DEVELOPMENT OF UR: A MOBILE-BASED 3D EVENT PLACE WITH CUSTOMIZATION AND VISUALIZATION USING UNITY

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DEVELOPMENT OF UR: A MOBILE-BASED 3D EVENT PLACE WITH CUSTOMIZATION AND VISUALIZATION USING UNITY

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ABSTRACT

In response to the challenges faced by the event planning industry, particularly regarding the visualization and customization of event spaces, this project introduces “UR: A Mobile-Based 3D Visualization and Customization using Unity.” Traditional methods often require physical visits to venues and lack real-time interactivity, leading to inefficiencies and client dissatisfaction. Leveraging Unity’s 3D capabilities, UR enables users to visualize and customize event layouts in real-time on mobile devices, bridging the gap between imagination and reality.

By integrating drag-and-drop tools and 3D objects, users can create personalized event layouts, zoom in/out, and save their designs. Additionally, UR offers top-view 3D models of event venues, enhancing visualization before the actual event. The system, developed using Unity, C#, Flutter, and Firebase, underwent rigorous testing for functional suitability, performance efficiency, and usability. Evaluation based on ISO 25010 criteria confirms its acceptability and performance efficiency. Through collaboration with ***Casa Pura Hall & Suites***, UR aims to revolutionize event planning, offering a seamless, immersive, and personalized experience for clients, thereby contributing to advancements at the intersection of technology and real-world experiences.

The findings of a survey conducted with 30 respondents, evenly divided between 15 event designers and planners and 15 clients, evaluated the “Development of UR: A Mobile-Based 3D Event Place Visualization and Customization using Unity." The system received an average score of 22.3 points, indicating general acceptance due to its features

and functions, with event designers rating its usefulness at 21.6 points and clients at 23 points, emphasizing its appropriateness to their needs and the effectiveness of its user-friendly interface, customization, and visualization features.

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Chapter 1

The Problem and Its Setting

This chapter discusses the study's background, problem statement, and significance. It also lists the project objectives, scope, and delimitations. This chapter provides an overview of the research and a brief discussion of the technology and concepts used in it.

Introduction

In today's fast-paced digital era, the event planning industry faces significant challenges in providing efficient and visually engaging methods for clients to choose and customize event spaces. Traditional planning methods often require physical visits to venues, numerous iterations of design layouts, and extensive coordination with event planners. These steps can be time-consuming, costly, and inefficient, especially for clients who seek a personalized and visually appealing setup. The need for an innovative solution that streamlines the visualization and customization process has become increasingly evident, prompting the exploration of advanced technological applications in this domain.

Elaborating on these challenges, the logistical hurdles of visiting multiple venues can be daunting, particularly for clients with limited time or those located remotely. Furthermore, the static nature of traditional design proposals, usually presented through floor plans or photographs, fails to capture the dynamic and immersive nature of a well-planned event space. This often results in a disconnect between the client's vision and the final setup, leading to dissatisfaction and last-minute adjustments. The demand for a more interactive, visually accurate, and easily accessible planning tool has never been higher,

paving the way for innovative solutions like mobile-based 3D visualization and customization.

The advent of 3D visualization and platforms like Unity presents a transformative opportunity for the event planning industry. Unity, a powerful game development engine, offers robust capabilities for creating immersive 3D environments that can be rendered and interacted with on mobile devices. By leveraging 3D technology, users can experience a realistic representation of potential event spaces, customize layouts, decorations, and other elements in real time, and make informed decisions without the need for physical presence. This not only enhances user engagement but also provides a practical solution for remote planning and collaboration, making it an invaluable tool in our increasingly digital society.

In this thesis, the researchers dedicated extreme efforts to the creation of UR: A Mobile-Based 3D Visualization and Customization using Unity. The main goal of this system is to offer users personalized suggestions for event places and elevate their overall experience by providing real-time visualization. Notably, the researchers plan to utilize the data obtained from *Casa Pura Hall & Suites Event Designer* as the initial client of this application. Through this work, the researchers aim not only to enhance the event place design process but also to contribute to the expanding field of knowledge where technology and real-world experiences intersect.

Background of the Study

The process of organizing and designing an event can be both physically and mentally demanding, necessitating a substantial amount of effort to ensure its seamless execution. In conducting an event, there are several crucial factors that need to be carefully considered. One of the tasks is modifying the arrangement of an event. To address this, this study aimed to develop a mobile-based 3D visualization and customization tool using Unity. This allowed customers to see their preferred design before the real event. These factors are crucial for the overall success and effectiveness of the event. Through meticulous assessment and resolution of these concerns, event designers may guarantee comprehensive and proficient planning and execution of all elements of the event, eventually resulting in a remarkable and influential experience for all participants.

Previous studies have explored the use of 3D visualization in event planning. Ouyang et al. (2017) developed a method for generating three-dimensional virtual crowd scenes using Unity 3D, focusing on establishing a database, creating a static virtual environment, and generating figures and models to simulate a dangerous environment. The method aimed to simplify the development process by utilizing Unity 3D's assemblies and plug-ins, enhancing efficiency. Lahoutifard et al. (2011) developed a system that provides multiple immersive 3D event spaces to different user groups, allowing for the setup and hosting of virtual events.

The problem addressed in this study arose from the challenge of finding an appropriate design for the event and the inability to visually evaluate the event layout, leading to customer dissatisfaction. Finding a suitable event design could be time-consuming, especially considering the additional time required to organize the entire event.

Event designers and clients often relied on floor plans or photographs as their primary method of finding a suitable layout, until they came across one that perfectly aligned with their preferences. Additionally, clients may need frequent modifications, such as replacing, enhancing, or removing design elements.The objective was to alleviate the challenges faced by customers when planning an event by providing a platform that catered to their specific requirements and preferences and personalized suggestions for event places, thereby bridging the gap between their imagination and reality. In order to ensure a memorable and flawless experience for the client, it is crucial to understand that this moment is a unique and significant occasion in their life.

The *Casa Pura Hall & Suites* is situated on Scout Santiago St. in Diliman, Quezon City. The company provides a diverse range of event options, including weddings, birthdays, and more. They also supply authentic photographs of each event, which we utilize to generate three-dimensional models.

Objectives of the Study

General Objective

The general objective of the study was to develop event layout designs using our easy drag-and-drop tools, providing 3D objects to bring your event visions to life.

Specific Objectives

The study focused on the following specific objectives:

1. Design an Event with a Customization and Visualizing System using Unity with the following features:

- **Customization in Event Place:** Users can create event layouts using drag-and-drop features, add 3D objects, zoom in and out the layout, and save their work as an image.
- **Visualizing Event Spaces:** This involves creating 3D models or overlays of event venues, allowing event designers and clients to visualize the layout from a top-view perspective before the actual event takes place.
- **User Registration and Account Creation**
    - Allow users to create an account
    - Collect user information for customization and user engagement
- **User Feedback and reviews**
    - Include a section for users to leave a rating based on their experience/ preferences

- **Security and privacy**
    - Secure authentication methods to protect user information (Google Account Authentication, Email Authentication)

- **Support and Help Center:**
    - Include a section for users to view FAQs and ask questions about the app or the events place
- **Responsive Design:** Adaptability of the interface across various devices and screen sizes. Emphasize the importance of responsive design in ensuring a consistent and user-friendly experience for event designers accessing the AR tools on different platforms.

2. Create the system using various developmental tools such as: (Unity, C#, Flutter, and Firebase)

3. Test and evaluate the system in terms of functional suitability and performance efficiency, usability.

4. Determine the level of acceptability of the developed prototype system using the ISO 25010 criteria such as functional suitability, performance efficiency, usability.

Scope and Delimitation

This study was exclusively about Casa Pura Hall & Suites Event Designer and their connection with 27 Roces Space. The use of 3D visualization in this collaboration was emphasized. The objective was to increase the efficiency and effectiveness of event design at Casa Pura Hall & Suites by matching the 3D visualization technology to its peculiarities. By focusing on one designer, we offered a comprehensive and individualized perspective

on how 3D visualization could be applied while considering both technical and artistic aspects that would match the preferences of the organization.

The incorporation of three-dimensional properties into the system significantly enhanced efficiency and effectiveness in event space design. This system employed three-dimensional visualization technologies for an interactive, user-friendly experience. This technology allowed event designers to see and change venue layouts and décor, among other crucial design elements, according to customers' choices. This technique ensured better judgments as well as a more personalized approach toward event designs. Thus, it fully explored the capabilities and limitations of 3D technology within the context of event design research.

Nonetheless, this study focused on the specific limitations. First, it will concentrate on only one aspect- the integration of 3D visualization technology into event place design. As a result, virtual reality (VR), augmented reality (AR), or mixed reality (MR) technologies were not included. Secondly, instead of conducting exhaustive logistical or financial assessments, the research focused only on visual and conceptual components of event design. Moreover, the system was limited to being tested and validated by select event designers, which restricted the generalizability of the results. Also, the software and user experience aspects of the technology were studied, but it did not look at hardware development. Finally, this system has been built for deployment on mobile phones with Android operating systems running on Android 6 (Marshmallow) and API level 23 at least.

Significance of the Study

The development of UR: A Mobile-Based 3D Event Place Visualization and Customization using Unity offered a transformative approach to creating immersive and interactive event experiences. This section highlights the importance of the study for benefit groups, including:

Event Designers

Event designers gain significantly from undertaking this research. It harmonizes the procedure of event place designing by incorporating mobile 3D visualization and customization, which enables designers to work effectively with clients. This means that prototypes of virtual events can be easily designed to experiment in different settings without having to set up physically. Consequently, it reduces mistakes and improves the overall quality of events. The findings also provide event designers with advanced tools for better service provision and client contentment.

Event Clients

Event customers will greatly benefit from this study. Furthermore, 3D visualization has been added to enhance the experience received during an event by providing clients with a preview of the event. This allows them to interact within such environments while giving them a clear idea of how it will look. Most importantly, this technology enables more customization of events, which meets client preferences and leads to higher levels of satisfaction and engagement on the final day.

Event Management Companies

Companies that offer event management will have a competitive edge by incorporating mobile-based 3D visualization. By showing the potential of 3D visualization in event previews, these companies can attract more clients and offer unique experiences. This technology helps improve event design, reduce logistical problems, and enhance overall event coordination, thus resulting in improved levels of client satisfaction and business success.

Technology Sector

This study is very significant for the technology industry. This exploration of the potential of 3D visualization using mobile phones has expanded the technology sector's frontiers. This research paper may also give rise to fresh tools, software, or specialist applications designed for customized visualizations in a technological setting, which can be developed by technology companies because of this research paper, thereby enhancing novelty in this field. Moreover, it has highlighted how important 3D technologies are to different industries.

Future Researchers

In these cases, my study would be a great source of information for any scholar who wants to study event place design, 3D visualizations, or their interconnection. The work presented here can form a baseline for other researchers to investigate more into the potential use of 3D visualization in enhancing event place design and/or related fields. The outcome of this research can also benefit future researchers interested in the same area as they can utilize some parts of such discussions or methodologies as grounds upon which

to build toward more detailed inquiries.

Chapter 2

CONCEPTUAL FRAMEWORK

This chapter provides an overview of related literature, related studies, the conceptual model of the study, and the operational definition of terms relevant to this study.

Review of Related Literature

This chapter discussed and presented significant literature and studies that provide an inclination to the current study. It also pertains to placing the proper context to review previous researchers who are relevant to this study.

I. Introduction to Mobile-Based 3D Visualization

A. Importance and Applications of 3DVisualization in Mobile Platforms

3D visualization on mobile platforms helps address communication gaps in the Architecture, Engineering, and Construction (AEC) industry, allowing a better understanding of complex designs and structures. By visualizing 3D models on mobile devices, users can proactively identify design errors, leading to improved planning and execution and reducing wastage of resources (Murthy et al., 2022).

