9-10 was used in Table 9. Design 1 received a total of 242.32 overall rank, Design 2 received a total of 250.87 overall rank, and Design 3 received a total of 242.84 overall rank.

## **2nd Combination for Sensitivity Analysis**

**Table 10.**

*Sensitivity Analysis Using 8-10-9 Criterion Rank*

<b>Decision Criteria</b>	<b>Criterion's Importance</b>	<b>Ability to satisfy the criterion (-10 to 10)</b>		
		<b>Design 1</b>	<b>Design 2</b>	<b>Design 3</b>
<b>Render Time</b>	8	<b>10</b>	8.43	8.88
<b>Memory Usage</b>	10	8.08	9.27	<b>10</b>
<b>File Size</b>	9	8.96	<b>10</b>	8.18
<b>Overall Rank</b>		241.44	<b>250.14</b>	244.66

The combination of 8-10-9 was used in Table 10. Design 1 received a total of 241.44 overall rank, Design 2 received a total of 250.14 overall rank, and Design 3 received a total of 244.66 overall rank.

### 3rd Combination for Sensitivity Analysis

**Table 11.**

*Sensitivity Analysis Using 9-8-10 Criterion Rank*

Decision Criteria	Criterion's Importance	Ability to satisfy the criterion (-10 to 10)		
		Design 1	Design 2	Design 3
Render Time	9	10	8.43	8.88
Memory Usage	8	8.08	9.27	10
File Size	10	8.96	10	8.18
<b>Overall Rank</b>		244.24	<b>250.03</b>	241.72

The combination of 9-8-10 was used in Table 11 . Design 1 received a total of 244.24 overall rank, Design 2 received a total of 250.03 overall rank, and Design 3 received a total of 241.72 overall rank.

### 4th Combination for Sensitivity Analysis

**Table 12.**

*Sensitivity Analysis Using 9-10-8 Criterion Rank*

Decision Criteria	Criterion's Importance	Ability to satisfy the criterion (-10 to 10)		
		Design 1	Design 2	Design 3
Render Time	9	10	8.43	8.88
Memory Usage	10	8.08	9.27	10
File Size	8	8.96	10	8.18
<b>Overall Rank</b>		242.48	<b>248.57</b>	245.36

The combination of 9-10-8 was used in Table 12. Design 1 received a total of 242.48 overall rank, Design 2 received a total of 248.57 overall rank, and Design 3 received a total of 245.36 overall rank.

### **5th Combination for Sensitivity Analysis**

**Table 13.**

*Sensitivity Analysis Using 10-8-9 Criterion Rank*

<b>Decision Criteria</b>	<b>Criterion's Importance</b>	<b>Ability to satisfy the criterion (-10 to 10)</b>		
		<b>Design 1</b>	<b>Design 2</b>	<b>Design 3</b>
<b>Render Time</b>	10	<b>10</b>	8.43	8.88
<b>Memory Usage</b>	8	8.08	9.27	<b>10</b>
<b>File Size</b>	9	8.96	<b>10</b>	8.18
<b>Overall Rank</b>		245.28	<b>248.46</b>	242.42

The combination of 10-8-9 was used in Table 13. Design 1 received a total of 245.28 overall rank, Design 2 received a total of 248.46 overall rank, and Design 3 received a total of 242.42 overall rank.

## 6th Combination for Sensitivity Analysis

**Table 14.**

*Sensitivity Analysis Using 10-9-8 Criterion Rank*

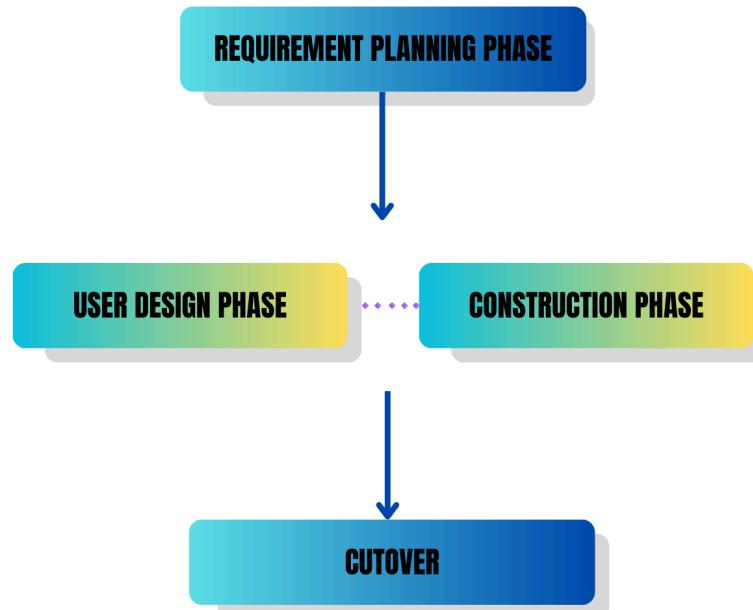
Decision Criteria	Criterion's Importance	Ability to satisfy the criterion (-10 to 10)		
		Design 1	Design 2	Design 3
<b>Render Time</b>	10	<b>10</b>	8.43	8.88
<b>Memory Usage</b>	9	8.08	9.27	<b>10</b>
<b>File Size</b>	8	8.96	<b>10</b>	8.18
<b>Overall Rank</b>		244.4	<b>247.73</b>	244.24

The combination of 10-8-9 was used in Table 13. Design 1 received a total of 244.4 overall rank, Design 2 received a total of 247.73 overall rank, and Design 3 received a total of 244.24 overall rank.

