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PARKING OCCUPANT MANAGEMENT SYSTEM USING QR CODE SOLUTIONS WITH AES ALGORITHM

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ABSTRACT

This study presents a Parking Occupant Management System utilizing QR Code Solutions integrated with Advanced Encryption Standard (AES) technology to address inefficiencies in manual vehicle cataloging within educational institutions. By automating this process, the system improves accuracy, efficiency, and security while ensuring adaptability across diverse school parking environments. QR codes facilitate seamless logging of vehicle entries and exits, embedding contact information that enables security guards to communicate directly with vehicle owners in case of issues. The incorporation of AES encryption provides robust protection for sensitive data, safeguarding it against unauthorized access. Designed as a mobile application for Android devices, the system empowers security guards to scan QR codes in real time, effectively recording vehicle activity. Focusing on educational institutions in General Santos City, this study demonstrates significant enhancements in parking management through automation and improved data protection. The system establishes a new standard for secure data management in parking operations and holds promise for application in sectors such as commercial and residential complexes. By offering a scalable solution that enhances efficiency while ensuring data security, it contributes to better resource management. Future developments may explore security enhancements and expansion to platforms beyond Android, increasing accessibility and catering to a wider range of parking management needs. Ultimately, this system serves as a blueprint for modernizing parking management, paving the way for smarter, more secure urban environments.

Keywords: *Parking Management System, QR Code, AES Encryption, Vehicle Cataloging, Data Security*

INTRODUCTION

The increasing vehicle populations and urbanization pose challenges in managing parking operations on college and university campuses (Dokania et al.'s 2020). This growing demand

highlights the urgent need for efficient parking solutions. Traditional manual cataloging methods fall short—they are slow, prone to mistakes, and lack strong security measures, resulting in operational hiccups and safety risks. To tackle this, this research proposes a QR-based vehicle management system paired with the Advanced Encryption Standard (AES) encryption algorithm to enhance the handling of vehicle entries and exits in university parking areas securely and efficiently.

This QR-based system with AES encryption offers a major improvement over outdated methods, delivering benefits to both campus parking facilities and vehicle owners. It strengthens security by encrypting QR codes with AES, safeguarding parking occupants' data from unauthorized access or tampering—only a decryption key can unlock intercepted details. The system also optimizes vehicle entry and exit through quick QR scanning, cutting down wait times, improving traffic flow, and boosting overall parking efficiency by reducing human errors. While urban parking systems have embraced technological upgrades, campus parking has lagged, often sticking to manual processes with little use of QR technology. This gap has weakened communication between parking users and attendants, increasing risks like theft, vandalism, accidents, and legal issues.

The main goal of this work is to create a secure, efficient, and user-friendly parking management system for educational institutions using QR code technology and AES encryption. By adopting automation and focusing on user needs, this research improves parking operations, enhances security, and fosters better communication, overcoming the drawbacks of manual methods. The author's key contribution is showing how these technologies can modernize campus parking, ensuring lasting efficiency, safety, and convenience as campuses adapt to rising vehicle numbers and urban growth.

RESEARCH QUESTIONS

Interface (This section evaluates the user interface of the Parking Occupant Management System):

1. The design is consistent across the web and mobile platforms.

2. The web interface layout is well-structured, making it intuitive and easy to navigate.
3. Pop-up messages are clear and help users easily understand what's happening.
4. The colors and fonts used in the web interface enhance both readability and user accessibility.
5. The web interface provides timely and clear feedback, improving user interaction and satisfaction.

Functionality (This section assesses how well the mobile app performs essential functions like QR code scanning, real-time updates etc.):

1. The system consistently and accurately recognizes and processes QR codes.
2. The QR code generator is easy to find, and using it is straightforward and simple.
3. The system reliably updates parking occupancy in real-time, ensuring efficient management.
4. All essential functions for parking management are integrated smoothly into the system.
5. The scanner efficiently identifies vehicle actions (entry & exit) with high accuracy.

Usability (This section focuses on how easy the mobile app is to use, especially for new users.):

1. The system is designed to be user-friendly and intuitive, allowing first-time users to get started easily.
2. Navigating within the system is simple and requires minimal effort.
3. Clear instructions and helpful support features significantly enhance the overall user experience.
4. Scanning QR codes with the system's scanner is smooth, quick, and seamless.
5. Users can easily access and use all necessary features without hassle

Experience (This section measures the overall user experience, including satisfaction with the app's performance, efficiency, and etc.):

1. The encryption process using the AES algorithm operates smoothly, without affecting the system's speed or performance.
2. The system has noticeably improved my parking experience in terms of convenience and efficiency.
3. I am very satisfied with the system's consistent and reliable performance.
4. The system saves me valuable time when locating and managing parking.
5. I would highly recommend this parking management system to others based on my positive experience.

