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Recalling the Position of the Vehicles in IOI City Mall Parking

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ABSTRACT

This study addresses the practical challenge users face in locating parked vehicles within large shopping malls, focusing on IOI City Mall, Malaysia. The selection of IOI City Mall is supported by documented user complaints and media reports highlighting frequent difficulties in recalling vehicle positions due to its extensive parking capacity of over 16,600 bays. A prototype navigation system has been proposed and developed using Blender software to simulate guided pathways within selected basement zones of the mall. Due to technical and privacy constraints, the project shifted from initial plans involving number plate data management to a focus on parking bay navigation. The approach employs qualitative methods, including interviews with parking management personnel, site visits, and expert evaluation involving four professionals with relevant experience. The Blender-based prototype offers 3D visualization and custom pathway navigation to guide users effectively to their parking spots. Expert feedback, summarized thematically around usability, design, and scalability, praises the innovative user interface but recommends enhancements such as real-time updates and interactive elements. This research contributes a foundational simulation model for parking navigation, outlining a roadmap for integration with existing systems. Limitations include the prototype nature of the application and the absence of live user testing, which are proposed areas for future research.

Keywords: Recalling, Position, Vehicles, Locates**.**

1. INTRODUCTION

Car locators are now essential worldwide, especially in public areas like shopping malls and airports with massive car parks and parking lots. For that scenario, most buildings that build indoor parking areas have multi-storey and basement parking areas. Multilevel indoor parking lots are the only solution to reduce city congestion [1]. A lot of parking areas will lead to a challenge, in that there is a situation where users will forget where they parked their cars. In the worldwide scenario, car locators are now a part of the intelligent component of innovative

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parking systems. Now, more examples of intelligent parking systems are introduced, such as innovative parking maps, signage, smart vehicle detectors, innovative payment and meters, and the License Plate Recognition (LPR) system in smart parking technology [2].

Car locators are a valuable topic for discussion among the public and researchers because they offer many advantages through the application of vehicle tracking technology. Due to the rapid technological shift from traditional to smart parking systems 4.0, this topic remains highly relevant [3]. In Malaysia, many parking areas implement smart parking systems, especially in shopping malls. However, in terms of the advanced parking system, only a few places have the advanced one, which makes others far behind the trendy parking system. IOI City Mall was selected as the study site due to its status as Malaysia's largest mall with over 16,600 parking bays, extensive basement parking, and the presence of smart parking technologies such as LPR and car finder machines. Moreover, as highlighted by several publicized user complaints and social media discussions [4], it is evident that many visitors have trouble recalling vehicle locations within the large, multi-zone parking structure. These issues represent challenges that many large retail complexes face, making IOI City Mall an ideal case study location. This indicator reveals that IOI City Mall remains a trending topic in the media because many users frequently mention forgetting where they parked their cars, a common issue at the mall [4].

The problem is that the majority think that having more parking spaces is better. As a result, too many parking spaces contribute to poor management of parking facilities. As the number of parking spaces is massive, issues happen when users forget where they park their cars [5-8]. The problem is more significant when there is confusion among the users, as there are many parking spaces, and the parking space design is almost the same at every level and zone. A preliminary study and site visit at IOI City Mall showed weaknesses in the existing car locator system. The result shows the system fails during upgrades, providing only zone-level data without precise parking positions, and leading to struggles to guide users to vehicles on different levels. The system cannot accurately capture license plates of fast-moving vehicles or those traveling in the wrong direction unless there is a specific camera to do so [9]. These issues lead to user frustration and inefficiency in vehicle retrieval.

This study identifies existing applications and vulnerabilities of the system at IOI City Mall through interviews, builds an application for managing number plate data to assist vehicle relocation using Blender, and evaluates the new application's effectiveness through expert reviews. This study only covers the application layer due to the limited cost to implement other hardware and infrastructure, the surface layer of the car finding system in IOI City Mall, and those related to managing number plate data, changing to navigating using parking numbers due to the inevitable thing that occurs.

At the end of this study, the study aims to help users locate their parked vehicles. Specifically, to achieve that aim, this study will discuss the existing applications utilized for vehicle management at IOI City Mall and what vulnerabilities are identified within these systems. The second thing it will provide is information on how to develop a new application to manage number plate data for relocating vehicles effectively, and what features it should incorporate to enhance user experience. Finally, what metrics will be used to evaluate the effectiveness of the newly implemented application in improving vehicle management at IOI City Mall will also be discussed.