In the study conducted by Keselj et al. (2023), they highlighted the significance of 3D visualization in education, emphasizing how mobile platforms can offer interactive and immersive learning experiences through visualizing complex concepts from various angles. By utilizing 3D visualization on mobile devices, users can engage with virtual models in real time, leading to more informed decision-making processes and streamlined project management within the AEC sector.

B. Importance of Mobile-Based Application in Event Management

The study aims to highlight the significance of mobile applications in event management by providing a comprehensive analysis of their impact on event organizations, focusing on their main characteristics, strengths, and weaknesses. By exploring mobile applications for event management, the research provides practical implications for managers in the hospitality industry, emphasizing the efficiency and organizational benefits these apps bring to event planning processes (Revilla et al., 2023).

The study aims to understand the role of mobile applications in supporting travelers' information needs during event attendance and travel planning stages, focusing on patterns of adoption and context-dependent usages among different categories of event attendees. Additionally, the study proposes benchmarking measures to evaluate the popularity of mobile applications for events and highlights the significance of user behavior analysis in enhancing electronic tourism management and marketing strategies for a deeper understanding of consumer preferences beyond standard analytics (Not, 2021).

C. Role of Unity in developing Interactive 3D Environments

Singh et al. (2022a) evaluates and optimize performance techniques in Unity3D for building 3D interactive applications like games, simulations, and augmented reality. The research focuses on addressing issues that can lead to poor performance in applications, such as inefficient code, disorganized memory management, and overly complex physics simulations, which can negatively impact user experience. Ultimately, the goal of the study is to contribute to the Unity3D community by providing insights into developing well-performing applications that offer users a high-quality interactive 3D environment.

Kiss and Pusztai (2022) utilize the Unity game engine to create a 3D simulated ecological system based on a predator-prey model extended by gene evolution. Unity is chosen for its ability to develop and manage a closed 3D ecosystem environment, allowing for the incorporation of genetic evolution to stabilize the system and reduce extinctions. The researcher focuses on enhancing system stabilization, long-term operation, and simulating reality more accurately by integrating genetic evolution into the predator-prey model within Unity.

II. Unity as Development Tool

A. Introduction to Unity

Unity is a widely used game development platform that empowers users to craft immersive 2D and 3D experiences across a range of platforms, including PC, mobile, and consoles. The Unity Editor is the ultimate hub for game development, providing a wide range of tools to create, code, and test game elements. Unity's toolset offers a wide range of features to help you create game assets, script interactions, implement physics, and optimize performance. Unity projects are organized with assets, scenes, scripts, and other components neatly arranged in a folder hierarchy for effective management (Halpern, 2018).

According to Uzayr (2022), Unity, introduced at Apple Inc.'s Worldwide Developers Conference in 2005, is a versatile tool for creating both 2D and 3D games, interactive simulations, and experiences across various industries like film, automotive, architecture, and engineering. It supports multiple programming languages like C#, JavaScript, Rust, and Mono, focusing on object-oriented principles and C# coding. Unity

projects are structured with assets, scenes, scripts, and other components organized within a folder hierarchy to facilitate project management and development.

B. Features and Capabilities of Unity for 3D Development

Unity offers advanced graphics capabilities for creating stunning 3D visuals, including high-quality rendering, shaders, and special effects like lightning and shadows, while also supporting multi-platform development, enabling developers to create 3D games for various platforms such as PC, mobile devices, consoles, and VR/AR devices, thereby ensuring a wider reach for developed games. Additionally, Unity provides an extensive Asset Store where developers can find ready-made 3D models, textures, animations, and scripts, which significantly saves time and effort in creating assets from scratch (Singh & Kaur, 2022).

Singh et al. (2022b) state that despite Unity's optimized performance, applications can suffer from inefficient code, disorganized memory management, and overly complex physics simulations. To ensure a smooth and responsive user experience, developers need advanced knowledge of Unity3d's engine architecture and optimization techniques. By evaluating and testing different optimization techniques within Unity3d, developers can enhance performance and improve the overall user experience.

C. Comparison of Unity with other 3D Development Tools

Razzhivin et al. (2023) indicate that Unity is well-suited for small development teams due to its user-friendly interface and comprehensive features, making it a preferred choice for its ease of use and flexibility. Conversely, Unreal Engine is recognized for its capacity to develop high-quality games with intense graphics, thus appealing to developers

targeting visually stunning results. Meanwhile, Cry Engine is distinguished by its emphasis on realistic natural environments, offering tools that enable developers to create lifelike landscapes and settings.

Unity3D engine technology outperforms BIM and Open Scene Graph technologies in landscape authenticity, achieving a high accuracy of 94.5%. BIM technology achieves an authenticity level of 86.3%. Open Scene Graph technology reaches an authenticity level of 90.30%. The comparison highlights the superior performance of Unity3D in creating realistic three-dimensional landscapes (Wu & Li, 2023).

III. Event Place Visualization

A. *Definition and Significance of Event Place Visualization*

Event place visualization involves depicting locations and their unique cultures through visual methods, commonly utilized in events such as fashion shows or festivals. This form of visualization is vital for establishing the image of a destination, aiding in both destination branding and reinforcing local identity (Walters, 2019). Studies on event cameras underscore their proficiency in capturing events with minimal delay and a wide dynamic range, which proves beneficial for visual place recognition tasks, particularly under challenging lighting conditions (Fischer et al., 2020). The integration of temporal windows of different durations through ensemble techniques can greatly improve the performance of event cameras in place recognition. This highlights the significance of adopting innovative methodologies to enhance the effectiveness of visual place recognition (Kong et al., 2020).

B. Historical Development and Technological Advancements in Event Visualization

Historical events are increasingly depicted through diverse media such as photography, cinema, and online games, which influence how audiences emotionally and ideologically connect with history. The digital age has transformed historical studies by converting traditional sources into digital formats, fostering new research methods through digital curatorial practices and visual history techniques (Wu, 2022).

Additionally, advancements in digitized humanities have introduced visual reasoning systems that help understand uncertainties associated with historical figures and events. These innovations enhance researchers' ability to analyze and interpret complex historical narratives (Ebbrecht-Hartmann, 2023). Event sequence data visualization techniques have also progressed, addressing the challenges of comparing event sequences by considering factors like scale, comparison type, size, data, and interaction. This evolution provides insights into the strengths and weaknesses of various visualization methods (Van, 2023).

C. Current Trends in Event Place Visualization

Recent advancements in event place visualization include the use of event cameras to ensure reliable perception even in difficult lighting conditions (*Cross-modal Place Recognition in Image Databases using Event-based Sensors*, 2023). Researchers are developing innovative multi-modal networks, such as VEFNet, to enhance visual place recognition (VPR). These networks extract detailed visual features from both RGB and

event frames independently and utilize attention modules to establish connections between the two modalities for better VPR performance (Huang, 2022).

IV. Customization in 3D Visualization

A. Concept and Importance of Customization in 3D Environments

Customization in 3D environments is pivotal across many domains, enabling tailored designs and experiences (Maxim et al., 2014). Techniques such as deformation fields from statistical shape models and semantic web methods for content customization allow for personalized adjustments in geometry, appearance, and interactions within virtual spaces. These strategies support the creation of adaptable 3D models, virtual objects, and scenes, enhancing user engagement and functionality (Romes et al., 2014).

Customization is vital for adapting products, simulations, and robots to specific environments. For instance, in developing mobile service robots for elderly care, digital twins are employed to refine responses prior to real-world deployment. This approach ensures that the robots are better suited to their intended environments and tasks. The ability to customize 3D environments empowers users to personalize designs, interactions, and functionalities, fostering innovation and efficiency across various applications (Flotyski, 2016).

B. Example of customized 3D environments

Customized 3D environments are utilized in diverse applications, demonstrating their versatility and practicality. Examples include creating personalized animated content for web-based VR or AR experiences, designing products tailored to specific environments

using deformation fields and statistical shape models, and reconstructing real-time 3D environments from data captured by inexpensive cameras for robotics and computer vision purposes (Philip, 2020). Additionally, overlaying virtual objects on real environments captured by user devices and modifying their surfaces based on captured content highlights the integration of virtual and real-world elements. Furthermore, the development of customizable 3D models with user-specified controls for geometry modifications in publicly available runtime environments and online marketplaces for 3D printing underscores the growing accessibility and customization options available (Maxim et al., 2021).

These instances illustrate the wide-ranging applications of customized 3D environments, spanning fields from entertainment and education to product design and accessibility. They highlight their potential to enhance user experiences and meet specific needs (Romes et al., 2014).

V. Mobile-Based 3D Applications

A. Example of customized 3D environments

The rise of mobile-based 3D applications has been remarkable, fueled by smartphones' advancing capabilities and the increasing prevalence of 3D multimedia (Frank, 2023). Modern mobile devices now offer advanced features like 3D body scanning for custom product development and virtual try-on experiences (Pasquale et al., 2017). Additionally, platforms like eIMES 3D Mobile enable healthcare professionals to access and share medical imaging data on the go, improving collaborative diagnostics and the management of rare cancers (Shervin et al., 2015).

B. Technical challenges and solutions in mobile 3D development

Achieving real-time 3D vision on mobile devices poses challenges due to the substantial computational power and memory needed for processing 3D data. This underscores the necessity of enhancing the efficiency and performance of mobile 3D vision systems (Ramasamy, 2020). These challenges include limited bandwidth for 3D rendering, constraints in thin mobile devices storing virtual environments that later lead to the development of 3D streaming techniques (Zorana et al., 2022), as well as commonly poor user experience with object manipulation due to excessive freedom in a three-dimensional virtual plane which are addressed by the usage of 2D transformation to limit the movement of objects for ease of navigation (Pavel et al., 2015).

C. Studies about successful mobile-based 3D event visualization applications

Research has extensively explored mobile-based 3D event visualization applications. Wang et al. (2018) developed a cost-effective and user-friendly mobile 3D reconstruction system with robust real-time performance. Ramasamy (2020) discussed the difficulties of visualizing 3D objects on mobile devices due to limited computational power and inefficient rendering interfaces, stressing the importance of size and shape for user orientation. Cao et al. (2020) investigated the benefits of 3D model images and animations over textual narratives, finding improvements in cognitive load, recall, and engagement. Li et al. (2020) highlighted advancements in 3D visualization technology within mobile apps, demonstrating enhanced operational efficiency through 3D data visualization. Collectively, these studies illustrate the progress and challenges in developing effective

mobile-based 3D event visualization applications, focusing on aspects such as cost-effectiveness, computational resources, user orientation, and cognitive support.

VI. User Interface (UI) and User Experience (UX) Design

A. Principles of effective UI/UX design for 3D applications

Effective 3D application UI/UX design entails the amalgamation of new and existing techniques to improve communication between designers and clients, concentrating on usability heuristics, visual and cognitive heuristics, as well as interactivity and complexity (Erzetic et al., 2019). There has been increased availability of APIs and libraries for mobile app development. However, the documentation regarding integrating 3D models is inadequate, calling for a deeper investigation into how SceneView and other 3D model technologies are relevant in the present trends of designing mobile applications (Sanjaya et al., 2023). Through UI/UX design, it is possible to make products more user-friendly and appealing not only to websites or apps but also to all kinds of electronic devices because its successful realization requires an understanding of the principles of user experience as well as user interface (Rajesh et al., 2022). Thus, designers can create immersive yet intuitive three-dimensional applications that efficiently fulfill users' needs.

B. Best practices for designing intuitive and user-friendly interfaces

To develop user-friendly and intuitive interfaces, it is necessary to consider several factors, such as natural language understanding, customization, user-centered design, integration with other technologies, and educational context (Reyes, 2023). In particular, user-centered design approaches play a crucial role in developing simple and intuitive interfaces, especially for safety-critical domains like the maritime sector, where good

interface design can help reduce human errors and accidents (Mu et al., 2023). Also, as technology progresses, Human-Centred Design (HCD) plus User-Centered Design (UCD), which are future-proofing methods, will create Natural User Interfaces (NUIs). NUIs, being nontraditional desktop-like applications, have grown from using UCD and HCD techniques (Schamonsky, 2018). Likewise, accessibility, usability, and effective communication are among the best practices for designing interfaces for visually impaired and blind users, thus enhancing better user experience among this group (Jantan et al., 2023). In this nascent field of human-robot interaction called HRI, emerging best practices focus on being heuristic evaluator's taxonomies that ensure positive user experience as commercial robotics expands into new markets (Schamonsky, 2017).