Security (This section evaluates how secure users feel when using the mobile app, especially regarding data protection and encryption during QR code scanning and data transmission):

1. The system uses the AES encryption algorithm to securely protect sensitive data.
2. I feel confident that my personal and vehicle data are well-protected by the system.
3. The QR code scanning feature effectively prevents unauthorized access.
4. The encrypted QR code is secure and cannot be scanned or decoded by unauthorized third-party apps or tools like Google Lens.
5. I trust that the AES encryption used in this system provides strong protection for sensitive information during data transmission.

LITERATURE REVIEW

Improving vehicle management systems on university campuses has become increasingly important in our rapidly changing environment. This literature review examines how Quick Response (QR) codes and the Advanced Encryption Standard (AES) encryption algorithm can enhance the security and efficiency of campus parking management. By leveraging these advanced technologies, the review draws on significant contributions from prior studies to justify their integration into parking systems, highlighting their potential to streamline operations and bolster data security.

QR Codes in Vehicle Management

As urban environments evolve, integrating QR codes into vehicle management systems significantly enhances user convenience by enabling faster queuing processes and minimizing waiting times. Lin, Rivano, and Le Mouël (2017) classify smart parking ecosystems, identifying essential components and usage trends that underscore the effectiveness of QR-based systems in optimizing parking operations. Their findings suggest that QR codes improve user experience and operational efficiency by streamlining data collection and vehicle tracking. Similarly, Barriga et al. (2019) explore the primary components and usage patterns of smart parking systems, emphasizing how QR codes, alongside sensors and software, enhance functionality and urban mobility. Kadu et al. (2014) further address urban parking challenges by introducing a QR code-based smart parking system that identifies users, provides real-time parking information, reduces traffic congestion, and increases user satisfaction. These studies collectively highlight QR codes as a key variable in improving parking management efficiency.

Encryption and Security

The combination of QR codes with AES encryption addresses crucial security concerns in vehicle management systems. Chai et al. (2023) stress the necessity of incorporating AES encryption into QR codes to protect sensitive information, preventing data leakage and unauthorized access while preserving system integrity. Ajini Asok and Arun (2016) explore the use of AES-128 encryption to secure private data within QR codes, mitigating risks like eavesdropping due to their visual nature. Their approach ensures safe verification without delays, enhancing security in data exchange.

Performance and Efficiency

The efficiency of AES encryption is vital for its practical implementation in parking systems, particularly on resource-constrained devices. Doomun, Doma, and Tengur (2008) assess AES in Cipher Block Chaining (CBC) mode, finding that optimized implementations improve encryption speed by 12% to 30%, though with increased memory demands. Almuhammadi and Al-Hejri (2017) analyze AES block cipher modes like Electronic Codebook (ECB) and CBC, evaluating

encryption time and throughput to guide mode selection. Vaidehi and Rabi (2014) highlight ECB's vulnerabilities and advocate for CBC to enhance security and effectiveness. These studies provide a foundation for optimizing AES performance, a critical variable for real-time parking applications.

Applications and Case Studies

Insights from related fields reinforce the applicability of QR codes and AES encryption in parking management. Ferdiansyah, Hadiana, and Rakhmat (2021) demonstrate their integration in healthcare administration, where encrypted QR codes secure sensitive data, offering a model for parking systems. Agun, Rabie, and Satoquia (2022) showcase a QR-based automated ticketing system for traffic violations, improving data collection and transaction efficiency— principles applicable to parking operations. Gangurde et al. (2022) further emphasize the broader implications of these technologies, noting their benefits in security and user experience across contexts. These case studies support the hypothesis that QR codes and AES can transform campus parking management

Hardware Implementations

Efficient hardware implementations enhance AES applicability in parking systems. Rachh, Mohan, and Anami (2012) propose two AES architectures using composite field arithmetic, optimizing S-boxes and operations like MixColumns for encryption and decryption. Their designs improve processing efficiency, making them suitable for mobile and embedded systems in parking management. This hardware focus complements software-based security measures, reinforcing AES as a versatile solution.