Despite the current use of sophisticated systems, several vulnerabilities remain, such as network congestion during peak times, difficulty recognizing electric vehicle plates, and exit congestion. A clear research gap exists in developing an accessible, user-friendly navigation tool that integrates real-time parking location information and enhances user experience in multi-level, zoned parking environments. This study aims to fill this gap by designing a navigation application prototype demonstrating the feasibility of a parking bay-based locating system, compared to existing license plate tracking methods, which face practical limitations in this context.

2. METHODOLOGY

Three methods are related to this study. All the methods use the qualitative approach to get the result. The first method is to obtain information about the project by conducting a preliminary study to investigate the case and find a correlation with the study topic. In this part, a site visit and simple interviews were conducted to get to know the information and weaknesses of the system in the IOI City Mall. Further detailed information is obtained using the second interview via email with the Car Park Department. In the second method, the focus is more on creating an application layer using Blender. The application system is easy and tricky to develop, but it can be done with the help of the Revit 3D model. Research also needs expert reviews to get feedback and opinions from users for future improvement regarding the application's performance and development. To carry out this research, the flow chart in Figure 1 visually represents the steps and decisions involved in a process, helping identify improvement areas.

2.1 Preliminary Study

A preliminary study was conducted to understand the situation before primary research. It is a small-scale investigation to understand the situation before conducting the primary research. It serves as a method to achieve the initial objective of the study, which is to identify the existing applications and vulnerabilities of the system. Due to limitations such as privacy and company policies that restrict access to the parking system at IOI City Mall, an alternative approach was adopted. This involved interviewing with a facility management team member, a site visit, and observation of the parking area.

2.1.1 Interview 1

An interview was conducted with a specialist member from the IOI City Mall to get a clear view of the parking system. The purpose of the interview was to get information about the existing parking system in the mall, to understand briefly how the system works, and to find out the weaknesses of the system based on observations. Miss Lou Isa Song was chosen as the only respondent because her position as a member of the facility management team in the organization parallels the scope of the field.

2.1.2 Site Visit and Observation

This site visit occurs in the parking section and is more of a question-and-answer session [10]. The purpose is to determine how the parking system process works and what existing system is available at IOI City Mall. The other purpose of the visit is to observe, interact, and collect data directly from the site, enabling a deeper understanding of the car locator system. Before the visit, permissions were necessary to obtain the excess and the visit schedule with the person in charge. When the date was set, a site visit was conducted to gather first-hand information about the physical environment, processes, and people involved. The physical environment is based on parking areas 1 and 2, some ground sections, and central access, while the department is correlated with parking management, and the system is the car park center.