## Project Development

**Figure 10.**

*Rapid Application Development Model*



The method that will be used for the project is the Rapid Application Model (RAD), which is a method of agile software development that is based on iterative prototyping. Prototypes of game mechanics and levels are created quickly, with user feedback implementing refinements. RAD allows for parallel production of visuals, music, and mechanics, making it ideal for small teams and independent app developers. It enables rapid adaptation to market trends and prioritizes real outcomes above detailed paperwork. RAD, on the other hand, may be less ideal for intricate or polished games. Overall, RAD enables game developers to iterate quickly, engage players in the process, and create exciting gameplay experiences.

### **Requirement planning phase**

In this phase, project planning and requirements must be addressed. The approval of the topic must be attained in order to move on to the next phase. After being approved, the developers should provide a schedule for planning the process of the development in order to start the project as soon as possible. In planning the project, the developers look at some issues

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on what happened right now in order to have an idea on how to begin the project. Aside from that, gathering of data is one of the requirements focused by the researchers to provide a solution from the given questions. Time management is also important for the project to work and accomplish the task at the end of the development.

### **User design phase**

For the user design phase, prototypes and models should be representing when the implementation of the project starts. There should be an interface design for the user to visualize and understand the idea of the application. Conceptual framework and System Architecture is also part of this phase to understand and modify the approved working model of the system. The developers think of what color combination will be used in the logo, style and background of the application. The design must compliment the project's concept and simplicity. Know the users of the application to focus on the usability and guidelines. The widgets and user interface must be consistent to maintain control when navigating the application. Design dialogs should recognize action for feedback and interfaces to prevent errors made by the user.

### **Construction phase**

The construction phase of developing a project is where the projected plans are physically realized. This step in game development includes constructing the actual game elements based on the design papers. It include creating game levels, characters, and locations, as well as implementing the intended gameplay mechanisms. To guarantee that the game's components fulfill set criteria, project managers monitor resource allocation, quality assurance, and risk management. Collaboration among developers, artists, designers, and testers is essential for a successful build. Regular progress monitoring, adaptation to changes, and adherence to safety

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rules guarantee that design concepts are smoothly transformed into playable and entertaining game experiences.

### **Cutover phase**

Activities in this phase include data conversion, testing, changeover to the new system, and user training. Where in the application that has been released will be tested by the beta tester. After thorough testing, the user will provide comments and feedback whether the application meets the requirements and it can be improved by the developer based on the user's review. After the construction phase, the application will be inspected by the developers to see if there are bugs and errors. In addition to that, the objectives of the project must meet the requirements if there are no concerns then the application will be ready for actual operation.

### **Testing and Operating Procedures**

The system will be tested using a smartphone that has an Android Operating System. The application will be tested and reviewed by a financial adviser, IT professional and investors. The IT professionals will check if the system is functioning well and has all the features that are needed by the user. The patients will check the usability of the application and how it guides them regarding their decisions in investing in the stock market. They will check the application if it has the right features that they need. The application is ready for operation, will be used by the target user. Evaluation is provided to measure if the requirements meet the standard. Users can give feedback and suggestions if there is something to improve, and then developer will address the issues

## Project Evaluation

**Figure 11.**

*Project Evaluation*



ISO/IEC 25010 is a set of international standards for assessing the quality of software products. It is divided into four sections and provides a thorough framework for evaluating software quality criteria. It offers a quality model with six major characteristics—functionality, reliability, usability, efficiency, maintainability, and portability—each of which is further subdivided. It discusses external measures for evaluating program behavior during execution, such as reaction time and availability. This will discuss internal metrics, with an emphasis on code organization and complexity. It introduces quality-in-use measures, which evaluate software quality in real-world usage scenarios while taking user happiness and effectiveness into account. These standards assist software developers and quality assurance specialists in identifying areas for improvement and ensuring that software fulfills the expectations of users.

## Algorithm Discussion

The players' pathways will be dynamically calculated and optimized using the Dijkstra Algorithm as they set out on virtual explorations to find lost historical relics and heritage locations around the Philippines. Dijkstra Algorithm will be used to create a fun, interactive experience that shows players the fastest ways to accomplish their goals while still keeping the trip tough and instructive.

Our game incorporates the Dijkstra Algorithm in order to accomplish two main goals. First, it improves the gameplay experience by giving players access to a dynamic and realistic pathfinding system, guaranteeing that they may effectively and engagingly explore the virtual Philippines. By enabling players to obtain historical and cultural context as they play the game, it also encourages an educational component. The implementation of the Dijkstra Algorithm is consistent with the larger goals of the project, which include creating a fun and instructive gaming application that encourages users to discover and value the cultural history of the Philippines. We will carefully assess the gaming application in accordance with ISO 25010 as we continue our research and development, paying particular attention to Functionality, Efficiency, Reliability, Portability, Maintainability, Usability, and Compatibility.

## Workplan

**Figure 12.**

*Work Plan of PAMANA*

<b>Work Plan 2023</b>					
Task	Date	Briones	Goroy	Ibisate	Salenga
Chapter 1 and 2	Tuesday, June 13 2023.	• <b>SCOPE</b>	• delimitation	• <i>Background of the study.</i> • <i>Delimitation.</i>	• <i>Introduction</i> • <i>Objectives</i> • <i>Significance</i>
Chapter 2 (cont.)	Wednesday June 14, 2023.			• <i>Review of related literature</i>	• <i>Theoretical framework</i> • <i>Conceptual framework</i>
Chapter 2 (cont.)	Thursday, June 15, 2023.				• <i>System archi</i> • <i>Definition of terms</i>
Chapter 3	Friday, June 16, 2023.			• <i>Project development</i> • <i>potential for commercialization</i>	• <i>Research methodology</i> • <i>Project evaluation</i>
Chapter 3 (cont.)	Sunday. June 18, 2023	• <b>Project Design</b>	• Project design	• <i>Messurable Benefits</i> • <i>go-to-market strategy</i> • <i>references</i>	• <i>market model</i> • <i>Three-Year Product Roadmap</i>
chapter 3 (cont.)	Monday October 2, 2023	• <b>story board</b>	• Storyboard	• <i>Algorithm</i>	• <i>Design Discussion</i> • <i>design trade offs</i> • <i>sensitivity analysis</i>