In conclusion, the literature underscores the critical role of QR codes and AES encryption in modernizing parking management systems on university campuses. These technologies address security, efficiency, and user experience challenges, justifying their adoption and suggesting hypotheses for further research, such as their impact on reducing parking delays and enhancing data protection.

METHODOLOGY

This section outlines the materials, tools, and methodologies employed to develop and evaluate the Parking Occupant Management System Using QR Code Solutions with AES Algorithm. The system was designed to automate vehicle cataloging, enhance data security, and improve parking management efficiency in educational institutions within General Santos City. The approach is detailed below, structured into subsections for clarity, providing sufficient information to replicate the study while maintaining a concise narrative.

System Development Methodology

In developing the parking occupant management system using QR code solutions with AES algorithm, the researchers used the Iterative Waterfall Model. The f low of this model takes you through system level requirements, requirement analysis, design, implementation, testing, integration deployment, and maintenance in a structured way. This is different from the traditional waterfall project management model, where each stage is fed feedback from all stages behind it, as opposed to the classic model comparison which just checks for similarities or differences between aspects of project management in practice.

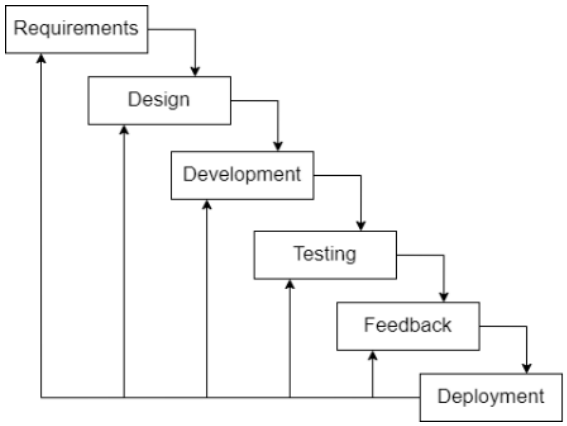

Figure 1

Iterative Waterfall Model of Software Development Life Cycle

Requirement Analysis

The initial phase involved analyzing the existing manual parking management processes in educational institutions to identify inefficiencies and define system requirements. Data were collected through interviews conducted with stakeholders, such as security guards and administrative personnel, from institutions like General Santos Doctors' Medical School Foundation Inc. For instance, interviews revealed that parking management relied on manual steps: occupants completed registration forms, administrators processed permits, and guards logged vehicle entries and exits manually. These processes were prone to errors and delays, necessitating automation. The collected data included occupant details (full name, contact number, address) and vehicle information (license plate number, type, color, brand, model), which were critical for system functionality and security verification. This information was securely stored in a MySQL database, forming the basis for QR code generation and access control.

System Design and Architecture

The system was designed as a multi-component architecture integrating web and mobile platforms. Key components included:

Frontend Technologies:

- **Vue.js** with **Vuetify**: Used for the web interface, providing reactive data binding and pre-designed UI elements (e.g., buttons, text fields) for a consistent and intuitive user experience.
- **Flutter** with **Material.dart**: Employed for the Android mobile app, ensuring a clean and intuitive design aligned with Google's Material Design guidelines.

Backend Technologies:

- **PHP Native** via RESTful APIs: Managed backend logic, such as form processing and database interactions, using HTTP methods (GET, POST) with Axios for communication.
- **MySQL**: Stored structured data, including occupant profiles, vehicle details, and parking logs.
- **XAMPP**: Provided a local development environment with Apache, MySQL, PHP, and Perl.

Cryptographic and QR Code Tools:

- **Crypto-JS**: A JavaScript library implementing AES encryption in Cipher Block Chaining (CBC) mode with PKCS7 padding, used to encrypt occupant and vehicle IDs.
- **encrypt.dart**: A Dart library for AES decryption in CBC mode with PKCS7 padding, used in the mobile app to decode encrypted QR code data.
- **QRCode.js**: Generated QR codes embedding encrypted data.
- **flutter_barcode_scanner**: A Flutter plugin for scanning QR codes on Android devices.