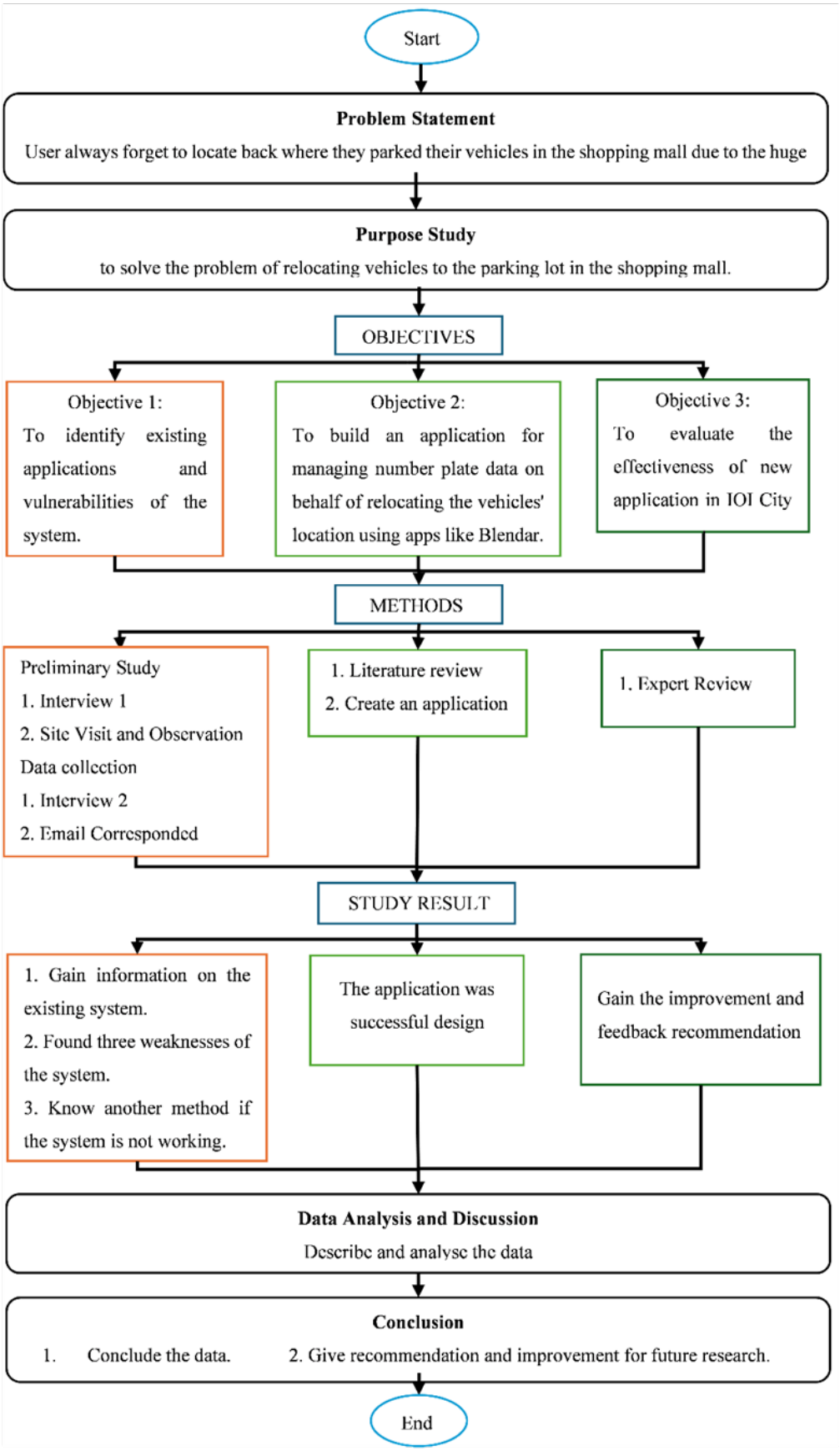


Figure 1: Flow chart of the study.

2.2 Data Collection

This is a follow-up regarding the preliminary study, as it provides good insight into the existing parking system at IOI City Mall. This phase also starts with the second interview to gain more specific information regarding the system. This second round of interviews is designed to delve deeper into aspects of the parking system, addressing any gaps identified during the preliminary study and ensuring a comprehensive understanding of the system's functionalities and vulnerabilities.

2.2.1 Interview 2

The interview was conducted with Ms. Nora, a car park department administrator who manages the parking system. The interviews and communication are undertaken entirely via email, allowing for the efficient exchange of information and clarification of any queries related to the parking system. Throughout this email correspondence, several specific questions exist to understand the system's specifications, user feedback mechanisms, and operational challenges for the car park.

2.3 Software Application

A platform or software must be used to create a design system. In a previous study, Java is a significant platform software with the first programming language that is easy to learn and that most systems and applications, such as smartphones and computers, use to create the project's design [11]. Until now, the Java platform has also been used to study license plate detection [12]. The Java platform was used to locate the parked car in the multi-storey building [6]. The Java platform was also used to develop and implement the parking system capacity information system on Android and the Web [5]. For this study, Blender chose to achieve the second objective of building an application for managing number plate data to relocate the vehicles' location using apps like Blender. Blender is a selected application as it is an excellent choice for navigation projects for several reasons that make it easy and effective. Blender can link with Revit, allowing users to seamlessly import 3D models and work with existing data.

Furthermore, Blender-based application shows strong potential as a tool for simulating and designing parking navigation and routing paths. Good software development can turn it into a real-time interactive system by connecting it with live data using APIs or custom plugins [6]. This upgrade would need teamwork between software developers, system integrators, and parking management to create a platform that combines Blender's 3D visuals with operational backend systems. Such collaboration would help expand the prototype into a practical tool for planning and managing parking efficiently without complex technical barriers in language.

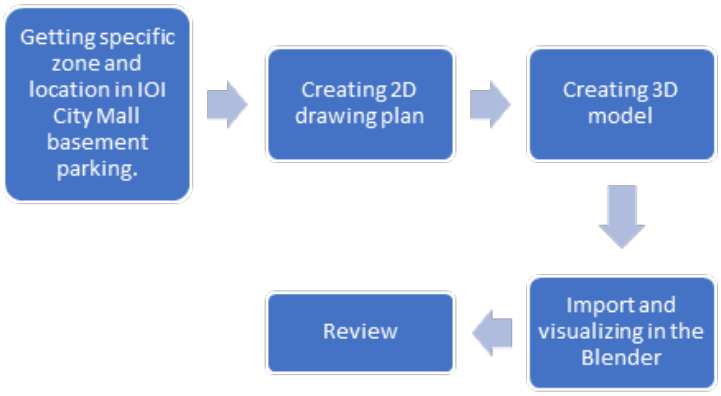


Figure 2: Flow chart for creating the application.