*Note:*

This is the Work Breakdown Structure of the project. It includes the specific task of each member that is assigned and needs to be accomplished on the allocated schedule

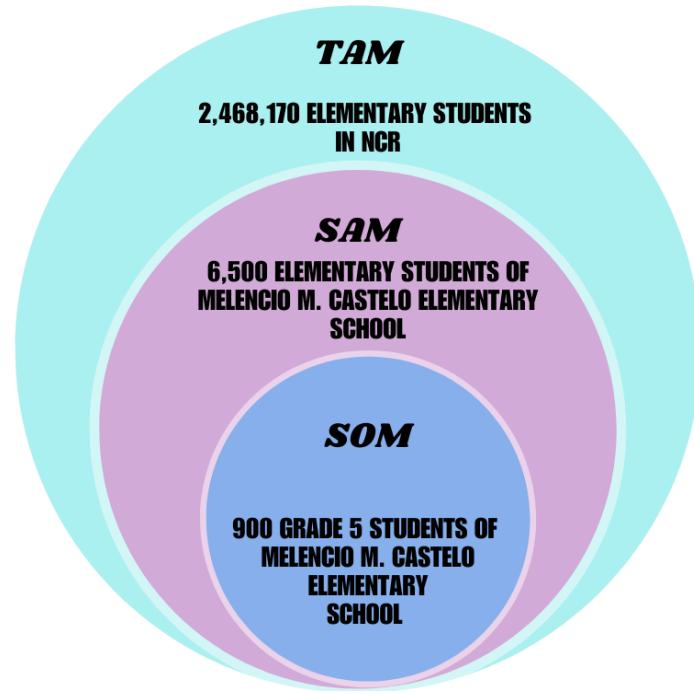
## Potential for Commercialization

The application will be made for computer devices using Unity, and its main goal will be to provide a fun and instructive game that completely submerges players in the realm of cultural heritage. This creative initiative intends to provide gamers with an engaging and immersive experience by fusing the thrill of gaming with the investigation and protection of cultural treasures.

## Market Model

**Figure 13.**

*Market Model of PAMANA*



The figure shows the layout of the Market Model of Pamana that consists of TAM SAM SOM.

**TAM**

According to the **Department of Education (DepEd)**, the total of Elementary Students that are currently enrolled in the National Capital Region (NCR) as of 2023 has a total of 2,468,170.

**SAM**

According to the Head of the Guidance Office of Melencio M. Castelo Elementary School. The Overall Elementary Students enrolled in the year 2023 is 6,500 in total.

**SOM**

Within the Student population of the School, specifically at the Grade 5 level, there are 900 students currently attending classes in Melencio M. Castelo Elementary School

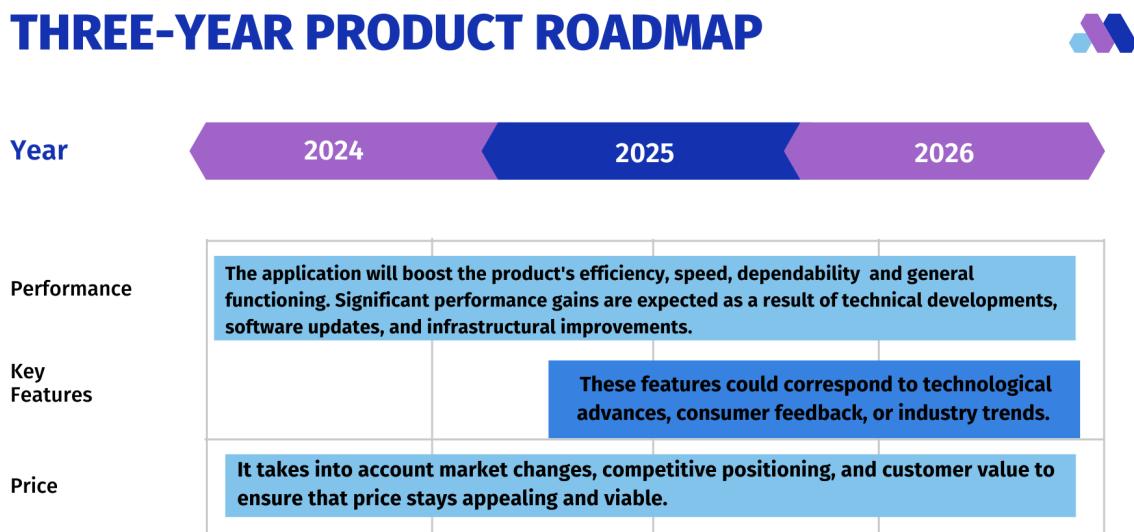
**Measurable Benefits**

The application is easily accessible to users and can be used on any laptop or computer. In places with an internet connection, the application's offline feature allows users to still utilize it. A module for instructions enhances the user experience by making gaming and navigation easier. The main goal of the application is to familiarize users with the heritage of the Philippines. It. educates through experiences that provide users with a profound understanding of the diverse tapestry that makes up Filipino culture.

## Three-Year Product Roadmap

**Figure 14.**

*The Three-Year Product Roadmap of PAMANA*



*Note:*

The Three-Year Product Roadmap represents a unified approach for long-term growth and competitiveness. It acts as an evolving framework for organizing ongoing performance metrics improvements, smart price adjustments in reaction to market dynamics, and the intelligent development or augmentation of features that respond to changing customer wants and industry trends. Its relevance and efficacy are ensured by regular reviews and adaptability.