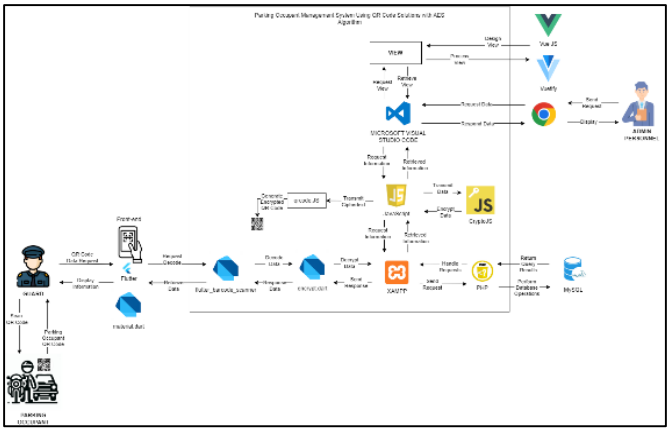

Figure 2
System Architecture

The system architecture supported secure data flow, with encrypted occupant and vehicle IDs embedded in QR codes, scanned by guards to log entries and exits.

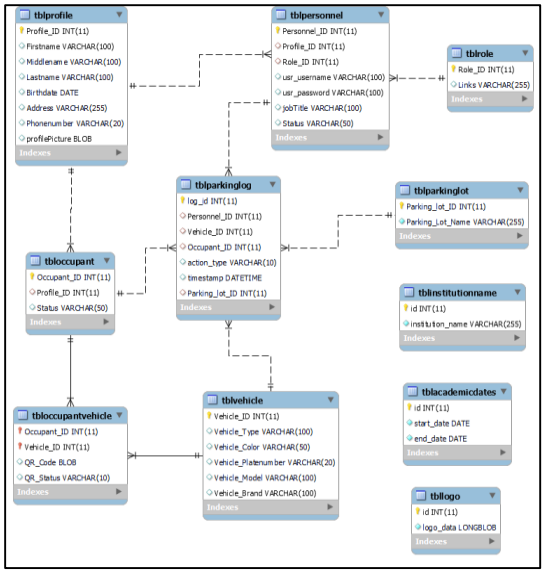

Figure 3

Entity Relationship Diagram of the Database

The Entity Relationship Diagram detailed the database structure, comprising ten interconnected tables to manage occupant profiles, vehicle data, and parking logs efficiently.

Data Collection and Encryption

Occupants registered via a web interface, providing personal and vehicle details. These data were encoded into a JSON string (e.g., {"vehicleId": 65, "occupantId": 126}; encrypted using the AES-CBC algorithm implemented in Crypto-JS. The encryption process, detailed, involved:

1. Generating a random 16-byte Initialization Vector (IV).
2. Encrypting the JSON string with a predefined AES key (stored as an environment variable) in CBC mode with PKCS7 padding.
3. Outputting a Base64-encoded string combining the IV and ciphertext (e.g., MM/sbt5xTvvBUVWv16nslg==:1tr4ZmBEInxw+FoRO7mAgeSa5mOthdrlpI6Dy9nkFr5xs81s/9ii5RNsXiSOLu+J; Appendix E, p. 77).

This encrypted data was embedded into QR codes using QRCode.js, printed, and affixed to vehicles for scanning.

QR Code Generation and Scanning

The QR code generation process linked encrypted Occupant ID and Vehicle ID to each vehicle, ensuring secure identification. The mobile app, developed in Dart using Flutter, utilized flutter_barcode_scanner to decode QR codes. Upon scanning, the app extracted the Base64-encoded data, decrypted it using encrypt.dart, and retrieved the original JSON string via the AES key and IV, enabling guards to log vehicle actions.

AES Algorithm Implementation

The AES encryption adhered to the standard outlined by the National Institute of Standards and Technology (NIST) in [FIPS 197], implemented in Cipher Block Chaining (CBC) mode as described by Doomun et al. (2008). Modifications to the standard included the use of a fixed AES key in Base16 format and a randomly generated IV for each encryption to bolster security.

In CBC mode, each plaintext block is XORed with the previous ciphertext block before encryption, with the IV serving as the initial vector for the first block. The encryption process for each block $\boldsymbol{i}$ is defined as:

$$C_i = E_k\ (P_i \oplus C_{i-1}),\ with\ C_0 = IV$$

The decryption process reverses this operation to recover the original plaintext, expressed as:

$$P_i = D_K(C_i) \oplus C_{i-1},\ with\ C_0 = IV$$

This implementation ensured both data integrity and confidentiality. The use of a random IV per encryption guaranteed that identical plaintext blocks produced distinct ciphertexts, significantly enhancing the system's security.