C. Challenges in designing UI/UX for mobile 3D applications

Developing UI/UX for mobile 3D applications poses a few problems to developers and programmers. One principal problem is the lack of detailed documentation about how 3D object models can be integrated into mobile applications; this has contributed to the low utilization of 3D models in building mobile apps (Sunjaya, et al., 2023). Moreover, designing a mobile UI is hard, which involves learning from best design practices and constructing wireframe templates that are inspired by other designs, hence expressing the necessity for dependable design tools as productivity enhancers and creativity boosters (Chen, 2022). Besides, UI/UX plays an important role in attracting users, with some survey results highlighting the importance of aspects like visuals, user behavior, usability, adaptability, language, feedback, and visual aesthetics on mobile app interfaces (Tanwar et al., 2022). To address these problems, a UI design pattern-driven approach such as Kiwi – a library that consolidates UI design knowledge for mobile applications – can facilitate

rapid prototyping and enhance the quality of UI design for Mobile 3D Applications (Sukadi, 2022).

VII. Technological Integration and Performance Optimization

A. Hardware and software requirements for mobile 3D applications

Typically, mobile 3D apps require a high-resolution display, a powerful GPU for rendering complex graphics, and sufficient internal storage to accommodate bulky 3D models and textures (Huan et al., 2022). In addition, using FPGA-based hardware designs that exploit parallel execution can considerably enhance the performance of 3D depth estimation algorithms by reducing the execution time as well as increasing energy efficiency. On the other hand, Unity and other 3D software tools are mostly used in producing and rendering 3D content on mobile devices (Faraz et al., 2021). The method TF-IDF combined with logistic regression is useful for categorizing user comments, which can assist in software development (Lingjuan et al., 2019). This means that a combination of both optimally designed hardware and robust software is necessary to deliver high-quality and immersive 3D experiences on mobile.

B. Optimization techniques for mobile performance

Mobile performance can be greatly improved through optimization strategies, mainly for mobile devices that have limited resources. Various approaches have been studied, including the use of non-functional performance parameters like energy and memory consumption to ensure user satisfaction and application success (Jia et al., 2022). Moreover, mobile game performance has been shown to significantly increase with lower resource usage through object pooling algorithms or low poly count models, which

minimize their footprint. Besides, because such methods as those for example provided by the Linear Parameter Varying Reduced Order Model now consider non-linear aspects such as natural convection and radiation in fast transient thermal simulations of mobile devices, they lead to accurate performance estimates and design optimizations (Hamrouni, 2020). On the whole, these optimization strategies are crucial when it comes to improving mobile performance, ensuring efficient computer offloading, as well as increasing user satisfaction with mobile apps and games.

C. Integration of Unity with mobile platforms

The integration of Unity with mobile platforms is a significant trend in mobile computing, as highlighted in various research papers. Unity serves as a cross-platform game engine that simplifies game development for multiple platforms, including Android, by providing a unified interface for different devices (Hu et al., 2023). This integration enables the creation of interactive learning media and gaming applications that are easily accessible on mobile devices, such as Android smartphones, contributing to the success of mobile gaming applications in the media and entertainment industries (Dawei et al., 2019). By utilizing Unity's capabilities, developers can design and develop mobile applications that support various features like touch event analysis, virtual reality experiences, and computational logic enhancements, ultimately enhancing the user experience on mobile platforms(Adeleke, 2023).

VIII. Developmental Tools

Developmental tools refer to the techniques or mechanisms employed to assist in the development. These tools will aid in creating UR: A Mobile-Based 3D Event Place Visualization and Customization using Unity.

Unity

Unity 3D is a crucial tool for creating engaging games with visually stunning 3D graphics, making it ideal for game development projects. Unity 3D enables developers to design interactive game interfaces, allowing for immersive and engaging user experiences within 3D environments. With Unity 3D, developers can create responsive video games that offer dynamic and immersive 3D experiences, enhancing player engagement and enjoyment (Parab et al., 2022).

Blender

Blender is a multifunctional and potent suite for 3D production that integrates modeling, animation, rendering, and other features into a unified software interface. From animation to game creation, it is appropriate for a variety of sectors since it provides a broad range of tools for activities like mesh modeling, sculpting, rigging, and texturing (Blender Foundation, n.d.). In this project, Blender was used to model an object based on information provided by Casa Pura Inn & Suites. It must be exported as a GLTF file after modeling to be imported into Unity.

C#

C# (C Sharp) is an elevated-level programming language that exhibits efficiency in the realm of software development. It constitutes an integral component of the NET platform and is predominantly employed for the creation of applications on the Microsoft platform. C# amalgamates the benefits of alternative programming languages, such as the potent numerical calculation functionalities found in MATLAB, in conjunction with its own distinctive attributes for software development (Čižmárik & Parizek, 2020). It furnishes a streamlined mechanism for blind signal processing and facilitates the assimilation of algorithms implemented in blind source separation (BSS). C# is extensively utilized within both the industrial and educational sectors and is frequently selected as the introductory programming language for novices. It offers superior tool support for the dynamic analysis and monitoring of program behavior, particularly in the context of multithreaded programs and concurrency errors (Watson et al., 2020).

Dart

Dart is a programming language developed by Google that can be used to build structured modern apps. It is class-based and object-oriented, and it can be compiled into JavaScript for use in web browsers. Dart is designed to scale from small scripts to large applications and offers optional typing and pure object orientation (Juneja et al., 2022). It has a syntax that closely resembles Java, JavaScript, and C#. Dart can be used in both the server and client environment, making it a versatile language for backend and frontend development. It also supports cross-platform development, allowing developers to create apps for Android, iOS, and the web with a single codebase. Dart can be coupled with

MongoDB, a distributed database solution, to create faster and more scalable web applications (Hassan, 2020).

Flutter

Flutter is an open-source SDK tool used for developing mobile applications for iOS and Android operating systems. It offers a framework that simplifies the process of building applications for various platforms. Additionally, Flutter provides a wide range of advantages over developmental tools. It supports multiple operating systems like Windows and Linux, has a vast set of ready-to-use widgets, and allows for fast and effortless code development (Patil et al., 2023).

Github

GitHub is a web-based platform that serves as a repository for software projects. It is widely recognized as the largest open-source community globally, with over 31 million repositories that encompass both the code and its corresponding documentation. GitHub is a platform that encompasses various development tools, including but not limited to issue tracking, notifications, diffs, and status dashboards. Additionally, GitHub also offers social features to its users. GitHub offers three alternatives for documenting a project, namely Readmes, a wiki, and GitHub Pages. Each of these alternatives can be composed using Markdown syntax. The co-location of documentation and code within a repository enables the documentation to adhere to the same workflow as the codebase, thereby proving to be particularly advantageous in an Agile setting (Bleiel, 2016).

Android OS

The Android Operating System, based on the Linux kernel, is an open-source platform that primarily caters to the mobile arena, encompassing devices such as smartphones and tablets. Developed by Google, this operating system offers a wide array of functionalities and utilities, thus endearing itself to a vast user base. Java serves as the programming language for Android applications, which can be developed through the utilization of the Google Android SDK. This software stack provides developers with a comprehensive toolkit. At its core, the Android OS software stack consists of Java applications that operate within a Java-based object-oriented framework. Android, as a platform, is highly adaptable, enabling developers to create applications endowed with convenient functions. The architectural framework of the Android platform comprises classes and methods that facilitate the development process. Furthermore, a variety of cross-platform approaches can be employed for the development of Android applications (Anirban, 2019). Overall, Android OS is a widely used and user-friendly operating system that has a large community of developers creating applications to extend its functionality.

Firebase

Firebase is a cloud and offshore development platform offered by Google for cloud data storage and cloud-based messaging. It provides a range of services and tools for building and managing web and mobile applications (How to Integrate Firebase into SQL Server Reporting Services (SSRS) – Zebra, 2023).

Saraf et al. (2022) conducted a study to examine and evaluate the functionalities and characteristics of Firebase as a Backend as a Service (BaaS) platform in the context of

mobile application development. This study seeks to emphasize the advantages of utilizing Firebase for performance optimization, visual enhancements, and cross-platform development through the utilization of JavaScript. The article also discusses the transformation of Firebase from a real-time database to a comprehensive platform for application development. The statement highlights Firebase's significance as an effective API for real-time data synchronization and storage and its capability to manage backend issues and transmit application state through web sockets.

IX. Evaluation System

ISO 25010

The ISO 25010 standard is globally recognized as a benchmark for assessing the quality of software and systems. The standard has undergone three significant revisions in the years 2007, 2011, and 2017. The SQuaRE model, which stands for Systems and software Quality Requirements and Evaluation, is an alternative designation for this standard. The text delineates the quality of software products and the quality in use. Peters (2019) asserts that ISO 25010 was derived from a revision of the ISO 9126 framework. As per their assertion, the antecedent ISO 9126 model comprises six (6) primary factors and twenty-one (21) subordinate factors. The ISO 25010 standard introduced two factors, namely "security" and "compatibility," along with their respective sub-factors. This was achieved through a straightforward comparison of the two models. The ISO 25010 standard comprises two primary dimensions: Product Quality and Quality-in-use (QinU). The concept of Product Quality encompasses a set of eight distinct quality characteristics, which are Functional Suitability, Efficiency Performance, Compatibility, Usability,

Reliability, Security, Maintainability, and Portability (Izzatillah, 2019).

The study conducted by Izzatillah (2019) described the Product Quality Model as a set of eight quality characteristics made up of two to six sub-characteristics. The following are the eight defined characteristics: functional stability, performance efficiency, compatibility, usability, dependability, security, maintainability, and portability:

Ffunctional Suitability refers to the extent to which a product or system offers functions that fulfill both explicit and implicit needs when used under specified conditions. It consists of the following sub-characteristics:

- Functional completeness. The degree to which the set of functions covers all the specified tasks and user objectives.
- Functional correctness. The degree to which a product or system provides the correct results with the required degree of precision.
- Functional appropriateness. The degree to which the functions facilitate the accomplishment of specified tasks and objectives.

Performance Efficiency refers to the performance concerning the resources utilized under stated conditions. It consists of the following sub-characteristics:

a) Time behavior. The degree to which a product or system's response times, processing times, and throughput rates meet requirements when performing its functions.
b) Resource utilization. The degree to which the amounts and types of resources a product or system uses meet requirements when performing its functions.

c) Capacity. The degree to which the maximum limits of a product or system parameter meet requirements.

Usability refers to the extent to which specified users can utilize a product or system to achieve particular goals with effectiveness, efficiency, and satisfaction in a specific context of use. It consists of the following sub-characteristics:

- Appropriateness and recognizability. The degree to which users can recognize if a product or system is suitable for their needs.
- Learnability. The degree to which specific users can use a product or system to achieve specific goals effectively, efficiently, and satisfactorily, depends on the user context.
- Operability. The degree to which a product or system has attributes that make it easy to operate and control.
- User error protection. The degree to which a system protects users from making mistakes.
- User interface aesthetics. The degree to which a user interface allows for a pleasing and satisfying interaction for the user.
- Accessibility. The degree to which a product or system can be used by people with the broadest range of characteristics and capabilities to achieve a specific goal in a defined user context.

Reliability refers to the degree to which a system, product, or component performs specific functions under specified conditions for a specified period. Its sub-characteristics include:

- Maturity: The extent to which a system, product, or component meets the reliability specification under operating conditions.
- Availability: The degree to which a system, product, or component is operational and accessible when required for use.
- Fault tolerance: The degree to which a system, product, or component operates as intended despite the presence of hardware or software faults.
- Recoverability: The degree to which, in the event of an interruption or a failure, a product or system can recover the data directly affected and re-establish the system's desired state.