**Go-to-Market Strategy****Figure 15.***Market Strategy*

Offerings	Target user	channel
<b>Free Download Application</b>	<b>Teachers / Students</b>	<b>Google Play Store</b>
<b>Edutainment Application</b>	<b>Future Researchers</b>	<b>Google Play Store</b>

This table shows the Go-to-Market Strategy that the researchers decided to publish the application through Android Market known as Google Play Store. The proponents have opted to distribute the application through the Google Play Store as the primary distribution

## CHAPTER 4

### Results and Discussions

#### **Project Description**

PAMANA is an adventure game developed in collaboration with Melencio M. Castelo Elementary School that provides a glimpse into Philippine history. It is a 3D game with five scenarios, each of which depicts one of the Philippines' most well-known towns and provinces: (1) Palawan, (2) Manila, (3) Kalinga, (4) Cebu, and (5) Ifugao. The entire scenario is designed to emphasize the significance of each piece and the location's history. Overall, this 3D mobile game is intended to educate young students about their country's history while also making learning enjoyable.

#### **Project Structure**

PAMANA is a 3D game that refers to a three-dimensional space, which is used by objects in length, width, and height. Allowing them to be represented as solid entities rather than just flat surfaces. The game represents the 5 places or heritages of the Philippines, including; Kalinga, Ifugao, Cebu, Manila, and Palawan.

#### **Figure 16.**

*Implementing Dijkstra Algorithm*

```
void Start()
{
    _rb = GetComponent<Rigidbody>();
    graph = new Dictionary<Vector3, Node>();
    BuildGraph(); // Build the graph for Dijkstra's algorithm
}
```

Figure 16 shows the implementation of Dijkstra Algorithm initializes the Rigidbody component and graph dictionary where the method is to set up the graph structure.

```
// Find path using Dijkstra's algorithm (for educational purposes)
Vector3 destination = hitInfo.point;
path = Dijkstra(transform.position, destination);
if (path != null && path.Count > 0)
{
    StartCoroutine(FollowPath());
}
```

The figure shows the code sets of the destination point, that calculates a path of Dijkstra

Algortihm, starts a coroutine to follow the path if it's valid and contains points

```
// Edge class for Dijkstra's algorithm
4 references
private class Edge
{
    4 references
    public Node Target;
    2 references
    public float Cost;

    1 reference
    public Edge(Node target, float cost)
    {
        Target = target;
        Cost = cost;
    }
}

1 reference
private void BuildGraph()
{
    // Example: Build a simple grid graph
    for (int x = -5; x <= 5; x++)
    {
        for (int z = -5; z <= 5; z++)
        {
            Vector3 position = new Vector3(x, 0, z);
            graph[position] = new Node(position);
        }
    }

    // Connect nodes with edges
    foreach (var node in graph.Values)
    {
        Vector3[] directions = {
            Vector3.forward, Vector3.back, Vector3.left, Vector3.right
        };

        foreach (var direction in directions)
        {
            Vector3 neighborPos = node.Position + direction;
            if (graph.ContainsKey(neighborPos))
            {
                node.Edges.Add(new Edge(graph[neighborPos], 1f)); // Uniform cost for simplicity
            }
        }
    }
}
```

This figure represents a connection between the nodes and the graph. Each edge has a target node and a travel cost. The constructor initializes these properties, allowing the algorithm to evaluate

```

Reference
private List<Vector3> Dijkstra(Vector3 startPos, Vector3 endPos)
{
    if (!graph.ContainsKey(startPos) || !graph.ContainsKey(endPos))
    {
        Debug.LogWarning("Start or end position not in graph");
        return null;
    }

    var startNode = graph[startPos];
    var endNode = graph[endPos];

    var distances = new Dictionary<Node, float>();
    var previousNodes = new Dictionary<Node, Node>();
    var unvisited = new List<Node>();

    foreach (var node in graph.Values)
    {
        distances[node] = float.MaxValue;
        unvisited.Add(node);
    }

    distances[startNode] = 0;

    while (unvisited.Count > 0)
    {
        unvisited.Sort((a, b) => distances[a].CompareTo(distances[b]));
        var currentNode = unvisited[0];
        unvisited.RemoveAt(0);

        if (currentNode == endNode)
        {
            var path = new List<Vector3>();
            while (previousNodes.ContainsKey(currentNode))
            {
                path.Add(currentNode.Position);
                currentNode = previousNodes[currentNode];
            }
            path.Reverse();
            return path;
        }

        foreach (var edge in currentNode.Edges)
        {
            var tentativeDistance = distances[currentNode] + edge.Cost;
            if (tentativeDistance < distances[edge.Target])
            {
                distances[edge.Target] = tentativeDistance;
                previousNodes[edge.Target] = currentNode;
            }
        }
    }
}

```

This method implements the Dijkstra algorithm to find the shortest path between two points on the graph. It initializes the distance, previous nodes, and unvisited lists. It iteratively select the nodes with the smallest distance, updates neighbors, and constructs the path if the end node is reached, returning the path as a list of Vector 3 positions

**Figure 17.***Unity Assets*

Figure 17 shows the unity assets used for the character selection to the game. It provides reusable resources like 3D models, textures, and enhancing the game development

**Figure 18.***Main Menu*

Figure 18 shows an image of the main menu used in the game. Here is where the player can begin the game.

**Figure 19.***Tutorial Section*

Figure 19 shows the tutorial map in the game. It consists of all of the guides that will teach the players how to play the game.