Testing and Evaluation

The system underwent thorough testing to assess accuracy, efficiency, and security:

- **Unit Testing**: Verified individual components (e.g., encryption, QR code scanning) using Microsoft Visual Studio Code as the primary IDE for debugging.
- **Integration Testing**: Ensured seamless interaction between web, mobile, and backend components.
- **Security Testing**: Confirmed that encrypted QR codes were unreadable by third-party scanners (e.g., Google Lens), validating AES effectiveness.
- **User Testing**: Conducted with five respondents from educational institutions on October 18, 2024, using a survey. Respondents rated interface, functionality, usability, experience, and security on a 1-5 scale, yielding a mean score of 5.0 (Very Satisfied) across all categories.

Testing focused on real-time logging accuracy, QR code scanning speed, and data protection, with results indicating high reliability and user satisfaction.

Deployment

The system was deployed in educational institutions in General Santos City, operating within the institution's WLAN for enhanced security. The deployment phase involved:

1. Installing the mobile app on institution-provided Android devices.
2. Configuring the MySQL database on a local XAMPP server to store parking data.
3. Distributing QR codes to registered occupants (faculty, staff, students).

Deployment ensured that guards could scan QR codes to log vehicle entries and exits, with logs stored securely and accessible only within the institution's network.

DATA ANALYSIS

Data collected included parking logs (e.g., Log ID, Vehicle ID, timestamp, action type; and user feedback. Logs were analyzed to evaluate system performance, such as entry/exit frequency and error rates. Survey responses were quantified to assess user satisfaction and security perceptions. The AES encryption's effectiveness was validated by its inability to be decrypted by unauthorized tools, ensuring data confidentiality.

DATA COLLECTION

This study introduces the Parking Occupant Management System that merges the use of QR code technology and Advanced Encryption Standard (AES) encryption to solve the inefficiency of manual vehicle cataloging in educational institutions. Fully automating vehicle tracking and strengthening data security, this system integrates QR codes with AES to provide a more optimize, accurate and secure method of campus parking management.

Prior to designing an automated solution, the researchers examined the manual methods of school parking management used. Analysis of

current management in educational institutions is essential for this project to determine particular inefficiencies and areas for improvement. These gaps can be identified through which the automated system can target and address the most pressing needs for a smoother transition and more overall impact.

According to the interview, the parking management in most of the educational institutions is dependent on a set of manual steps. Parking occupant submits a registration form which is submitted to an administrator who records the information and generates the parking permit. Vehicle entry and exit is handled by security guards manually by recording the details. While this is a functional process, errors and delays are usually common, and there is a greater need for an automated solution to optimize operations, enhance accuracy, and minimize process time for both processing and record keeping.

The manual cataloging process receives full name, contact number, address, and vehicle specific information about each parking occupant including license plate number, brand, model, type and color. Its importance for security personnel, who can verify parking occupants' identities and assure only vehicles authorized to park are allowed access to the campus after hours. This system provides a comprehensive profile for each occupant, producing a high level of security while being limited by manual effort to manage and update records efficiently.

All of the occupant and vehicle information is securely stored in a MySQL database to be further processed and managed. The system uses the AES CBC symmetric encryption algorithm to encrypt critical identifier such as occupant ID and vehicle ID to further increase security. After being encrypted, this data will be embedded in unique QR codes and will be printed to be attached to parking occupant's vehicle. These QR codes enable you to scan and have immediate, secure accessibility and efficient cataloging.

ETHICAL CONSIDERATION

The study adhered to ethical research principles to ensure the protection of participants' rights, privacy, and well-being during data collection. The primary data collection methods included a survey evaluating the Parking Occupant Management System Using QR Code Solutions with AES Algorithm and interviews with stakeholders at educational institutions in General Santos City. The following ethical measures were implemented:

1. **Informed Consent**: All participants, including survey respondents (students, faculty, and security personnel) and interviewees (e.g., stakeholders at General Santos Doctors' Medical School Foundation Inc.), were provided with a digital consent form prior to participation. The form clearly explained the study's purpose, the voluntary nature of participation, the right to withdraw at any time without consequences, and how their data would be used. Participants were required to provide explicit consent before engaging in the survey or interviews.
2. **Confidentiality and Anonymity**: To protect participants' privacy, survey responses were anonymized by assigning unique identifiers instead of using personal information. No identifiable data, such as names or contact details, were linked to survey responses in the database. Interview data were aggregated and reported without identifying individual participants. All data were stored securely in a MySQL database protected with AES-256 encryption, consistent with the system's security features, to prevent unauthorized access.
3. **Voluntary Participation**: Participation in both the survey and interviews was entirely voluntary. Participants were informed that there would be no penalties or repercussions for choosing not to participate or for withdrawing from the study at any point. No incentives were offered to avoid undue influence on participation.
4. **Minimizing Harm**: The study was designed to pose minimal risk to participants. The survey questions focused on user experiences with POMS and did not request sensitive personal information beyond what was necessary for evaluating the system. Interviews were conducted in a professional and respectful manner, ensuring stakeholders' comfort and willingness to share insights.
5. **Ethical Approval**: As the study involved human participants, ethical approval was sought from the Research Ethics Committee of Holy Trinity College of General Santos City. The committee reviewed the study's methodology, survey instrument, and interview protocols to ensure compliance with institutional ethical guidelines. Approval was granted prior to data collection, confirming that the study adhered to principles of ethical research conduct.
6. **Data Security**: Given the study's focus on AES encryption within POMS, similar security measures were applied to protect collected data. All survey and interview data were stored on a secure server with restricted access, using AES-256 encryption to safeguard against unauthorized access or data breaches. Only the research team had access to the raw data, and it was used solely for the purposes of this study.

These ethical considerations ensured that the data collection process was conducted responsibly, respecting participants' rights and aligning with the study's objective of evaluating a

secure and efficient parking management system. Any feedback or comments provided by participants were handled confidentially and used to improve the system without compromising their privacy.

RESULTS AND DISCUSSION

To assess the effectiveness of the Parking Occupant Management System in enhancing data security through AES encryption and automating vehicle cataloging processes in real-world scenarios within educational institutions in General Santos City, a comprehensive evaluation was conducted.

Section 1: Interface (*This section evaluates the user interface of the Parking Occupant Management System*)	**Mean**	**Verbal Description**
1. The design is consistent across the web and mobile platforms.	5.0	Very Satisfied
2. The web interface layout is well-structured, making it intuitive and easy to navigate.	5.0	Very Satisfied
3. Pop-up messages are clear and help users easily understand what's happening.	5.0	Very Satisfied
4. The colors and fonts used in the web interface enhance both readability and user accessibility.	5.0	Very Satisfied
5. The web interface provides timely and clear feedback, improving user interaction and satisfaction.	5.0	Very Satisfied
Total Mean:	**5.0**	**Very Satisfied**

Every respondent is fully satisfied with the consistency of the design across both web and mobile platforms. All respondent found the web interface layout to be well-structured, intuitive, and easy to navigate. The clarity of pop-up messages was highly appreciated by all respondent, aiding their understanding of ongoing actions. Respondents agreed that the use of colors and fonts enhances readability and accessibility. Feedback provided by the interface is clear and timely, significantly improving user satisfaction. All statements in under section one has a mean of 5.0 which has a total mean of 5.0 which shows very satisfied.

Section 2: Functionality (*This section assesses how well the mobile app performs essential functions like QR code scanning, real-time updates etc.*)	**Mean**	**Verbal Description**
1. The system consistently and accurately recognizes and processes QR codes.	5.0	Very Satisfied
2. The QR code generator is easy to find, and using it is straightforward and simple.	5.0	Very Satisfied
3. The system reliably updates parking occupancy in real-time, ensuring efficient management.	5.0	Very Satisfied
4. All essential functions for parking management are integrated smoothly into the system.	5.0	Very Satisfied
5. The scanner efficiently identifies vehicle actions (entry & exit) with high accuracy.	5.0	Very Satisfied
Total Mean:	5.0	Very Satisfied

The system's ability to accurately recognize and process QR codes received high appreciation. The QR code generator was rated as simple and straightforward by all respondent. All respondent acknowledged the system's real-time updates as being reliable for efficient parking management. Every respondent noted that the integration of essential parking management functions is smooth and seamless. Respondent expressed complete satisfaction with the accuracy of the scanner in identifying vehicle actions. The statements provided in Section Two possess a mean of 5.0, leading to a total average of 5.0, which demonstrates full satisfaction.