Security refers to the extent to which a product or system protects information and data so that users or other products or systems have access to data depending on their types and levels of authorization. Its sub-characteristics include:

- Confidentiality: The degree to which a product or system ensures that data is accessible only to those authorized to have access.
- Integrity: The degree to which a system, product, or component prevents unauthorized access to computer programs or data modification.
- Non-repudiation: The degree to which actions or events can be proven to have taken place so that the events or actions cannot be repudiated later.
- Accountability: The degree to which the actions of an entity can be detected uniquely to the entity.
- Authenticity: The degree to which the identity of a subject or resource can be proved to be the one claimed.

Compatibility refers to the extent to which a product, system, or component can exchange information with other products, systems, or components and perform its required functions while sharing the same hardware or software environment. Its sub-characteristics include:

- Co-existence: The degree to which a product can perform its required functions efficiently while sharing a typical environment and resources with other products without detrimental impact.
- Interoperability: The degree to which two or more systems, products, or components can exchange information and use the information exchanged.

Maintainability represents the degree of effectiveness and efficiency with which a product or system can be modified to improve, correct, or adapt to changes in the environment and requirements. Its sub-characteristics include:

- Modularity: The degree to which a system or computer program is composed of discrete components so that changes in one component have minimal impact on others.
- Reusability: The degree to which an asset can be used in more than one system or in building other assets.
- Analyzability: The degree of effectiveness and efficiency with which it is possible to assess the impact of an intended change, diagnose deficiencies or causes of failures, or identify parts to be modified.
- Modifiability: The degree to which a product or system can be effectively and

efficiently modified without introducing defects or degrading existing quality.

- Testability: The degree of effectiveness and efficiency with which test criteria can be established, and tests can be performed to determine if they have been met.

Portability refers to the degree of effectiveness and efficiency with which a system, product, or component can be transferred to another hardware, software, or operational environment. Its sub-characteristics include:

- Adaptability: The degree to which a product or system can be effectively and efficiently adapted for different or evolving environments.
- Installability: The degree of effectiveness and efficiency with which a product or system can be successfully installed and uninstalled in a specified environment.
- Replaceability: The degree to which a product can replace another specified software product for the same purpose in a similar environment.

The present study utilized the ISO 25010 standards to assess the suitability of each constituent in the existing system. These criteria encompass all the characteristics mentioned earlier, namely functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability.

Conceptual Model of the Study

Based on the research findings, related literature, studies, and insights gained from them, a conceptual model has been constructed and is shown in Figure 1. This model explains and illustrates the basic aspects necessary for the growth of the system, which consists of components that are input, processed, and output, respectively.

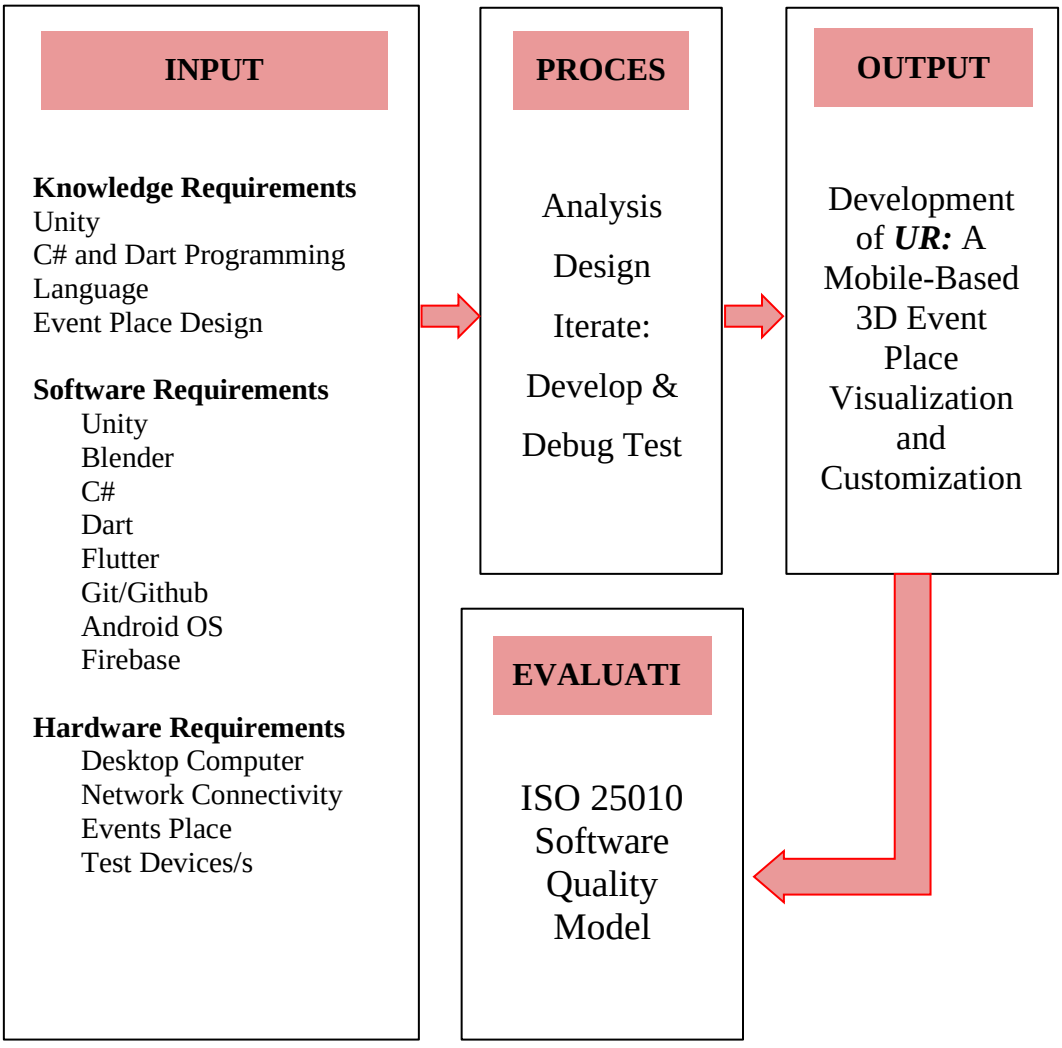

Figure 1. Conceptual Model of the UR Mobile App

Input

The input involves knowledge, software, and hardware requirements needed to develop a *UR*: A Mobile-Based 3D Event Place Visualization and Customization using Unity. The knowledge requirements are the concepts and facts that the researchers must comprehend and master to lay the groundwork for the investigation. These requirements include key knowledge in Unity, C#, Dart Programming Language, and Event Place Design. To thoroughly test the system, researchers are also required to have knowledge and understanding of software testing and software quality evaluation. The Software requirements are the application programs, programming languages, frameworks, databases, and operating systems needed to develop the *UR:* 3D Event Place using Unity. The hardware requirements are essential for ensuring optimal performance and efficient handling of workload in Event Place Design, which utilizes Unity. These requirements include a Desktop Computer, Network Connectivity, Events Place, and Test Device/s.

Process

The process in the conceptual model involves all the phases in a Software Development Life Cycle (SDLC). These phases are requirement analysis, system design, system development, system testing, and system improvement. Requirement analysis is the phase where the functionalities of the system are gathered, as well as all the necessary components that are used for the development of the system. System design is the phase where flowcharts and diagrams are created, as well as the initial design for the front-end and back-end of the system, such as Context Level Data Flow Diagram, Entity, and Program Flowchart Diagram. System development is the phase where all the requirements

and designs will be executed to create a system. System testing is where all the functionalities in the system are working properly. This is also the phase where the system is evaluated. Lastly, system improvement is where the problems discovered in the previous phase will be given a solution. This is also the phase where recommendations based on the previous project build will be discussed.

Output

In connection with the inputs and processes stated above, the output of the study is "Development of *UR*: A Mobile-Based 3D Event Place Visualization and Customization using Unity".

Operational Definition of Terms

The following definitions of operational words are provided for readers so that they can gain a deeper understanding of and become more familiar with the terms frequently referenced in the study.

1. **Mobile App**. is to provide users with a convenient platform to customize and visualize event spaces in 3D. The mobile-based nature of the application ensures accessibility and convenience, enabling users to manage event spaces from anywhere at any time.

2. **UR**. The 'UseR' system enables the customization of event design through the utilization of 3D objects. It provides users with a visual representation of the layout where they can interactively move objects within space.

3. **QA Testing**. Denotes the systematic process of quality assurance and testing methodologies applied to the mobile app, ensuring its functionality, reliability, and adherence to predefined standards and requirements, thereby guaranteeing a high-quality and error-free user experience.

4. **GLTF.** A glTF (GL Transmission Format) file is a 3D model file format used to store 3D models in a compact, efficient, and portable format. Khronos Group, an industry consortium dedicated to the creation of open standards for the authoring and acceleration of 3D graphics, created the glTF file format in 2015.

Chapter 3

METHODOLOGY

This chapter includes project design, project development, operations and testing procedures, and evaluation procedures. It provides a detailed description of the methods that will develop this mobile application.

Project Design

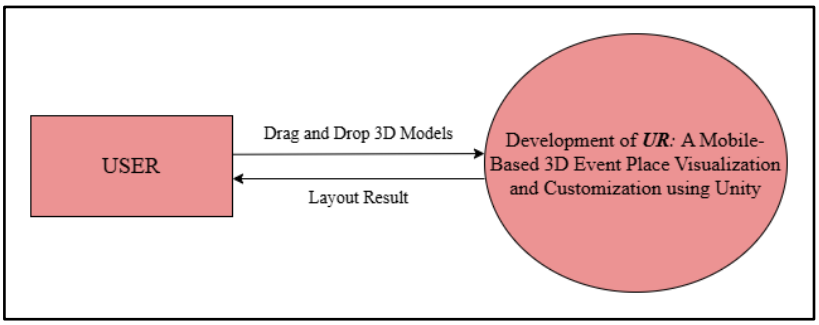

Figure 2. Context Diagram of UR Mobile App

The diagram visually shows the general system process of how it works. Figure 2 shows how it operates when using the "UR: A Mobile-Based 3D Event Place Visualization and Customization Using Unity" app. This figure demonstrates how users interact with mobile phones by dragging and dropping 3D models as they create their own customized event spaces. Through this process, users can visually arrange the event area in real time. The app then takes this information from the user into account. It presents a three-dimensional outcome that creates an engaging, interactive experience where one is almost immersed in the happenings themselves.

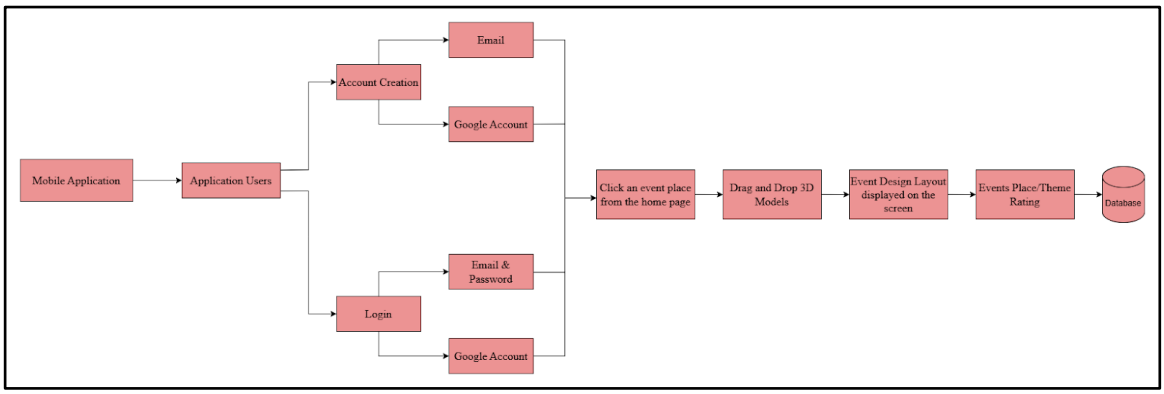

Figure 3. Block Diagram Flow of Application Users of the UR Mobile App

The mobile app "Development of UR: A Mobile-Based 3D Event Place Visualization and Customization using Unity" starts with a user journey which is created through the Account Creation stage, wherein users can either sign up by entering their email address, personal information, and password or go for the quicker option of Google Account authentication. Likewise, the User Login phase permits entry via email, password, or Google credentials. On logging in, users choose an event place from the home page where they may manipulate the 3D space by dragging models into it and editing them as well as zooming in and out on it. This is followed by displaying an event place layout designed along with its theme and rating. Lastly, all customization data is stored in a database for future reference and use.