Figure 2 is a flow chart for creating the application. To make the application in Blender, the first step is starting with getting the specific zone and location to design and the utilized places in Parking 1 Zone E and G. When the area has been identified, the next step is creating the 2D drawing of the floor plan parking layout using AutoCAD version 2024. The parking floor plan can be seen in Figure 3. The car park with red colour stands for Zone E, while the blue stands for Zone G.

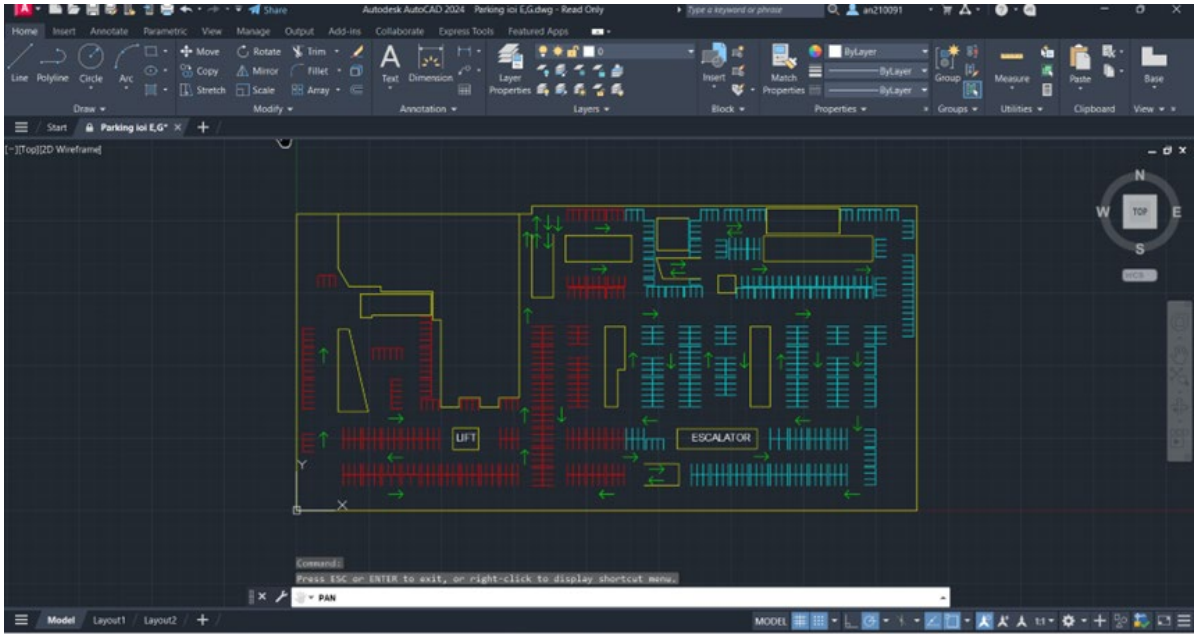


Figure 3: Floor plan parking Zone E and G.

After creating the 2D floor plan, it is time to generate a 3D model to visualize the parking area. This time, the Software Revit 2024 is utilized to show the model shape. This time, take a few steps to ensure that you can do the 3D. The step should start with opening the file and linking it to the AutoCAD drawing plan, as it is a reference in the 3D model. Once the drawing is connected, adjust the settings and measurements, naming the file. Ensure all units are consistent and clarified with design requirements. Next, insert the component, such as the floor, in the floor plan, and make sure it is positioned as an overlay from the 2D drawing to maintain the alignment. Insert the wall component. Then, the last one enters the parking component. Ensure the parking component is edited with the correct measurement for the width of 2.4 meters and the length of 4.8 meters. At the end of the modeling, the 3D design can be done, as shown in Figure 4.