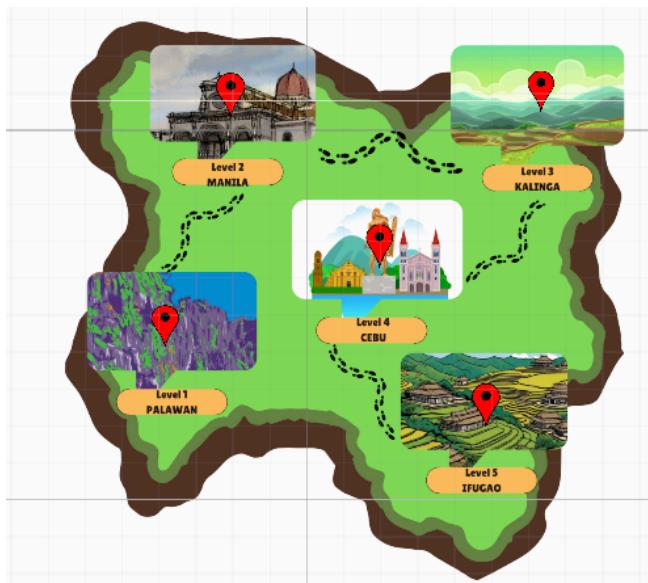
**Figure 20.***Map Levels*

Figure 20 shows every level of the game's map. It contains each location that players can unlock.

**Figure 21.***Storyline*

Figure 21 shows the backstory for each map. It contains cutscenes for each map, which can help players understand more about history.

**Figure 22.**

Pre-Assessment Quiz per Map

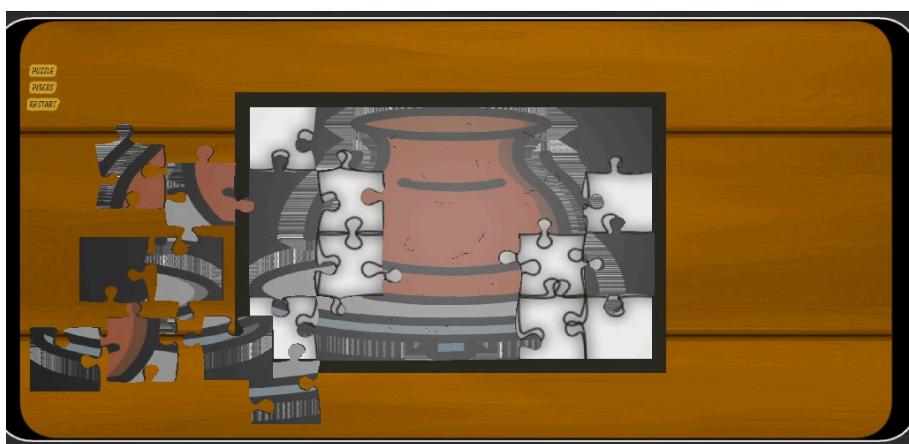


Figure 22 shows a puzzle quiz of the game. Each map features various quiz games that a player could enjoy.

## Project Capabilities and Limitations

### Capabilities

- **Learning Engagement** - successfully engages young learners by presenting Philippine history in an interactive and visually engaging 3D manner.
- **Cultural Immersion** - The game allows players to discover the cultural heritage of many Philippine cities and provinces, helping them better understand and appreciate their country's past.
- **Mobile Accessibility** - As a 3D mobile game, PAMANA is widely accessible to a wide audience, allowing students to learn about Philippine history at any time and from any location.
- **Collaborative Development** - The cooperation with Melencio M. Castelo Elementary School highlights how educational institutions and game creators may work together to produce unique learning aids.
- **Scalability** - PAMANA's modular design enables the addition of new situations or features, thereby broadening its reach and instructional value over time.

### Limitations

- **Limited Scope** - Although PAMANA covers five scenarios, it may not provide a thorough account of Philippine history, omitting major events or places.
- **Technological Requirements** - Because the game is in 3D, it may require very recent mobile devices with enough processing power and graphics capabilities, limiting accessibility for some users.

- **Educational usefulness** - The usefulness of PAMANA as an educational tool varies according to individual learning styles and preferences, and it may not be equally engaging for all students.
- **Cultural Bias** - The game's portrayal of Philippine history may be influenced by cultural biases or perceptions, giving players a biased perspective.
- **Language Obstacle** - the game has a single language setting, it excludes other native languages.

### Likert Scale

**Table 15.**

*Likert Scale*

Equivalent Score	Percentage Rating	Interpretation
6	5.17 - 6.00	Strongly Agree
5	4.33 - 5.16	Agree
4	3.50 - 4.32	Slightly Agree
3	2.67 - 3.49	Slightly Disagree
2	1.83 - 2.66	Disagree
1	1.00 - 1.82	Strongly Disagree

Table 15 shows the Likert scale, which is crucial for assessing system development. Typically ranging from “Strongly Agree” to “Strongly Disagree”, it allows the participant to express the extent to which they agree or disagree with the statement.

## Frequency Distribution

The five locations of the application where it presented the breakdown of respondents. Table 16 shows where grade 5 elementary students made up of the respondents. IT professionals made up , and lastly, teachers made up as well.

**Table 16.**

*Number of Respondents*

Respondents	No.of Respondents	Percentage
Grade 5 Students	50	86.20%
IT Professional	5	8.62%
Teacher	3	5.17%
<b>Total</b>	<b>58</b>	<b>100%</b>

## Statistical Treatment of Data

It plays a vital role in mobile application development by providing insights from the collected response

$$\text{Average Rating} = \frac{(f_6 \times 6) + (f_5 \times 5) + (f_4 \times 4) + (f_3 \times 3) + (f_2 \times 2) + (f_1 \times 1)}{n}$$

Where:

N = Total number of respondents per column

$f_n$  = number of respondents per column

## Project Evaluation

The project's proponents used ISO 25010 to evaluate the project's quality, specifically in terms of functionality, portability, reliability, usability, efficiency, and maintainability. It is an international standard for measuring project goals and objectives while evaluating software.