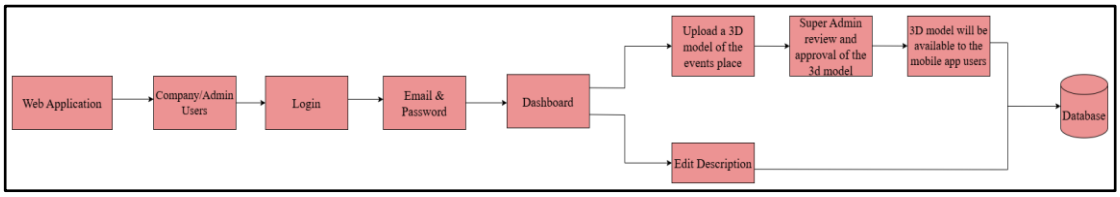

Figure 4. Block Diagram Flow of Company and Admin Users of the UR Mobile App

The UR Mobile App's block diagram shows the flow of Company users and Admin Users. The first step is that they must log in by filling out a login form that requires their email and password. The dashboard comes as a feature that provides an organized display of various information on each event place, including descriptions, comments, and ratings. Company users begin here by uploading 3D models of event places, upon which they are reviewed thoroughly to ensure quality and suitability. Once permitted, these 3D models can be accessed by users of the mobile application. This also enables company users to modify event place descriptions with the touch of a button where they update text, save the updates made, and see these changes instantly reflected across the mobile application. These interactions, along with data, are all retained as well as managed within the Database for a smooth dealing process plus easy retrieval by any Admin or mobile application user.

Project Development

This section outlines the progress made in the project and the complexities involved in the procedure that the researcher will use to develop the system. The procedure comprises six distinct phases, namely planning, requirements, designing, implementation, testing, and deployment. The project's progression begins with the identification of existing studies related to the construction of systems. This study was chosen from the three projects

that the researchers proposed. Subsequently, the researchers collected additional data that supported this study and created diagrams that assist in visualizing the structure of the system. To develop the project, Agile Software Development is employed. The researchers aim to construct and refine the project in a successful manner until the expected requirements and precision are achieved. The users will actively participate in this project by contributing feedback and ideas on how to enhance the system's performance.

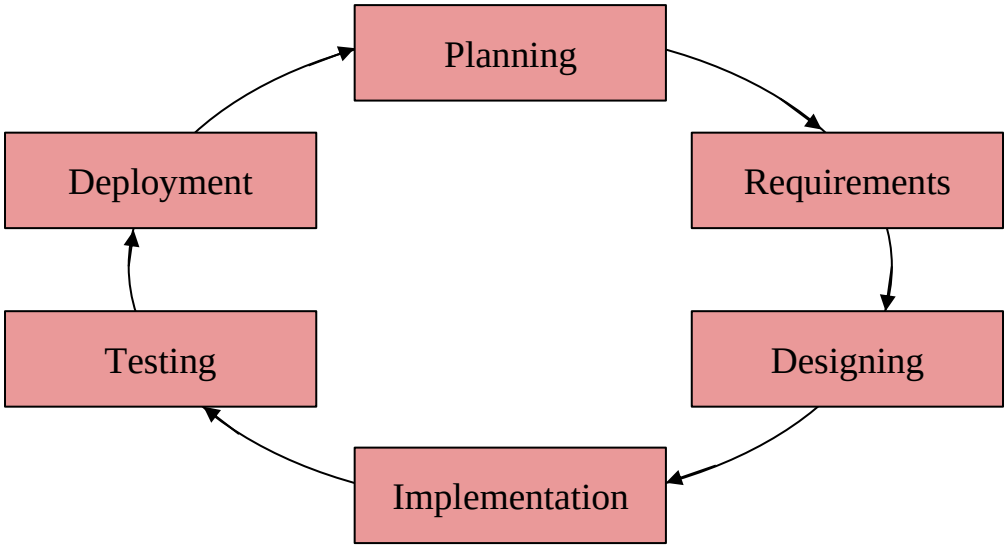

Figure 5. Agile Software Development

Planning. This initial phase defined the project scope, set clear objectives, and established priorities for the upcoming iterations or sprints. It involved identifying the key features or deliverables to be included in the product and determining the timeline and resources required to achieve them.

Requirements. These enabled users to customize the layout by dragging and dropping objects, visualizing 3D event layouts on mobile devices, and saving multiple custom layouts.

Designing. **The researchers** promoted iterative and incremental design practices, fostering collaboration among team members. Design decisions were made collectively, allowing for flexibility and adaptation as the project progressed. Prototypes were developed and refined continuously throughout the project, ensuring alignment with user needs and project goals.

Implementation. Teams executed the development process through short iterations or sprints. During each sprint, the team focused on implementing specific features or user stories, aiming to deliver working software by the end of the iteration. This iterative approach allowed for frequent feedback and adjustments, enabling the team to respond effectively to changing requirements and priorities.

Testing. A pre-delivery testing phase was conducted for the scanning of surroundings before it was sent to the server. The process involved a pre-evaluation to assess the system's error-free status and successful completion of debugging. Additionally, a series of tests and experiments were conducted to assess the system's consistency and accuracy in delivering results.

Deployment. During the development phase, the researchers conducted coding and software design. The system was developed in this phase using approved requirements and prototypes from the previous phase. This process was extensive, as researchers were engaged in developing and designing the fundamental aspects of the subject matter. The development phase concluded when the program was successfully designed based on accepted conceptual plans and any errors have been rectified.

Operation and Testing Procedure

Mobile application testing was applied to test if the mobile application functions performed as expected. The following tasks were done to properly use the *UR* mobile application and test if the intended features function properly:

1. Install the UR app on mobile devices.

2. Open the UR app, navigate to the event place section, and use the customization options to tailor the experience according to your preferences

Table 1. Operating and Testing Procedure of the UR Mobile Application (App User)

System Function	Procedure	Expected Output
1. Account Creation	Via Email: - User fills out the registration form with personal information, email, and password. - Click the "Register" button.	- Successful registration message/ notification. - User's account is created and stored in the system database.
	Via Google Account: - User clicks the button that redirects to Google's login form. - Users authenticate using their Google credentials.	- Successful authentication message. - User's account details (if new, create an account; if existing, link accounts) are stored in the system.
2. User Login	Via Email and Password: - User enters their email and password in the login form. - Click the "Login" button.	- Successful login message/notification. - Users gain access to their account features.
	Via Google Account:	- Successful authentication

	- User selects the Google login option. - Authenticates using Google credentials.	message. - Access to the user's account features.
3. Event's Place AR Visualization and Customization	- User clicks on an event's place from the home page. - Clicks a button to view the event's place, which opens the device's camera. - User points the camera around to explore. - Access to customization options.	- AR visualization and customization of the event place displayed on the screen.
4. Booking	- User selects a date and time from the calendar.	- Display calendar with color-coded dates: Green: Available Pink: Fully Booked Yellow: Pencil Booked
5. Rating Feature	- Users can provide ratings (stars, likes, comments) for the place.	- Updated ratings displayed for the specific event place on the home page. - Comments or feedback visible for users to see.
6. Help Center	- A list of FAQs is displayed. - The user can select a FAQ or use a "send-a-question" button to inquire.	- Access to FAQs for immediate assistance. - Ability to submit questions/inquiries and receive appropriate responses.

Table 2. Operating and Testing Procedure of the UR Website (Admin User)

System Function	Procedure	Expected Output
1. Account Creation	- Admin requests account creation. - Developer manually creates the admin account after approval.	- A form for admin requesting account creation. - Newly created admin account pending developer approval.

2. User Login	- User admin fills up the login form with their email and password.	- Successful authentication message.
3. Dashboard	- The dashboard provides a structured overview, presenting detailed information about various event locations. This includes descriptions, comments, and ratings, all organized within a tabular format for easy access and reference.	- The dashboard showcases a table layout containing detailed data about each event's place, including descriptions, comments, and ratings.
	- Admin clicks a button to edit the event's place description. - Admin updates the event's place text description and saves the changes. - Confirmation appears, acknowledging the successful update and reflecting the changes in the mobile app. If an error occurs during the update, the system displays an error message, asking the admin to retry the process.	- After editing and saving the description, a message confirms, "Description updated successfully. Changes reflected on the mobile app." - In case of an error during the update process, a message prompts the admin to try again, such as "Error updating description. Please try again." .
4. Event's Place 3D Manual Upload	- Admin clicks a button to upload a 3D model of the event's place. - Post-upload, a confirmation message indicates the successful upload and that the model is awaiting Super Admin review. - Super Admin reviews the uploaded model to ensure its quality. - Upon approval by the Super Admin, the system notifies the admin that the 3D model is now available for mobile app users.	- Upon successful upload, a message appears saying, "3D model uploaded successfully. Awaiting Super Admin review." - After Super Admin review and approval, another message displays, "3D model approved and now available for mobile app users."

Evaluation Procedure

Form the criteria-based assessment derived from the International Organization for Standardization/International Electrotechnical Commission (ISO/EIC) - 25010:2011 Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — System and software quality models which include the functional suitability, performance efficiency, and usability.

The assessment involves:

- **Functional Suitability**. This refers to the degree to which a system or product can do specific tasks that satisfy both explicit and implicit demands.

- **Performance Efficiency**. This refers to how the performance of the software is related to the number of resources that were used.

- **Usability**. This refers to how easily, successfully, and satisfactorily a system or product may be used to accomplish specific goals.

After determining the different characteristics that the system must comprise, the researchers:

1. Select (15) event designer and event planner (15) clients who will try and evaluate the system and its services.
2. The evaluation will contain the 3-point Likert Scale, as stated in Table 4.
3. Once the evaluation has been processed, the data will be tallied to acquire the mean rating per characteristic.

Table 3. Evaluation Form

SYSTEM EVALUATION (30%)		SCALE		
A. FUNCTIONAL SUITABILITY		1	2	3
1.1	The UR Application allows you to create event layouts using drag-and-drop features.			
	The UR Application correctly displays user login authentication status and messages.			
1.2	The UR Application accurately reflects the dimensions and proportions of event spaces.			
	The UR Application provides a useful dashboard layout for viewing detailed event location information.			
1.3	The UR Application offers realistic and 3D models of objects.			
	The UR Application appropriately facilitates the manual upload and approval of 3D models of event places.			
1.4	The UR Application allows users to easily move objects within the space.			
	The dashboard updates efficiently when the admin edits and saves event descriptions, immediately reflecting changes without lag.			

B. PERFORMANCE EFFICIENCY				
2.1	The UR Application loads quickly and operates smoothly on various devices.			
	The UR Application minimizes the time required for uploading and processing 3D models.			
2.2	The UR Application minimizes battery consumption on mobile devices.			
	The login procedure generally provides efficient authentication, facilitating user access without significant delays.			
C. USABILITY				
3.1	The UR Application interface is user-friendly and easy to navigate.			
	The UR Application offers a user-friendly process for admins to edit and update event place descriptions.			
3.3	The UR Application effectively adapts to different screen sizes and devices.			
	The UR Application's login form is easy to understand and use for admin users.			

3.3	The UR Application provides a cohesive and visually appealing user interface.			
	The UR Application's dashboard is user-friendly and allows easy access to event location details.			