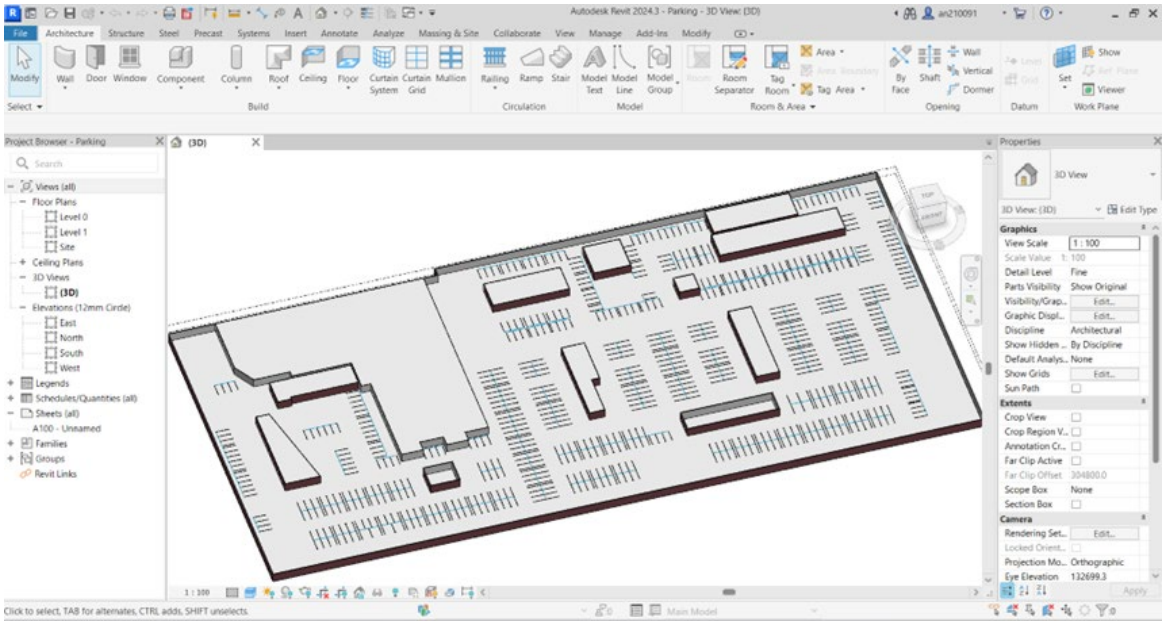


Figure 4: 3D Revit modelling.

The last thing is to move to the critical part, which is to import the 3D design into Blender for simulation and visualization. The Blender also has the command to ensure that it can do the simulation. The command for importing a Revit model can be followed by opening Blender and selecting the file format. The format must be in an RVT file, which means Revit. Import and adjust the import settings. Switch to the material preview mode. This is to look at the model regarding material and texture performance. This can be done by switching the solid mode to material preview mode and identifying the missing texture, as it will always occur when the file link is incorrect. Access the material properties, select the model, and navigate it. Relink the texture by clicking the texture node and the shader editor. Edit other material needs, such as color, text, and number. Lastly, preview the changes. The final look at some parts of the zone with paths and navigation can be seen in Figure 5. Finally, the application is ready to be reviewed.

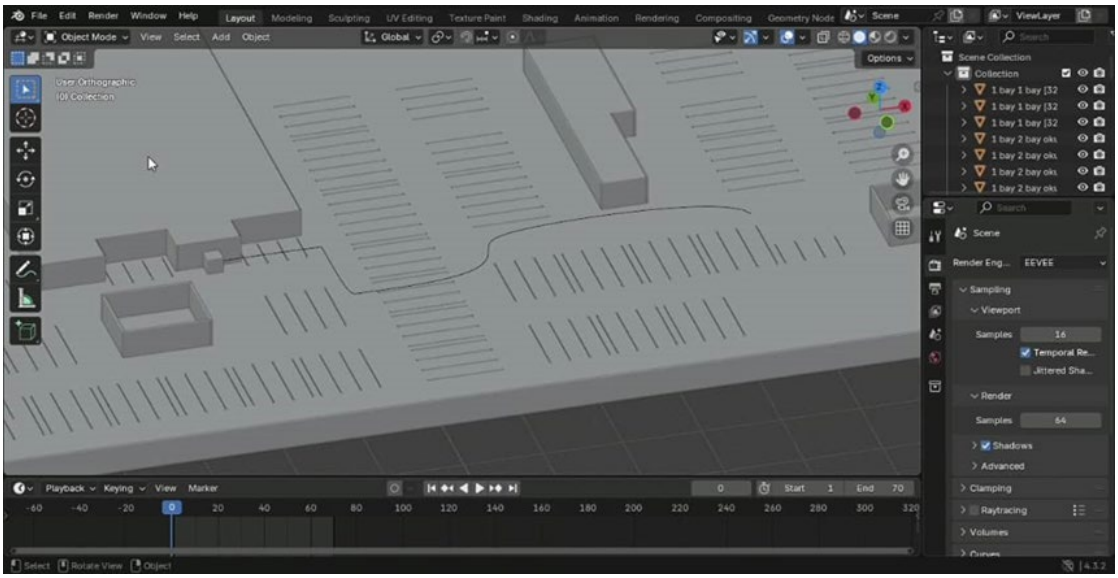


Figure 5: Navigation in Blender in some parts of the zone.