## Summary Results

**Table 17.**

Respondents	Standard	Results	Interpretation	Results
<b>Grade 5 Students</b>	Functionality	5.02	Agree	<b>4.92</b>
	Usability	4.91	Agree	
	Reliability	4.88	Agree	
	Efficiency	5.01	Agree	
	Portability	5.05	Agree	
	Maintainability	4.9	Agree	
	Compatibility	4.67	Agree	
<b>Teachers</b>	Functionality	5	Agree	<b>5.23</b>
	Usability	5	Agree	
	Reliability	5	Agree	
	Efficiency	5.16	Strongly Agree	
	Portability	5.33	Strongly Agree	
	Maintainability	5.66	Strongly Agree	
	Compatibility	5.5	Agree	
<b>IT Professionals</b>	Functionality	5.16	Agree	<b>5.01</b>
	Usability	4.75	Agree	
	Reliability	5.33	Strongly Agree	
	Efficiency	5.33	Strongly Agree	
	Portability	5.33	Strongly Agree	
	Maintainability	4.66	Agree	
	Compatibility	4.5	Agree	
<b>Average Results</b>				<b>5.10</b>

Table 18 shows the summary results evaluated in terms of the ISO 25010 Standard.

## **Computing Standards, Modern Tools, and Techniques Applied**

### **Computing Standards**

ISO/IEC 25010 was a critical collection of standards designed for evaluating the quality of software systems, providing a comprehensive framework that went beyond its six basic characteristics. The ability of software to provide features and capabilities that meet both stated and implicit needs is referred to as Functionality. Efficiency evaluates how well the software performs under diverse settings, with an emphasis on resource optimization and responsiveness to user activities. Reliability can fulfill its intended duties consistently and dependably under specified situations is measured by dependability. Portability evaluates the software's ability to be easily adapted and transferred across different environments. Usability Focuses on the user experience, measuring how easily and effectively users can interact with the software to achieve their goals. Lastly, Maintainability refers to the ease with which the software can be modified and maintained over time

### **Modern Tools**

- **Canva** - is an online graphic design platform that is used to create social media graphics and presentations. The company has announced it intends to compete with Google and Microsoft in the office software category with website and whiteboard products.
- **Figma** - is a collaborative web application for interface design, with additional offline features enabled by desktop applications for macOS and Windows
- **Blender** - a 3D computer graphics application used for creating visual effects, interactive 3D models.

## Techniques Applied

Dijkstra's algorithm is used for pathfinding and character movement optimization. For example, it aids characters in navigating obstacles by directing non-player characters (NPCs) or foes towards targets or people. The approach aids in efficient resource allocation in resource-driven games by determining the shortest pathways between resource nodes or manufacturing facilities. Dijkstra's technique also helps to create paths that improve the gameplay experience in dynamically created game levels. Overall, its application provides intelligent and realistic mobility within virtual worlds, which contributes to engrossing and demanding gaming settings.

## Development Tools

- **Blender** - is free and open-source 3D creation suite. It supports the entirety of the 3D pipeline—modeling, rigging, animation, simulation, rendering, composing, motion tracking, and even video editing and game creation.
- **Visual Studio Code** - also commonly referred to as VS Code, is a source-code editor developed by Microsoft for Windows, Linux and macOS. Features include support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git.
- **Unity** - is a cross-platform game engine developed by Unity Technologies, first announced and released in June 2005 at Apple Worldwide Developers Conference as a Mac OS X game engine. The engine has since been gradually extended to support a variety of desktop, mobile, console, and virtual reality platforms.

## Trade-Offs

- **Visual Appeal and Performance** - 3D graphics may enhance the visual appeal of the application. But it can also impact the performance of the game through certain devices. The developers may face difficulties by trying to balance between the performance and the visual appeal of the 3D mobile game. Our goal is to develop an immersive 3D mobile game-based learning to accommodate player preferences and experience through the quality and the smoothness of the gameplay.
- **Memory** - When the game loaded the assets at once, it may take a long time for the loading process to finish that may cause performance problems. Furthermore, we use Standard Rendering Pipelines which will consume low memory usage to devices compared to Universal Rendering Pipeline which will consume high quality graphics and memory usage.

## Multiple Constraints

- **User Experience Constraints**- the process can greatly increase by simultaneously balancing restrictions related to time, resources, and user experience. Within the allotted time, the developers may have to make sure that the game fulfills players' expectations and quality requirements while making effective use of the limited resources.
- **Resource Compromises** - Applications' quality may be compromised as a result of constraints and pressure to fulfill deadlines, the developers might take short cuts or work quickly throughout the development cycles, which could lead to defects, poor user experience or performance problems.

- **Time Constraints** - There may be limitations on the resources available for the application, such as necessity to prevent copyright infringement. Only legally or freely accessible materials may be used by the developers.

## CHAPTER 5

### Summary of the Study

The goal of this project, Pamana, is to engage young students and educate them about the rich history of the Philippines, as well as to make them understand the beauty and uniqueness of each culture through a pleasant and interactive game. The application is tested to 50 Grade 5 elementary students, 3 professors, and 3 IT professionals. All of whom provided a valuable feedback. According to the survey and data that have gathered based on ISO 25010 software quality standard evaluation, the 3D mobile application achieved an average of 5.10, indicating to "Agree" in terms of the seven quality standards used: functionality, usability, portability, reliability, efficiency, maintainability, and compatibility.

