Implementation of the REST API Model using QR Codes on Mobile Devices to Order Parking Tickets

Mauluddini Amras[1], Erwin Yulianto[2], Deshinta Arrova Dewi[3], Awan Setiawan[4]
Department of Informatics, Faculty of Engineering, Langlangbuana University, Bandung, Indonesia[1, 2, 4]
Faculty of Data Science and Information Technology-INTI International University, Nilai, Malaysia[1, 3]

***Abstract*—Many parking lots are still operate manually, and delays are commonly caused during the parking process when unforeseen events occur, such as when the parking ticket paper runs out or the ticket machines jam. New services are added to the parking system online with the aim of decreasing the amount of time that people spend waiting in line to park. This is done by conducting a parking booking system to obtain a parking ticket in the form of a QR Code as well as parking information, payment transactions, and other things that interfere with the parking process. In this study, the Forward Chaining Algorithm will be combined with the survey research method as the research methodology. The Rapid Application Development model is used for analysis and design (RAD). Representational State Transfer Application Programming Interface (REST API) is one of the solutions offered to overcome this problem. With the advent of online parking services, it is envisioned that customers who intend to park their vehicles in public spaces will be able to reserve a parking space in advance, greatly simplifying the process and eliminating the problem of the drawn out queue process.**

***Keywords*—Representational state transfer application programming interface (REST API); online parking ticket; quick response code (QR Code); smart city; public transport**

I. INTRODUCTION

Parking service is one of the services in the field of services, where parking is almost available in all places, shopping centers, schools, and is also available on the side of the road. Parking is a necessity for vehicle owners and wants their vehicles to be parked in a place, where the place is easy to reach [1]. In Indonesia, having a place to store vehicles (parking lots) when visiting a place for shopping, playing, and other activities is a place that must be available.

Often the process of parking the vehicle will cause a queue if unwanted things such as the parking ticket paper run out, the ticket machine is jammed and other things will result in a long queue during the parking process. Determination of location and construction of parking facilities for the public is carried out by taking into account the general design of regional spatial planning, safety and smooth traffic, environmental sustainability, and convenience for service users [2]. However, currently there are still many parking places that use manual habits, namely after arriving at the parking lot, then pressing the button for a ticket and then entering the parking area and looking for a place to park. In addition, there are often long queues due to system errors, running out of ticket paper, and processing queues during the payment process.

Based on the preliminary description above, it can be concluded that several problem points that are the purpose of this activity include providing information and providing easy parking processes for users who will do parking. In addition, it also anticipates problems in the vehicle parking process such as the problem of running out of parking tickets, jammed ticket machines that can prolong the parking queue. Based on the preliminary description, this research aims to address several problem points, including:

1) Providing accessible information and streamlining the parking process for users.

2) Anticipating and preventing common issues encountered during the vehicle parking process, such as ticket shortages and queue delays.

The research problem revolves around the need for a more efficient and convenient parking experience, particularly in regions where parking services frequently face issues like long queues and technical disruptions. These problems stem from traditional, manual parking processes that may not align with modern expectations and urban development. The research seeks to answer the following questions:

1) How can the parking experience be improved for users?

2) What are the specific challenges associated with traditional parking processes?

3) How can the implementation of the REST API and QR Code technology enhance parking services?

The research objectives include:

1) To streamline the parking process, making it more user-friendly and efficient.

2) To identify and address common challenges in the existing parking systems.

3) To demonstrate the advantages of implementing the REST API and QR Code technology in the context of parking services.

This research is significant because it presents a solution to common issues encountered in parking services while aligning with the broader Smart City ecosystem. By implementing the REST API and QR Code technology, it seeks to enhance the parking experience for users, reduce queue times, and contribute to the efficiency and sustainability of urban transportation. The primary contribution of this research is the innovative application of REST API in online ticket ordering using mobile device QR Codes, offering a solution that

enhances the efficiency and convenience of parking services within the Smart City ecosystem. This contribution addresses issues commonly encountered in parking processes and aligns with modern urban development goals. The novelty that is unique in this research is the application of the REST API in ordering tickets online using a mobile device QR Code, which is part of one of the solutions in the Smart City ecosystem.

II. Literature Review

A. Representation State Transfer Application Programming Interface

In 2000, after the Web scalability crisis was averted, Fielding named and described the Web architectural style with a Ph. on. Web services are custom built web servers that support the needs of other sites or applications. Client programs use the Application Programming Interface (API) to communicate with web services. In general, an API provides a set of data and functions to facilitate interaction between computer programs and allow them to exchange information as shown in Fig. 1[3]:

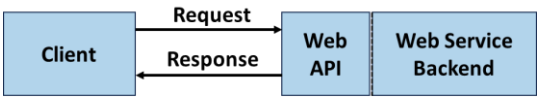

Fig. 1. Data request process [3].