Section 3: Usability *(This section focuses on how easy the mobile app is to use, especially for new users.)*	**Mean**	**Verbal Description**
1. The system is designed to be user-friendly and intuitive, allowing first-time users to get started easily.	5.0	Very Satisfied
2. Navigating within the	5.0	Very

system is simple and requires minimal effort.		Satisfied
3. Clear instructions and helpful support features significantly enhance the overall user experience.	5.0	Very Satisfied
4. Scanning QR codes with the system's scanner is smooth, quick, and seamless.	5.0	Very Satisfied
5. Users can easily access and use all necessary features without hassle	5.0	Very Satisfied
Total Mean:	**5.0**	**Very Satisfied**

First-time users found the system easy to use and navigate, meeting their expectations. Navigating the system required minimal effort, as confirmed by all respondent. The clarity of instructions and helpful support features significantly enhanced the user experience. QR code scanning was reported to be smooth and efficient by all respondents. Respondent had no trouble accessing and using all necessary features. Every statement in Section Three has an average of 5.0, contributing to a total mean of 5.0, which indicates that it is highly satisfactory.

Section 4: Experience (*This section measures the overall user experience, including satisfaction with the app's performance, efficiency, and etc.*)	**Mean**	**Verbal Description**
1. The encryption process using the AES algorithm operates smoothly, without affecting the system's speed or performance.	5.0	Very Satisfied
2. The system has noticeably improved my parking experience in terms of convenience and efficiency.	5.0	Very Satisfied
3. I am very satisfied with the system's consistent and reliable performance.	5.0	Very Satisfied
4. The system saves me valuable time when locating and managing parking.	5.0	Very Satisfied

5. I would highly recommend this parking management system to others based on my positive experience.	5.0	Very Satisfied
Total Mean:	**5.0**	**Very Satisfied**

The encryption process using the AES algorithm was reported to function without any negative impact on system speed or performance. All respondents agreed that the system has improved their parking experience in terms of convenience and efficiency. The system's performance was consistently reliable, satisfying all respondent. The system's ability to save time during parking management was recognized by all respondent. Every respondent indicated that they would highly recommend the system based on their positive experience. The use of AES encryption to secure sensitive data was strongly supported by all respondent. All statements in Section Four have a mean value of 5.0, and the aggregate average also stands at 5.0, suggesting that they are highly satisfactory.

Section 5: Security *(This section evaluates how secure users feel when using the mobile app, especially regarding data protection and encryption during QR code scanning and data transmission)*	**Mean**	**Verbal Description**
1. The system uses the AES encryption algorithm to securely protect sensitive data.	5.0	Very Satisfied
2. I feel confident that my personal and vehicle data are well-protected by the system.	5.0	Very Satisfied
3. The QR code scanning feature effectively prevents unauthorized access.	5.0	Very Satisfied
4. The encrypted QR code is secure and cannot be scanned or decoded by unauthorized third-party apps or tools like Google Lens.	5.0	Very Satisfied

5. I trust that the AES encryption used in this system provides strong protection for sensitive information during data transmission.	5.0	Very Satisfied
Total Mean:	**5.0**	**Very Satisfied**

Respondents expressed high confidence that their personal and vehicle data are well-protected. The QR code scanning feature effectively prevents unauthorized access, as noted by all respondent. Respondents were assured that encrypted QR codes are secure and cannot be decoded by unauthorized QR Code scanners and Google Lens. All respondent trusted the AES encryption for safeguarding sensitive information during data transmission. The following statements in section five have the mean of 5.0; the total mean of entire survey is also 5.0 which clearly shows that the audience is highly satisfied.

All the five section tables displayed in the survey used statements from which the average response from all is 5.0 clearly indicating high satisfaction of the system in terms of interface design, usability, and functionality. In addition, all tables have a grand mean of 5. The above-mentioned, as it follows from these tables and analyses. The layout format was clear for the respondents; the respondents experienced QR code features within the layout format as stable, and the overall experience was convenient and effective. Specifically, the AES encryption had positively been evaluated in terms of security measures and good data protection capabilities since respondents felt a lot of trust and confidence.

CONCLUSION

AES encryption used in the Parking Occupant Management System has also helped partly in securing the satisfaction by protecting information. A number of the respondents expressed their appreciation for several security measures adopted in the process of scanning QR codes and data transmission to affirm that the system has assured high standards of security. Furthermore, the dependability of the QR code-bearing system added ease to parking management as expected.

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