Table 4. 3-point Likert's Scale

Scale	Adjectival/Descriptive Rating	Range
3	Highly Acceptable	2.5 - 2.99
2	Acceptable	1.5 - 1.99
1	Not Acceptable	1.0 - 1.49

Chapter 4

RESULTS AND DISCUSSION

This chapter presents the results and discusses the conducted study. It includes the project description, structure, capabilities and limitations, and test results and evaluation.

Project Description

The study developed a Mobile-Based 3D Event Place Visualization and Customization platform enabling users to virtually view and customize event layouts using 3D objects before the actual event. Constant internet access is needed to operate the mobile and web applications. The project was developed using the Flutter framework for the front end and Firebase for the back end.

Administrators are responsible for providing a dashboard displaying detailed data on each venue, including descriptions, comments, ratings, and the ability to upload 3D objects. To edit a place description, the administrator clicks a designated button, updates the text, and saves the changes. A confirmation message appears upon successful update, reflecting the changes in the mobile app. If an error occurs, the system prompts the administrator to retry the process with an error message. Administrators have the capability to set the dimensions of event spaces to suit specific requirements.

Users must install UR and Google Play Services for AR to view the layout. The platform features interfaces for Login, Homepage, and See Event Place. Users can create accounts via email or Google account on the Login Page. The Homepage displays company

information, venue details, and a color-coded calendar indicating availability and FAQs are conveniently located on the left side of the homepage for user inquiries. The View Place feature allows users to access customization options. The booking section is accessed by clicking on the preferred event location and displays a color-coded six-month calendar.

Project Structure

This project focused on these modules for the **Application user**: *Login or account creation, Homepage, Event Place, and Booking.*

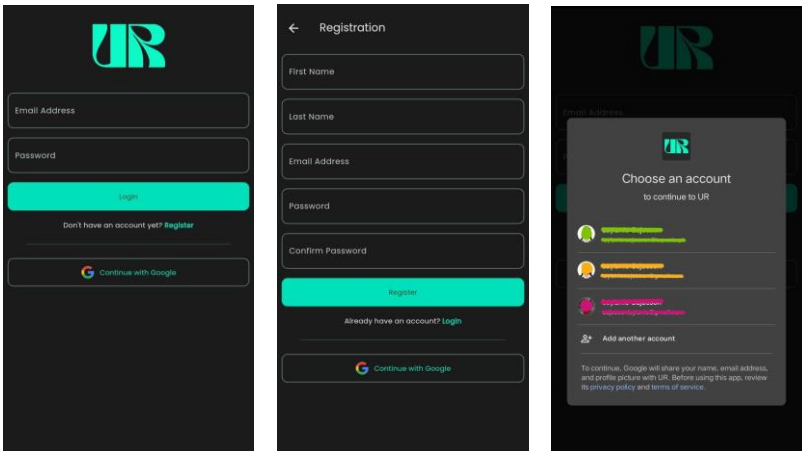

Figure 6. Login or Account Creation (User)

The Login or Account Creation displayed in Figure 5 shows the registration form for account creation and a redirected page where the mobile application asks the user to log in using a Gmail account of their choosing.

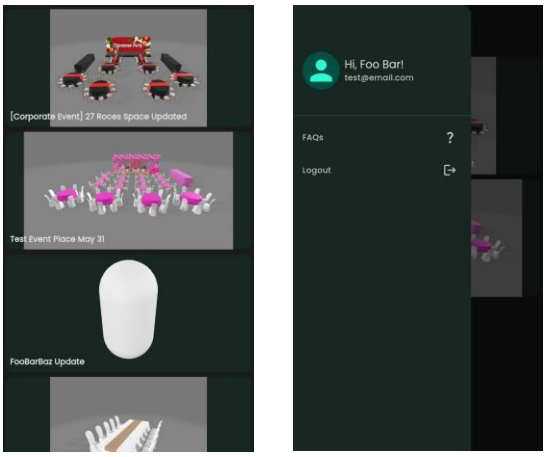

Figure 7. Homepage

The Home page displayed in Figure 6 serves as the primary interface that users interact with when they first open the mobile app.

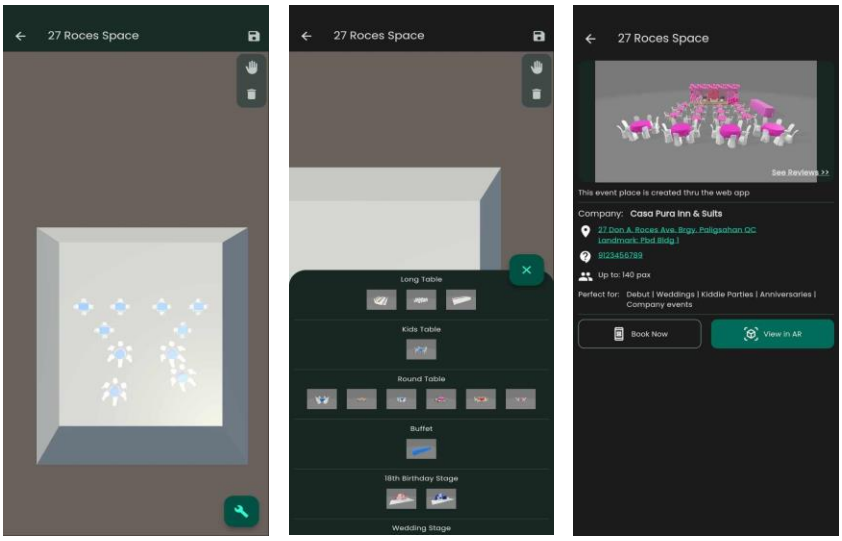

Figure 8. Event Place

The events place shown in Figure 7 enable users to virtually explore and customize event venues using 3D models before the actual event.

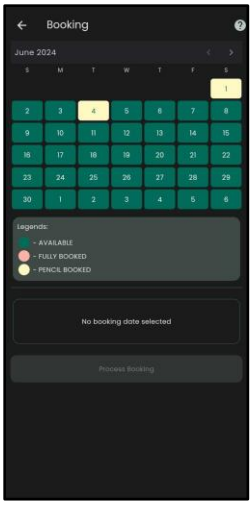

Figure 9. Booking

User views the availability calendar. The booking module shown in Figure 8 allows users to find and reserve event spaces quickly and efficiently.

This project would focus on the following modules for admin users: Login or account creation, Dashboard, and Event's Place 3D Manual Upload.

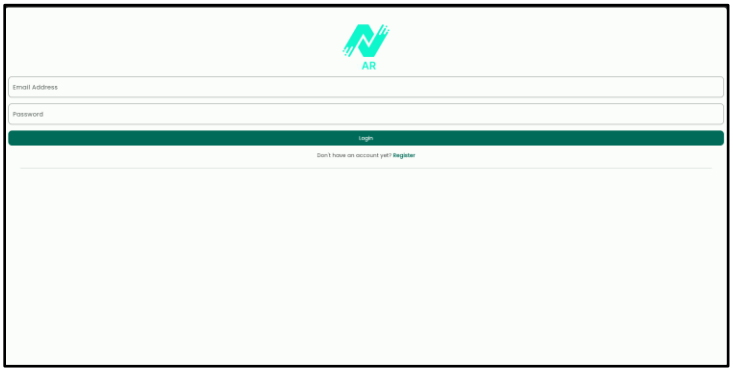

Figure 10. Login or account creation (ADMIN)

The Login Module displayed in Figure 5 provides seamless navigation through authentication processes, ensuring secure and personalized interactions with the website's functionalities.

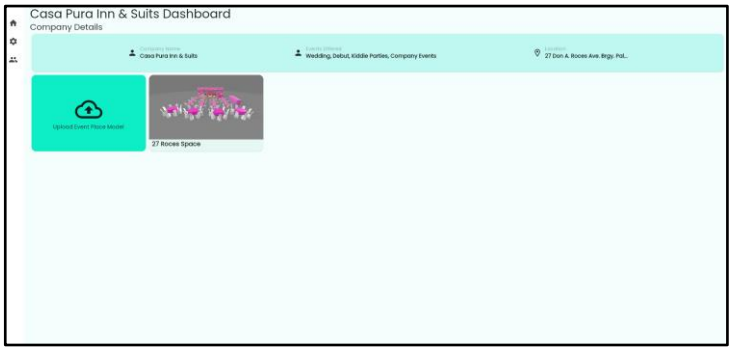

Figure 11. Dashboard

The Dashboards shown in Figure 9 serve as an effective way to present key information and metrics in a visually appealing and easily digestible format of the website for Admin User.

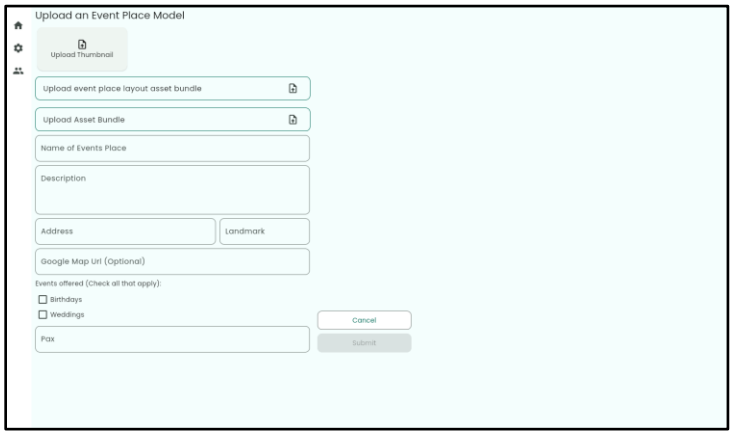

Figure 12. Event's Place 3D Manual Upload

The Event’s Place 3D Manual Upload shown in Figure 10 is designed to allow admin users to upload and manage 3D models or virtual representations of event spaces manually.

Project Capabilities and Limitations

The following are the capabilities of the system:

1. The mobile application permits users to inquire about the app.
2. The mobile application enables users to book their preferred event dates.
3. The mobile application allows users to create their desired layout using 3D objects.
4. The administrator has the capability to upload 3D objects on the website.
5. Users can create accounts in the mobile app, while companies are advised to do so on the website.

The following are the limitations of the system:

1. The application only works with specific supported Android devices.
2. The application will not have an inventory or budgeting system, as it will only concentrate solely on visual and conceptual aspects, neglecting logistical and financial considerations.

Test Results

The tables below show the testing procedure for each system function, including the steps undertaken during testing and the actual results. The actual results of the testing were compared to the expected results from the tables in Table 1. Operating and Testing Procedure of the UR Mobile Application (App User) and Table 2. Operating and Testing Procedure of the UR Mobile Application (Admin User).

Table 5. Operating and Testing Results of the UR Mobile Application (App User)

System Function	Procedure	Actual Output
1. Account Creation	Via Email: - User fills out the registration form with personal information, email, and password. - Click the "Register" button.	- The user's account has been successfully registered and is now stored in the system database.
	Via Google Account: - User clicks the button that redirects to Google's login form. - Users authenticate using their Google credentials.	- The system stores user account details, allowing users to create new accounts or link existing ones.
2. User Login	Via Email and Password: - User enters their email and password in the login form. - Click the "Login" button.	- The user has successfully logged in and is now able to access their account features.
	Via Google Account: - User selects the Google login option. - Authenticates using Google credentials.	- The user has successfully authenticated and has access to their account features.
3. Event's Place Visualization and Customization	- User clicks on an event's place from the home page. - Clicks a button to view the event's place, which opens the device's camera. - User points the camera around to explore. - Access to customization options.	- AR visualization and customization of the event place displayed on the screen.
4. Booking	- User selects a date and time from the calendar.	- Display calendar with color-coded dates: Green: Available Pink: Fully Booked Yellow: Pencil Booked

5. Rating Feature	- Users can provide ratings (stars, likes, comments) for the place.	- The home page displays the most recent ratings for the particular event location. Users can see any comments or feedback.
6. Help Center	- A list of FAQs is displayed. - The user can select a FAQ or use a "send-a-question" button to inquire.	- Access to FAQs for immediate assistance. Ability to submit questions/inquiries and receive appropriate responses.