As it can be seen in Fig. 1 above, there is a web service system, the web service itself is a software system that is intended as a liaison for interaction between machines and other machines in a system [4].

Web APIs are the face of web services, listening directly to and responding to client requests. The REST architectural style is generally applied to the design of APIs for modern web services. The web API that fits the REST architectural style is the REST API. Having a REST API makes a web service "RESTful". REST APIs consist of a collection of interrelated resources. This collection of resources is known as the REST API resource model. A well designed REST API can attract client developers to use web services. In today's open market where competing web services compete for attention, an aesthetically pleasing REST API design is a must have feature [3], [13].

B. Ticket

The ticket is an important document that must be owned by passengers who will make a trip, the document is issued by the company or related body that acts as the owner of the services offered [5]. By having a ticket, a person will get services on land, sea and air transportation, both domestic and international. However, if this ticket is not used in whole or only part of the routes listed on the ticket, it can be cashed back according to the agreed agreement. Some of the ticket types used to date is as follows [6]:

- Ticket Paper Manual is a ticket made of valuable paper/document in the form of a book which is issued by writing using a pen. This ticket, although it has been used for a long time, is still used by several airlines. The ticket book is printed on special paper so that it is not easily counterfeited. There are audit coupons, agent coupons and passenger coupons that are useful as control over the issuance of a ticket.
- Ticket paper printers are those made of valuable paper/documents in the form of books issued by printing using a printer that is operated with a certain ticketing system. One ticket book consists of four flight coupons, audit coupons, agent coupons and passenger coupons.
- Electronic ticket is a ticket made electronically, where all flight and passenger data written in it are stored in an electronic document in the airline database or ticketing system Provider Company. Passengers only need to bring a printout of the data which can be reprinted repeatedly.

C. Park

Based on the results of studies in Guidelines for Planning and Operation of Parking Facilities, measuring space requirements Parking at activity centers is determined according to the nature and purpose of the parking. In practice in the field, it must be adjusted to parking demand every type of vehicle [12].

Every trip using a vehicle begins and ends at the parking lot, therefore parking spaces are spread out at the origin of the trip, which can be in the car garage, yard, roadside, and the destination of the trip, in the parking lot, parking building or on the side of the road. Because the concentration of the destination of the trip is higher than the place of origin of the trip, it usually becomes a problem at the destination of the trip. Parking is a temporary state of immobility of a vehicle, while stopping is a temporary state of immobility of a vehicle with the driver not leaving the vehicle [7]:

- Parking tariff policy is determined based on location and time, the closer to the City activities the higher the tariff, the higher the higher the rate. This policy is directed at controlling the number of parkers in the city center or activity center and encouraging the use of public transportation.
- Parking space restriction policy, especially in the downtown area or activity center. This policy is usually carried out on roadside parking whose main purpose is to smooth traffic flow, as well as restrictions on offstreet parking spaces which are carried out through IMB (Building Permits).
- Strict law enforcement policies against violators of the provision that parking is prohibited and prohibited from stopping and parking outside the designated place for this purpose, law enforcement can be carried out through fines or with wheel locks.

D. Quick Response Code

Since its introduction in 1994, the QR Code has gained widespread acceptance in various industries such as manufacturing, warehousing and logistics, retail, healthcare, life sciences, transportation, and office automation. Now with the tremendous growth of smartphones, QR Codes are also

being used in mobile marketing and advertising campaigns as a fast and effective way to connect with customers and provide end user content, including Web links, mobile coupons, airline boarding passes, etc. Successful implementation of QR Code in any of these fields requires knowledge of certain basic information about the QR Code itself and the technology associated with it. Although the QR Code was originally designed to track automotive components and systems through the manufacturing process and distribution supply chain, it quickly spread to almost every other area where traditional barcodes are used, as well as some entirely new ones [8]. The following is an example of the display of the QR Code which can be seen in Fig. 2.

Fig. 2. QR code [8].

A QR Code (Quick Response Code) is a two dimensional (2D) matrix code belonging to a larger set of machine readable codes, all of which are often referred to as barcodes, regardless of whether they consist of bars, squares or other shaped elements. Compared to 1 D code, 2 D can hold a larger amount of data in a smaller space, and compared to other 2 D codes, QR Code can store more data. In addition, advanced error correction methods and other unique characteristics allow QR Codes to be read more reliably and at a higher speed than other codes. Like written language, barcodes are a visual representation of information. Unlike languages, however, which can be read by humans, barcodes are designed to be read and understood (decoded) by a computer, using a machine vision system consisting of an optical laser scanner or camera and barcode interpretation software. The rules used to create barcodes (grammar) and the characters they use (the alphabet) are called symbology [8].