2.4 Analysis of the System

To achieve the third objective, which is to evaluate the new application's effectiveness in IOI City Mall, collecting feedback from the expert review is the way to determine the effect of the latest application. Collecting feedback and review from the expert is very important when collecting data because of the cost and time effectiveness. Other than that, it is the only way to get real-time data in a convenient and accessible way.

2.4.1 Collecting Expert Feedback

The research will gather insights from at least three and a maximum of eight experienced professionals, each with at least two or three years in their field, focusing on freelancers. In some cases, eight experts needed to review a therapeutic guided imagery therapy mobile application, with six having consistent reviews to show success [13]. According to [14], it is stated that about three to five people with three years of experience in the relevant field conduct an expert review on mobile augmented reality applications for language learning, and it is an ideal number to gather knowledge and get recommendations [15-16]. The process will start by defining the review's goals and developing key questions to guide the feedback. Next, suitable freelancers will be identified to ensure a diverse range of expertise. Their comments will be collected, and once gathered, the responses will be analyzed and categorized based on expert review. This structured approach evaluates the new application's effectiveness and identifies areas for improvement.

For this paper, expert review was conducted with four professionals possessing two to four years of relevant experience in industrial engineering, electronic engineering, and computer systems. While the number of interviewees and experts was limited, this approach was appropriate for evaluating an early-stage prototype developed using Blender software.

3. RESULTS AND DISCUSSION

This section will show the interview results and detail the existing car-finding system in IOI City Mall. The details of the car finder system include the number of the car finding machines provided with the exact location. Besides that, the Blender application has already built a layer for navigating parking numbers. The application layer is ready to be reviewed by the expert. A review based on the experts' feedback and recommendations will be conducted to determine the new application's quality. At the end of the study, it is expected to provide a good solution for those who constantly forget to locate parked vehicles.

3.1 Overall Insight Identifying Existing Applications and Vulnerabilities

The IOI City Mall parking is well occupied with highly advanced designated technology for vehicle management and user experience. IOI City Mall is using Jieshun product, a supplier and expert in smart parking & and access control, positioning number one in the parking industry in China. These findings align with previous research and highlight the importance of comprehensive technological solutions in large-scale parking facilities. For instance, previous researchers emphasized the integration of smart vehicle detectors, payment systems, and license plate recognition as crucial components of modern parking systems [2]. Similarly, other researchers noted the trend toward adopting smart parking systems in shopping malls to enhance management effectiveness [3].

According to Ms. Nora, the administration of the car park department, this mall is equipped with 23 car-finding machines located at all entrances on the route to the mall and underground parking entrances. Also, car-finding machines are situated on various wings and levels. Ms. Nora also stated that can find the car-finding machine in each zone, which is zones A, B, C, D/E, F, G, H/LG,

C/LG, D/Level 1,2,3/LG, H, LG, G. To make sure that this car-finding machine can capture and record the vehicle's data, which is a number plate, LPR is also implemented in this parking system. It was captured by 3,360 total camera installations in this parking building, with 1,990 cameras in phase one and 1,370 units in phase two. This camera records the car once parked and the live parking. The zone controller controls all the cameras.

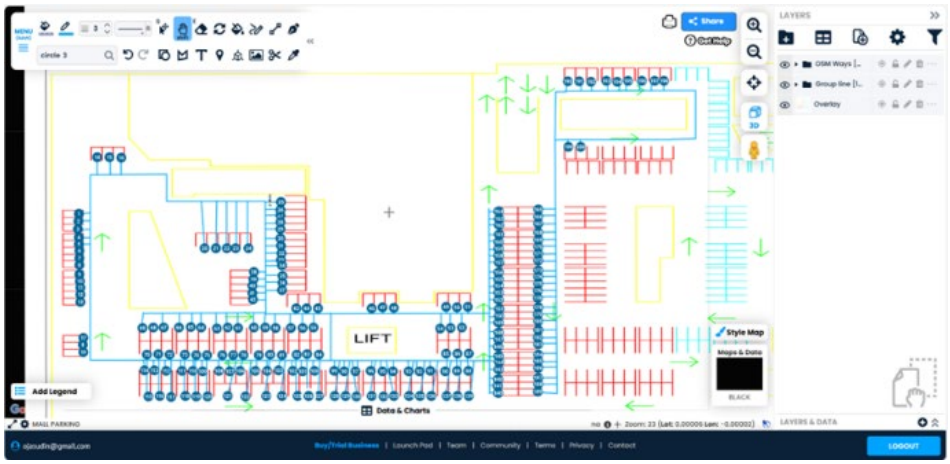
To maintain the system's optimal functioning, Ms. Nora stated that it would be updated or maintained weekly to ensure accuracy and reliability by level or zone. If the user cannot find their car, they can directly ask at the information center. However, the user has reported three significant weaknesses of the system. The first one is that the network slows down during usage. Other than that, there is the inability to capture new EV number plates and some unique words. The problem with EV plate recognition aligns with ongoing challenges in adapting ANPR systems to new number plate designs [17]. Lastly, congestion at exits occurs during weekends when many customers leave simultaneously. These issues reflect the challenges identified in previous studies. For example, it discussed similar difficulties in managing high volumes of vehicles in shopping mall parking areas [5].