### Conclusion

Throughout its development, Pamana as a Game-Based Learning Application has been thorough. We began with extensive research and meticulous planning, delving into the curriculum requirements and studying existing educational games for insights. With a solid understanding established, collaborative brainstorming sessions ensued to conceptualize a game storyline and characters that would resonate with our target audience while effectively conveying key concepts. Progressing into the design and development phase, we scoured for various assets that could enhance our maps and overall game experience. Throughout this journey, iterative testing and feedback sessions with Grade 5 students were prioritized, leveraging their insights to refine and optimize the game for maximum educational impact.

The Dijkstra Algorithm is used to assist players in locating artifacts within the game swiftly and efficiently. By generating the shortest possible path between the player's current position and the target artifact, the algorithm significantly enhances the gameplay, user experience, the quality of

the Pamana. This 3D game application has been thoroughly evaluated using ISO 25010. This rigorous evaluation process ensures that the game not only meets its functional requirements but also delivers a superior user experience in terms of performance, usability, and reliability.

Finally, the ISO 25010 evaluation of Pamana, a 3D game, provided an objective measure of the game's functionality, usability, efficiency, reliability, maintainability, and compatibility. The evaluation results show that the 3D game performs exceptionally well in all metrics, ensuring that players have an interactive and educational experience. The ISO 25010 evaluation also identified areas for improvement, ensuring that the application remains relevant and works smoothly for the educational and entertainment purposes of the target audience.

## Recommendations

In order to optimize the development of the application as the basis of the subsequence study for future researchers,. Developers suggest the following for improvements to the application.

- **Muti-player mode** - Due to multiplayer games allowing players to provide an interactive platform where players can engage with each other, fostering competition, cooperation, and community. It enhances the gaming experience by adding unpredictability and social elements that single-player modes cannot offer.
- **Online Mode** - The future researchers will adopt online platforms that aim to improve accessibility, cooperation, and involvement. This will enable users to experience smooth connectivity, overcome obstacles, and promote an inclusive learning environment.
- **IOS Version** - The availability of an app on IOS serves to reach a wide audience of Apple device users, providing a seamless experience tailored to the IOS ecosystem.

- **Localization** - it ensures the players from different regions can enjoy the game in their own tongue, improving accessibility, user experience and engagement, as well as the game's marketability.

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## Appendix A

### *Risk Management Plan*

#### **Project Title: PAMANA: Exploring the Philippines' Heritage through Integrating Quest-Based Item Exploration in a 3D Game using Dijkstra Algorithm**

### **RISK MANAGEMENT PLAN**

<b>RISKS</b>	<b>LIKELIHOOD (Low/ Medium/High)</b>	<b>Impact (Low/ Medium/High)</b>	<b>Mitigation Strategies</b>
Uncooperative partner organization	Medium	High	<ul style="list-style-type: none"> <li>• Ensure open and transparent communication with the partner organization.</li> <li>• Establish a shared vision and clear objectives that align with the interests of the partner agencies.</li> </ul>
The app crashes frequently on certain devices.	Medium	High	<ul style="list-style-type: none"> <li>• Utilize crash reporting tools to identify specific device-related issues.</li> <li>• Provide clear communication to the affected users about troubleshooting</li> </ul>
Slow loading times or crashes during peak usage periods due to inadequate server capacity or inefficient code optimization.	Medium	High	<ul style="list-style-type: none"> <li>• Perform load testing to identify performance bottlenecks.</li> <li>• Optimize code for efficiency, and consider scalable cloud infrastructure to handle increased traffic.</li> </ul>
Implementing responsive and intuitive touch controls for navigating 3D environments and interacting with game elements, which can be challenging compared to traditional controller inputs.	Medium	High	<ul style="list-style-type: none"> <li>• Designing user interfaces with large touch targets</li> <li>• Providing customizable control options and implementing gesture recognition for intuitive actions.</li> </ul>
Mobile screens are smaller than PCs or consoles. Limiting the	Low	Medium	<ul style="list-style-type: none"> <li>• Optimizing layout for efficiency, providing contextual information,</li> </ul>

amount of information that can be displayed at once			and offering customizable UI options for the player
Poor user interface design, confusing navigation, or lack of responsiveness.	Low	Medium	<ul style="list-style-type: none"> <li>Conduct usability testing, gather feedback from beta users.</li> <li>Iterate on design improvements to enhance the overall user experience and increase user engagement.</li> </ul>
Working within the constraints of mobile device hardware, including limitations on processing power, memory, and graphics capabilities.	Medium	High	<ul style="list-style-type: none"> <li>Optimizes code and assets, implementing efficient rendering techniques.</li> <li>Utilizing performance profiling to ensure optimal resource utilization</li> </ul>
Balancing graphical fidelity with performance to achieve smooth rendering and frame rates, especially on lower-end devices.	Low	Medium	<ul style="list-style-type: none"> <li>The team offers graphic settings that allow players to adjust quality based on their devices</li> </ul>

## Appendix B

### *Questionnaire*

#### **PAMANA: Exploring the Philippines' Heritage through Integrating Quest-Based Item Exploration in a 3D Game Using Dijkstra Algorithm**

#### **EVALUATION FORM (ISO 25010) (Students)**

Name (Optional):

Date:

I acknowledge and agree that by participating in the application's testing. I consent the researcher to collect and utilize my personal information for their capstone project as long as necessary. I understand that my personal information will be treated confidentially and will not be disclosed to any third parties without my explicit consent, except when mandated by law.