Table 6. Operating and Testing Results of the UR Website (Admin User)

System Function	Procedure	Actual Output
1. Account Creation	- Admin requests account creation. - Developer manually creates the admin account after approval.	- A form for admin requesting account creation. Newly created admin account pending developer approval.
2. User Login	- User admin fills up the login form with their email and password.	- Successful authentication message.
4. Dashboard	- The dashboard provides a structured overview, presenting detailed information about various event locations. This includes descriptions, comments, and ratings, all organized within a tabular format for easy access and reference.	- The dashboard showcases a table layout containing detailed data about each event's place, including descriptions, comments, and ratings.
	- Admin clicks a button to edit the event's place description. - Admin updates the event's place text description and saves the changes. - Confirmation appears, acknowledging the successful update and reflecting the changes in the mobile app. If an	- After editing and saving the description, a message confirms, "Description updated successfully. Changes reflected on the mobile app." - In case of an error during the update process, a message prompts the

	error occurs during the update, the system displays an error message, asking the admin to retry the process.	admin to try again, such as "Error updating description. Please try again." .
3. Event's Place 3D Manual Upload	- Admin clicks a button to upload a 3D model of the event's place. - Post-upload, a confirmation message indicates the successful upload and that the model is awaiting Super Admin review. - Super Admin reviews the uploaded model to ensure its quality. - Upon approval by the Super Admin, the system notifies the admin that the 3D model is now available for mobile app users.	- Upon successful upload, a message appears saying, "3D model uploaded successfully. Awaiting Super Admin review." - After Super Admin review and approval, another message displays, "3D model approved and now available for mobile app users."

Project Evaluation

Table 7. Evaluation Responses from (15) Event Designer/Event Planner respondents

A. FUNCTIONAL SUITABILITY				B. PERFORMANCE EFFICIENCY		C. USABILITY			TOTAL
1.1	1.2	1.3	1.4	2.1	2.2	3.1	3.2	3.3	
3	3	3	2	2	2	3	3	3	24
2	3	2	2	2	2	3	3	3	22
2	2	2	2	2	2	2	2	2	18
2	2	2	2	2	2	2	2	2	18
3	3	2	2	2	2	2	3	3	22
2	2	2	3	2	2	3	3	3	22
2	2	2	2	2	2	2	2	2	18
2	3	3	3	2	2	3	3	3	24

2	3	3	2	2	2	3	3	3	23
2	2	2	2	2	2	3	3	3	21
2	3	3	2	2	2	3	3	3	23
2	2	3	2	2	2	3	3	3	22
3	2	3	2	2	2	3	3	3	23
2	2	3	2	2	2	3	3	3	22
2	3	3	2	2	2	3	3	3	23

In the event designer and event planner survey for functional suitability *(1.1)* question, scale 2 (Acceptable) received the majority of responses, with 12 out of 15 respondents selecting it. In contrast, scale 3 (Highly Acceptable) was chosen by 3 respondents. None of the respondents selected scale 1 (Not Acceptable). For the functional suitability *(1.2)* question, scale 2 (Acceptable) received the majority of responses, with 8 out of 15 respondents selecting it, whereas scale 3 (Highly Acceptable) was chosen by seven respondents. None of the respondents selected scale 1 (Not Acceptable). For the functional suitability *(1.3)* question, scale 3 (Highly Acceptable) received the majority of responses, with 8 out of 15 respondents selecting it, whereas scale 2 (Acceptable) was chosen by seven respondents. None of the respondents selected scale 1 (Not Acceptable). For the functional suitability *(1.4)* question, scale 2 (Acceptable) received the majority of responses, with 13 out of 15 respondents selecting it, whereas scale 3 (Highly Acceptable) was chosen by two respondents. None of the respondents selected scale 1 (Not Acceptable).

Performance Efficiency *(2.1)* question, scale 2 (Acceptable) received the majority of responses, with 15 out of 15 respondents selecting it. None of the respondents selected

scale 1 (Not Acceptable) or scale 3 (Highly Acceptable). Performance Efficiency *(2.2)*, scale 2 (Acceptable) received most responses, with 15 out of 15 respondents selecting it; none of the respondents selected scale 1 (Not Acceptable) or scale 3 (Highly Acceptable).

Usability *(3.1)* question, scale 3 (Highly Acceptable) received most responses, with 11 out of 15 respondents selecting it, whereas scale 2 (Acceptable) was chosen by four respondents. None of the respondents selected scale 1 (Not Acceptable). Usability *(3.2)* question, scale 3 (Highly Acceptable) received the majority of responses, with 12 out of 15 respondents selecting it, whereas scale 2 (Acceptable) was chosen by 3 respondents. None of the respondents selected scale 1 (Not Acceptable).

Usability *(3.3)* question, scale 3 (Highly Acceptable) received many responses, with 12 out of 15 respondents selecting it, whereas scale 2 (Acceptable) was chosen by 3 respondents. None of the respondents selected scale 1 (Not Acceptable).

Table 8. Evaluation Responses from (15) Client respondents

A. FUNCTIONAL SUITABILITY				**B. PERFORMANCE EFFICIENCY**		**C. USABILITY**			**TOTAL**
1.1	1.2	1.3	1.4	2.1	2.2	3.1	3.2	3.3	
3	2	3	3	3	2	3	3	3	25
3	3	2	3	3	2	2	2	3	23
3	3	3	3	2	3	3	2	3	25
2	2	2	3	3	3	2	3	2	22

2	2	3	3	3	2	3	2	3	23
3	3	3	2	2	3	2	3	3	24
3	3	3	3	2	3	3	2	3	25
3	2	3	3	2	3	3	2	2	23
2	2	3	3	3	3	2	3	2	23
2	2	2	2	2	2	3	2	3	20
3	2	2	3	2	2	2	3	2	21
3	2	3	3	3	2	3	3	3	25
2	2	3	2	3	2	3	3	2	22
3	3	2	3	3	2	2	3	2	23
3	2	2	2	3	3	2	3	2	22

In the client survey for functional suitability *(1.1)* question, scale 3 (Highly Acceptable) received the majority of responses, with 10 out of 15 respondents selecting it, whereas scale 2 (Acceptable) was chosen by five respondents. None of the respondents selected scale 1 (Not Acceptable). For the functional suitability *(1.2)* question, scale 2 (Acceptable) received the majority of responses, with 10 out of 15 respondents selecting it, whereas scale 3 (Highly Acceptable) was chosen by five respondents. None of the respondents selected scale 1 (Not Acceptable). For the functional suitability *(1.3)* question, scale 3 (Highly Acceptable) received the majority of responses, with 9 out of 15 respondents selecting it, whereas scale 2 (Acceptable) was chosen by six respondents.

None of the respondents selected scale 1 (Not Acceptable). For the functional suitability *(1.4)* question, scale 3 (Highly Acceptable) received the majority of responses, with 11 out of 15 respondents selecting it, whereas scale 2 (Acceptable) was chosen by four respondents. None of the respondents selected scale 1 (Not Acceptable).

For the performance efficiency *(2.1)* question, scale 3 (Highly Acceptable) received the majority of responses, with 9 out of 15 respondents selecting it, whereas scale 2 (Acceptable) was chosen by six respondents. None of the respondents selected scale 1 (Not Acceptable). Performance Efficiency *(2.2)*, question, scale 2 (Acceptable) received the majority of responses, with 8 out of 15 respondents selecting it, whereas scale 3 (Highly Acceptable) was chosen by seven respondents. None of the respondents selected scale 1 (Not Acceptable).

Usability *(3.1)* question, scale 3 (Highly Acceptable) received the majority of responses, with 8 out of 15 respondents selecting it, whereas scale 2 (Acceptable) was chosen by seven respondents. None of the respondents selected scale 1 (Not Acceptable). Usability *(3.2)* question, scale 3 (Highly Acceptable) received the majority of responses, with 9 out of 15 respondents selecting it, whereas scale 2 (Acceptable) was chosen by six respondents. None of the respondents selected scale 1 (Not Acceptable). Usability *(3.3)* question, scale 3 (Highly Acceptable) received the majority of responses, with 8 out of 15 respondents selecting it, whereas scale 2 (Acceptable) was chosen by seven respondents. None of the respondents selected scale 1 (Not Acceptable).

The evaluation results from the 30 respondents are equal to 22.3 mean points. Dividing the respondents between event designers and clients, event designer respondents

have a total mean score of 21.6 or 22. Meanwhile, the client respondents have a 23 total mean score.

Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATION

This chapter provides a concise summary of the research findings, draws conclusive insights, and offers recommendations for future studies on the Development of UR: A Mobile-Based 3D Event Place Visualization and Customization using Unity.

Summary of Finding

The *"Development of UR: A Mobile-Based 3D Event Place Visualization and Customization using Unity"* underwent assessment through feedback gathered from 30 participants, including designers and clients. The system got an average total mark of 22.3 points, which shows that it was accepted due to its features and functions. Event designers gave a mean rating of 21.6 or exactly more than 22 points in terms of usefulness while specifying that some improvements must be made, especially in the areas concerning professionalism and logistics. On the other hand, clients had an average score of 23, which indicated its appropriateness to them, considering all their needs. Feedback is timelier through a user-friendly interface, customization, and visualization.

The total average score of 22.3 points indicates a generally positive reception of the *"Development of UR: A Mobile-Based 3D Event Place Visualization and Customization using Unity"* by clients who showed eagerness towards it despite their specific attachment to some aspects more than others. However, they had a strong affinity with certain aspects above the others. The significant variance in the scores says that, while the clients were impressed with the visual and interactive features, the designers perhaps expected even

more in-depth planning skills.

Conclusions

This study has successfully addressed its specific objectives by designing and developing *"Development of UR: A Mobile-Based 3D Event Place Visualization and Customization using Unity"* with simple drag-and-drop tools with 3D objects in order to actualize events. Detailed event layouts can be made by users with the ability to add and manipulate 3D objects, and they are able to see their designs from a top-down view so that they are well-planned before the execution date.

The features of the system include vast customization options for event layouts, user registration and account creation, feedback and review systems, and security protocols. Google Account integration with Email Authentication ensures that user information is secure while at the same time offering a support/help center where resources for navigating through the platform efficiently are provided.

The implementation of the system technically uses a blend of development tools, Unity, C#, Flutter and Firebase, these are key to creating a system that works well and can be relied upon and assessed for functionality and reliability. The use of this technology ensures that the system is not just effective but also efficient plus easy to use.

The evaluation of the prototype system based on ISO 25010 criteria, which are functional suitability, performance efficiency, and usability, shows some level of acceptance. The fact that it meets these standards demonstrates its effectiveness, indicating a possible acceptance in the event planning business. This study not only proves the feasibility and benefits of such a system but also lays the way for future advances in this

field, promoting innovation and bringing in new waves of solutions aimed at enhancing design aspects for event developers, among other things.

Recommendation

The purpose of this system is to enable designers to simply customize and visualize event layouts. It helps designers to talk effectively with clients and show them what the event should look like in real-time. Based on the researchers' experience, the comments and suggestions below seek to provide valuable insights for future studies.

1. ***Integrated Booking:*** The booking process can be completed within the app instead of being redirected to external platforms such as Google Forms, making it more comfortable and easier.
2. ***Finance and Payment:*** Add options that enable customers to pay directly through the app, speeding up transactions and improving planning.
3. ***Clear Event Layout Images:*** Offer high-quality images of user-created event layouts so users can easily see how they arranged their spaces and make appropriate choices.
4. ***Advanced customization:*** Let there be an inclusion of lighting, furniture arrangement and color schemes among other options for customization which will give customers greater control over how their events are organized.