3.2 Software Finding and Analysis

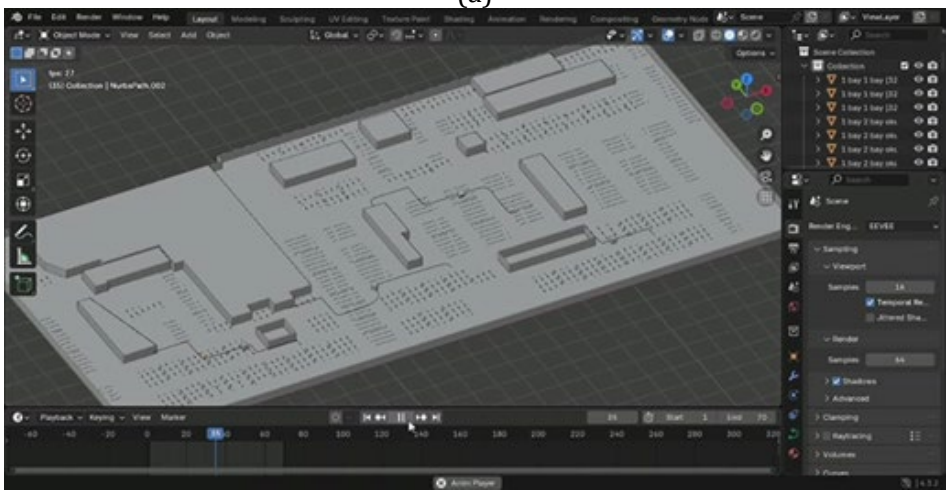
Due to technical errors, the software is not built as stated in objective two, which is to make an application for managing number plate data to relocate the vehicles' location using apps like Blender. As mentioned, Blender is a suitable application for building the new one as it lies with objective two. To ensure the application works, the plate number management criteria are modified to navigate the parking bays. Still, the aim is to help the user locate their parked vehicles. The element of improvement and modification is the car's navigation based on the parking number. In this development, the primary key findings include building custom pathways connected to parking numbers, 3D visualization of parking zones, and creating navigation options, including shortcuts.

Figure 6 shows the custom path already connected to the parking number. The path created in Figure 6 is a walkway. From the creation path, there are huge distances, and there are not many shortcut paths created that a person could use. This can be seen in Figure 6. The pros and cons of using or not using shortcuts can also be considered. The shortcut can give a minimum time to walk. However, the shortcut has a contradiction, which, most of the time, does not show the safe pathway. Compared to the path created, it creates a safety measurement for users to walk, but it also takes time. In a good term, this approach is better to use others as it includes only a single software design compared to other technologies and software that need more than one software for creating a pathway, like combining Near Field Communication (NFC) with Beacon triangulation [18].

This approach builds upon previous work in creating user-friendly parking applications. Developed an Android-based indoor parking locator using QR codes, emphasizing the importance of visual navigation aids [7]. Similarly, a smartphone-based car-finding system for underground parking lots highlights the value of technology in assisting users in locating their vehicles [8]. In terms of navigation proposed, this can be seen in the previous study, which mentioned that the implementation of an intelligent parking system with existing navigation applications is needed, as the local parking system cannot guarantee the creation of a unique mapping app and must operate with the current one [3]. Focusing on parking space navigation rather than number plate management represents an adaptation to practical constraints, a common theme in applied research. This aligns with the previous findings emphasizing the need for flexible, user-centric solutions in parking management systems [6].



(a)



(b)

Figure 6: Software design: (a) Custom path that connected to the parking number, (b) Picture of some shortcut path.