**Please rate the following statements based on your experience with Pamana**

**1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Somewhat Agree, 5 = Agree, 6 = Strongly Agree**

Functional Sustainability	1	2	3	4	5	6
1. Does the application accurately represent the historical sites and artifacts?						
2. The application gives interesting facts about cultural heritage while playing the game?						
3. The application navigates around the game world easily to explore different historical locations?						
4. Are the tasks and instructions clear enough to help you progress through the quest?						
Performance Efficiency	1	2	3	4	5	6
5. The game loads quickly when you open it						
6. The application responds promptly to your actions without noticeable delays?						

<b>Portability</b>	1	2	3	4	5	6
7.. I seamlessly transitioned between playing the game on different devices without losing progress						
8. The application's file size is small enough to download and install quickly on various devices						
<b>Maintainability</b>	1	2	3	4	5	6
9. Does the application recover smoothly from unexpected errors or crashes without losing player's progress or data?						
<b>Reliability</b>	1	2	3	4	5	6
10. Does the game run smoothly without crashing or freezing?						
11. Can you trust that the game will work every time you want to play it?						
<b>Usability</b>	1	2	3	4	5	6
12. Is the game interface easy to understand and navigate?						
13. The application quickly understands how to interact with the game and complete quests?						
14. The application gives you the comfort of playing on your device for extended periods?						
15. Are the sizes of the in-game items and structures realistic, reflecting their real-life counterparts?						
<b>Compatibility</b>						
16. Are there clear and comprehensive guidelines for developers and users?						
17. Does it cause any conflicts or crashes?						

**PAMANA: Exploring the Philippines' Heritage through Integrating Quest-Based Item Exploration in a  
3D Game Using Dijkstra Algorithm**

**EVALUATION FORM (ISO 25010)**  
**(IT Professionals)**

Name (Optional):

Date:

I acknowledge and agree that by participating in the application's testing. I consent the researcher to collect and utilize my personal information for their capstone project as long as necessary. I understand that my personal information will be treated confidentially and will not be disclosed to any third parties without my explicit consent, except when mandated by law.

**Please rate the following statements based on your experience with Pamana**

**1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Somewhat Agree, 5 = Agree, 6 = Strongly Agree**

Functional Sustainability	1	2	3	4	5	6
1. Pamana is accurately represent the intended content and functionality?						
2. The application provide valuable and engaging information relevant to its purpose?						
3. Can users easily navigate through the application to access different features and content?						
4. Are the tasks and instructions within the application clear and helpful for user progression?						
Performance Efficiency	1	2	3	4	5	6
5. How does it start up and load all necessary resources quickly, ensuring that users do not experience prolonged waiting times before they can begin using its features?						
6. Does the application respond swiftly to user interactions, ensuring a seamless and efficient user experience without noticeable lag or delays?						
Portability	1	2	3	4	5	6
7. Is the application capable of running smoothly on various devices and operating systems?						

<b>8.</b> Is the application's file size optimized for quick download and installation across different platforms?						
<b>Maintainability</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
<b>9.</b> Does the application handle errors or crashes gracefully, preserving user data and progress?						
<b>Reliability</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
<b>10.</b> Does the application run consistently without unexpected crashes or freezes?						
<b>11.</b> Can users rely on the application to perform as expected each time it is used?						
<b>Usability</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
<b>12.</b> Does Pamana find it easy to learn how to use the application and complete tasks efficiently?						
<b>13.</b> Are the graphical elements and layouts in the application appropriately designed and proportionate?						
<b>Compatibility</b>						
<b>14.</b> Does the application include comprehensive guidelines for integration and usage for developers and end-users?						
<b>15.</b> How well the application avoid causing conflicts or compatibility issues with other software or systems?						

**PAMANA: Exploring the Philippines' Heritage through Integrating Quest-Based Item Exploration in a  
3D Game Using Dijkstra Algorithm**

**EVALUATION FORM (ISO 25010)**

**(Teachers)**

Name (Optional):

Date:

I acknowledge and agree that by participating in the application's testing. I consent the researcher to collect and utilize my personal information for their capstone project as long as necessary. I understand that my personal information will be treated confidentially and will not be disclosed to any third parties without my explicit consent, except when mandated by law.

**Please rate the following statements based on your experience with Pamana**

**1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Somewhat Agree, 5 = Agree, 6 = Strongly Agree**

Functional Sustainability	1	2	3	4	5	6
1. Does the game accurately reflect the learning objectives and content specified in the curriculum?						
2. Does the game provide interactive experiences that enhance the understanding of key educational concepts?						
Performance Efficiency	1	2	3	4	5	6
3. Does the game load and start quickly, minimizing wait times for students?						
4. Does the game respond promptly to student actions without noticeable lag, ensuring a smooth learning experience?						
Portability	1	2	3	4	5	6
5. Can students access and use the game seamlessly across different devices and operating systems without issues?						
6. Is the game's file size optimized for quick download and installation on a variety of devices?						
Maintainability	1	2	3	4	5	6
7. Does the game handle errors and crashes effectively, ensuring that students do not lose their progress or data?						

<b>Reliability</b>	1	2	3	4	5	6
<b>8.</b> Does the game operate consistently without crashing or freezing during use?						
<b>9.</b> Can you depend on the game to function correctly each time it is used for classroom activities?						
<b>Usability</b>	1	2	3	4	5	6
<b>10.</b> Is the game's interface intuitive and easy for students to understand and navigate?						
<b>11.</b> Do students quickly grasp how to interact with the game and complete educational tasks or challenges?						
<b>12.</b> Is the game comfortable for students to use for extended periods, promoting a positive learning experience?						
<b>Compatibility</b>						
<b>13.</b> Are there clear and comprehensive guidelines for teachers and students to effectively use the game?						
<b>14.</b> Does the game integrate well with other educational tools and resources without causing conflicts?						