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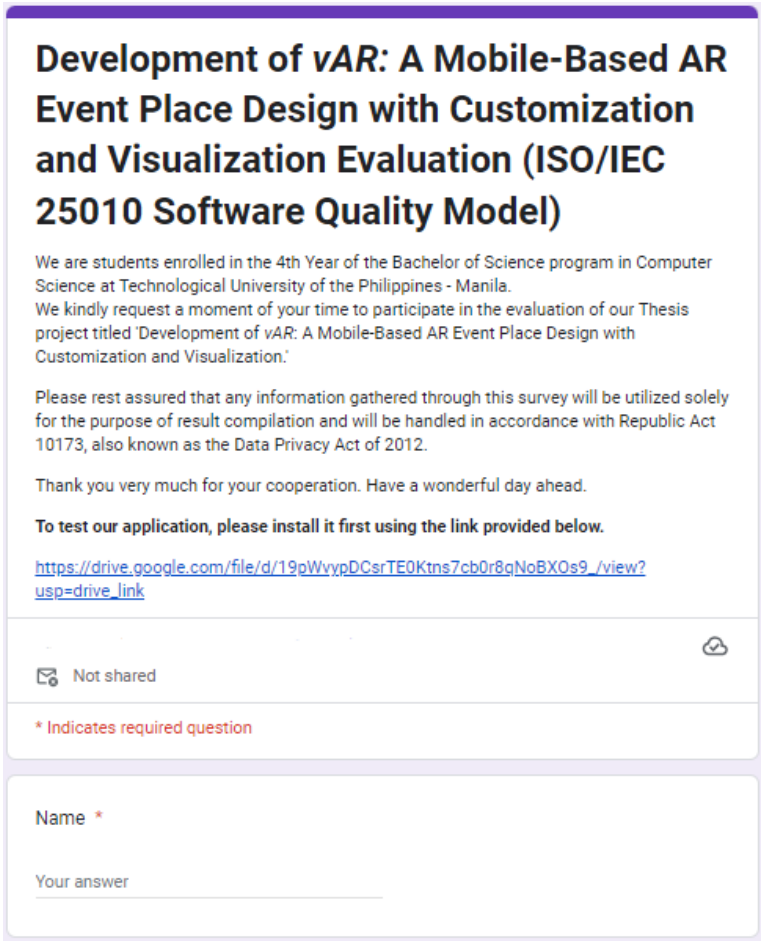
APPENDIX A

Survey Questionnaire Form

Client Form



Development of *vAR*: A Mobile-Based AR Event Place Design with Customization and Visualization Evaluation (ISO/IEC 25010 Software Quality Model)

We are students enrolled in the 4th Year of the Bachelor of Science program in Computer Science at Technological University of the Philippines - Manila.
We kindly request a moment of your time to participate in the evaluation of our Thesis project titled 'Development of *vAR*: A Mobile-Based AR Event Place Design with Customization and Visualization.'

Please rest assured that any information gathered through this survey will be utilized solely for the purpose of result compilation and will be handled in accordance with Republic Act 10173, also known as the Data Privacy Act of 2012.

Thank you very much for your cooperation. Have a wonderful day ahead.

To test our application, please install it first using the link provided below.

https://drive.google.com/file/d/19pWvypDCsrTE0Ktns7cb0r8qNoBXOs9_/view?usp=drive_link

Not shared

* Indicates required question

Name *

Your answer

A. FUNCTIONAL SUITABILITY

1.1 The UR Application allows you to create event layouts using drag-and-drop features. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

1.2 The *UR* Application accurately reflects the dimensions and proportions of event spaces. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

1.3 The UR Application offers realistic and 3D models of objects. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

1.4 The UR Application allows users to easily move objects within the space. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

B. PERFORMANCE EFFICIENCY

2.1 The *UR* Application loads quickly and operates smoothly on various devices. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

2.2 The *UR* Application minimizes battery consumption on mobile devices. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

C. USABILITY

3.1 The UR Application interface is user-friendly and easy to navigate. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

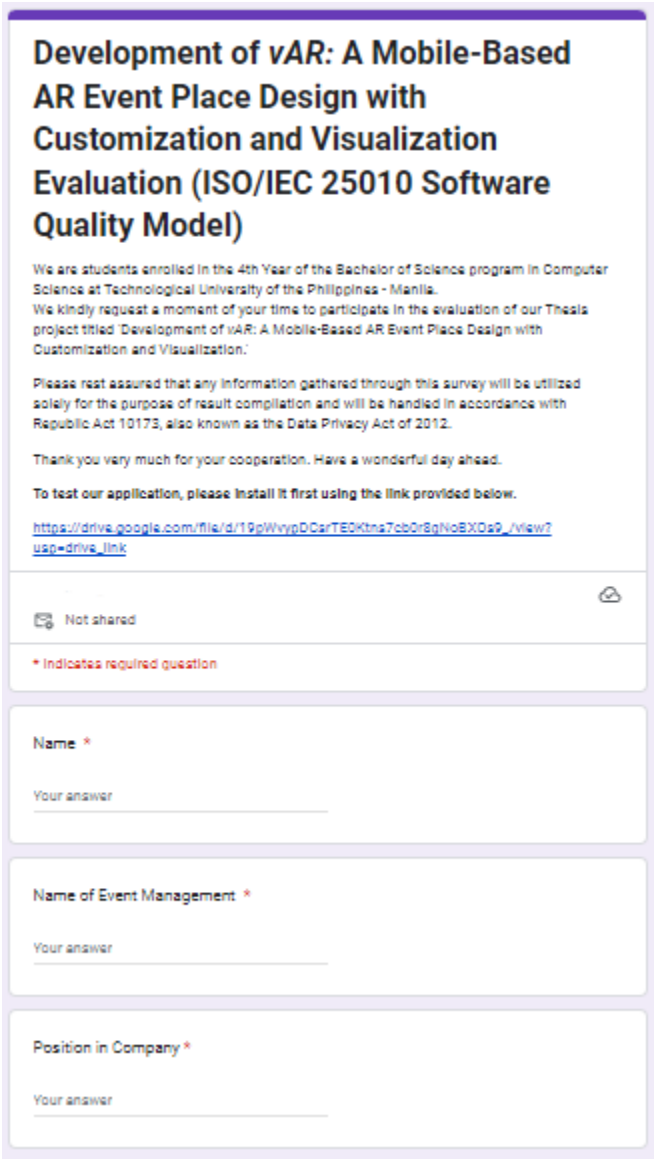
3.2 The UR Application effectively adapts to different screen sizes and devices. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

3.3 The UR Application provides a cohesive and visually appealing user interface. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

Event Designer or Event Planner



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https://drive.google.com/file/d/19pWvypDCsrTE0Ktns7cb0r8gNoBXDs9_/view?usp=drive_link

Not shared

* Indicates required question

Name *

Your answer

Name of Event Management *

Your answer

Position in Company *

Your answer

A. FUNCTIONAL SUITABILITY

1.1 The UR Application correctly displays user login authentication status and messages. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

1.2 The UR Application provides a useful dashboard layout for viewing detailed event location information. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

1.3 The UR Application appropriately facilitates the manual upload and approval of 3D models of event places. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

1.4 The dashboard updates efficiently when the admin edits and saves event descriptions, immediately reflecting changes without lag. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

B. PERFORMANCE EFFICIENCY

2.1 The UR Application minimizes the time required for uploading and processing 3D models. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

2.2 The login procedure generally provides efficient authentication, facilitating user access without significant delays. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

C. USABILITY

3.1 The UR Application offers a user-friendly process for admins to edit and update event place descriptions. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

3.2 The UR Application's login form is easy to understand and use for admin users. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

3.3 The UR Application's dashboard is user-friendly and allows easy access to event location details. *

	1	2	3	
Not Acceptable	○	○	○	Highly Acceptable

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THESIS GRAMMARIAN CERTIFICATION

This is to certify that the thesis entitled,

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authored by

Eyvind Zach S. Balasta
Mark R. Cabalona
Laylanie C. Cajucson
Amelia F. Lamera
Shelimiah A. Suson

has undergone editing and proofreading by the undersigned.

This Certification is being issued upon the request
for whatever purposes it may serve them.

JENNIFER P. ALINSUNOD, CHRA, LPT
Grammarian

Technological University of the Philippines

June 13, 2024

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Mark R. Cabalona
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College of Science

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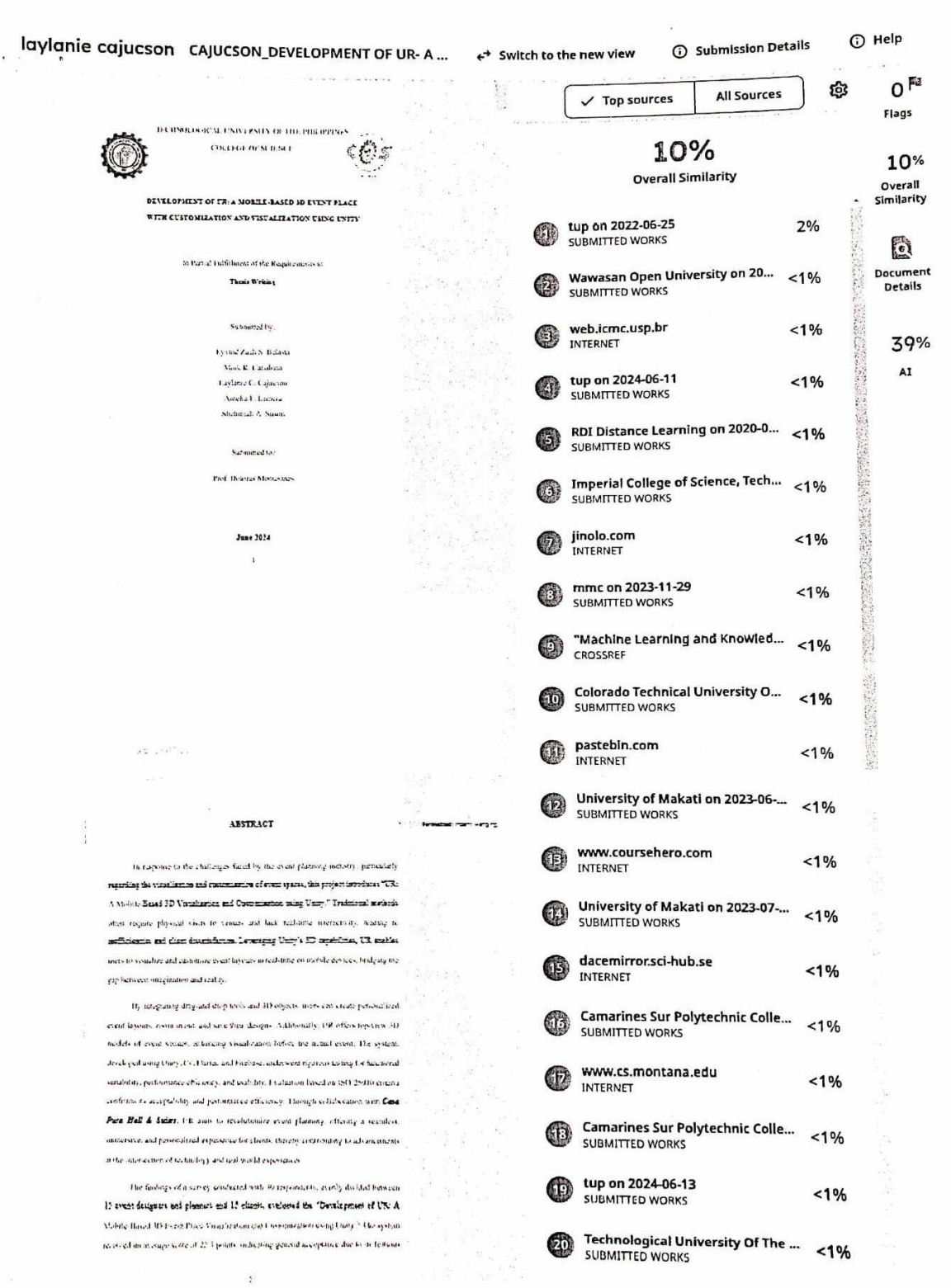
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- Knowledgeable in web development and mobile development.

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  - June-July 2022
- Election System (Dart Application)
  - Developer
  - January-February 2023

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