3.3 Expert Comments and Feedback

Expert review is a way to achieve this study's third objective, which is to evaluate the effectiveness of the new application in the IOI City Mall. An expert review is selected to determine what improvements can be made with the new application. Expert review is a suitable candidate as this application is in an early evaluation stage, and they have a significant role to review and verify the system and software [16]. Based on Table 1, there are two experts, Expert 1 and Expert 3, who have 4 years of experience in their field, and each is an industrial engineer and an electronics engineer. In contrast, Expert 4 has 3 years of experience as a Computer System Engineer. At the same time, the other expert is Expert 2, whose profession in Electronic Engineering does not fulfill the requirement in terms of only 2 years of experience. The number of selected experts and their profession align with some previous journals about application review. In the end, this expert review will review the application that has been built, and at the same time, this expert review is a way to fulfill the third objective.

Table 1: Expert and Profession.

Name	Year Experience	Profession
Expert 1	4	Industrial Engineer
Expert 2	2	Electronic Engineer
Expert 3	3	Electronic Engineer
Expert 4	4	Computer System Engineer

Table 2: Summary of Experts' Response.

Theme	Mentioned By	Key Feedback	Suggested Improvements
Scalability	Expert 1 Expert 2 Expert 4	The focus on user interaction and feedback loops is missing.	Add user testing, interactive simulations, and real-time feedback features.
Usability	Expert 2 Expert 3 Expert 4	The project has potential for large-scale implementation but needs refinement.	Refine pathway designs and prepare for larger infrastructure and diverse user cases.
Design & Visualization	All experts	Visual elements are strong but could benefit from a dynamic presentation	Incorporate animations, videos, and enhanced materials for realism.
Technology Integration	Expert 1 Expert 3 Expert 4	Opportunities to use AI/IoT/sensors have not been fully explored.	Integrate smart technologies for adaptive and efficient parking management.

From Table 2, three main insights from the evaluation of the new application through expert reviews are praised for its innovative design and user-friendly interface. Experts noted the potential for improving traffic flow and user satisfaction, while also providing suggestions for improvement. Specifically, experts agreed that although the visual elements are strong, the application would benefit from more dynamic presentations, such as animations, videos, and enhanced materials, to increase realism. Regarding usability, experts recognized the project's potential for large-scale implementation. However, they stressed the need for refinement, particularly in pathway designs and preparing for diverse user scenarios. Regarding scalability, experts emphasized the lack of focus on user interaction and feedback loops, recommending adding user testing, interactive simulations, and real-time feedback features. Opportunities to utilize AI, IoT, and sensors for technology integration remain underexplored, with suggestions to incorporate smart technologies for adaptive and efficient parking management.

These findings correspond with previous research on the importance of user experience in parking applications. An earlier study emphasized how smartphone applications can significantly enhance the parking management experience [19]. The experts' suggestions for more interactive features aligned with recommendations by [20], who stressed the importance of user engagement in innovative parking systems. The expert reviews also highlighted areas for improvement, such as the need for more detailed testing and real-world implementation data. This echoes the previous study emphasizing the importance of thorough testing and verification in system development [21].

3.4 Limitation

Due to privacy, security, and corporate policy restrictions, direct access to detailed number plate data and complete parking system architecture was unavailable. Thus, the qualitative methodology involved interviewing key personnel responsible for parking management at IOI City Mall, including a facility management representative and a car park department administrator, to gain insights into system capabilities and limitations. During application development, challenges accessing number plate data and integrating real-time system inputs led to a strategic focus change from number plate data management to navigation based on parking bay numbers. This pragmatic shift enabled the modeling of safe, user-oriented walking paths within selected zones, providing a proof-of-concept simulation rather than a full-scale operational system**.**

4. CONCLUSION

This study successfully achieved its key objectives by identifying existing applications and vulnerabilities in IOI City Mall's parking system through interviews with stakeholders, developing an application prototype using Blender to assist users in navigating parking spaces, and evaluating its effectiveness through expert reviews. Although originally intending to manage number plates, practical constraints led to a focus on navigation via parking numbers, which still addresses the core problem of vehicle recall in large parking structures. As a simulation prototype, this application has yet to undergo real-world testing or integration with live parking management infrastructure, representing a significant limitation. Future research should prioritize practical field testing at IOI City Mall involving actual users and piloting implementation phases to refine navigation accuracy and usability. Additionally, exploring integration with existing License Plate Recognition systems and linkage to customer-facing platforms such as the IOI Club app will enhance accessibility and user convenience.

The conceptual framework and application design presented herein are adaptable to other large shopping centers with multi-zone, indoor parking challenges, provided appropriate customization to site-specific layouts and technologies. This study thus offers a practical and scalable foundation for advancing smart parking navigation solutions that can improve operational efficiency and customer experience. Overall, the research contributes meaningfully to bridging the gap between theoretical parking system design and practical, user-friendly implementation, laying the groundwork for future advancements in smart parking technologies.

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