Fig. 3. QR code vs. barcode [8].

Unlike 1 D barcodes, QR Codes are 2D matrix codes that convey information not based on the size and position of the bars as seen in Fig. 3 above and spaced in one dimension (horizontal), but by arrangement of dark and light elements, called "modules"., in columns and rows, i.e. in both horizontal and vertical directions. Each dark or light module of a QR Code symbol a specific example of a code represents a 0 or 1, thus making it machine understandable [8].

QR Code modules perform several functions, some contain the actual data itself, while others are grouped into various function patterns that improve reading performance and allow symbol alignment, error correction, and distortion compensation. The timing pattern allows the scanning device to know the symbol size. There is also a required "quiet zone", a buffer area four modules wide that contains no data, to ensure that the text or creation area is not mistaken for QR Code data. The function pattern on the QR Code can be seen in Fig. 4 below.

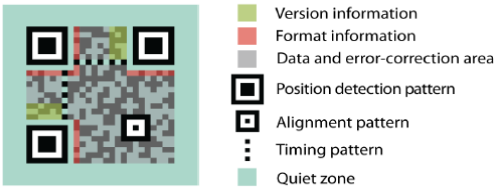

Fig. 4. QR code function pattern [8].

Conventional 2D matrix codes require a lot of time to search for symbol codes to determine orientation angle, position (x and y coordinates), and size. To solve this problem, the QR Code was designed with a special position detection pattern located at the three corners of each symbol. The patterns have a 1:1:3:1:1 symmetric scan line ratio, which allows them to be scanned from any direction in a full 360 degrees. In addition, pattern position relationships allow quick access to relevant angle, position, and size information contained in the periphery of the code. As a result, QR Codes do not require lengthy code searches, enabling read speeds up to 20 times faster than conventional matrix codes. The position detection pattern search process can be performed by the scanning hardware, further increasing the overall speed by allowing image reading and data processing to be performed simultaneously [8].

Developing Android applications for a Parking Information System using Adobe AIR involves creating a mobile app that provides users with real-time parking information, such as available parking spots, pricing, location details, and navigation assistance. Adobe AIR is a cross-platform runtime that allows developers to build applications using web technologies like HTML, JavaScript, and ActionScript. [14]

A comprehensive review of the research entitled "Implementation of the REST API Model Using QR Codes on Mobile Devices to Order Parking Tickets" will include an understanding of the REST API concept, parking ticket ordering, and the use of QR Codes in the context of mobile applications. This research focuses on applying the REST API concept, ordering parking tickets, and using QR codes to create a solution that makes it easier to order parking tickets via mobile devices. This can improve user experience and efficiency in parking management, as well as utilize modern technology to overcome challenges in urban transportation and parking management.

III. Research Method

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation, as well as the experimental conclusions that can be drawn.

A. Data Collection Stage

The data collection stage was carried out with the Literature Study stage, carried out by searching for information from books, e-books, websites, modules, journals, internet browsing and various other literature related to making the Forward Chaining algorithm application. Next is the observation method or observation is direct observation, which is an activity that aims to obtain the necessary information by observing and recording and reviewing.

B. System Development Stage

The stages of system development used in this application are the Rapid Application Development (RAD) model, with black box testing. The stages of the Rapid Application Development (RAD) method can be seen in Fig. 5 below:

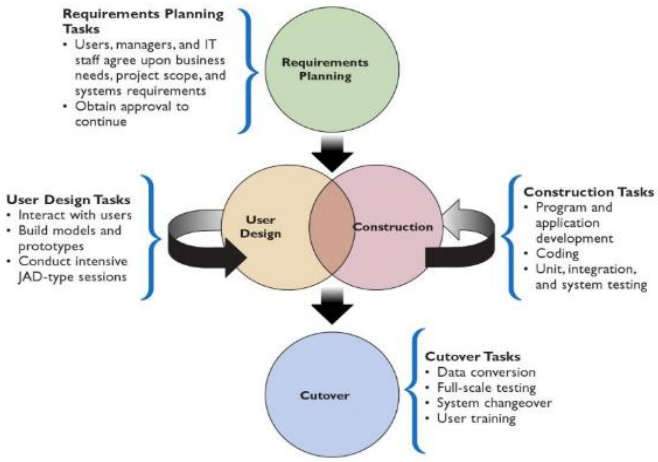

Fig. 5. RAD phases [9].

The explanation of these stages can be seen in the following points: [10].

1) Requirements planning: The requirements planning phase combines elements of the systems planning and systems analysis phases of the SDLC. Users, managers, and IT staff members discuss and agree on business requirements, project scope, constraints, and system requirements. The requirements planning phase ends key issues and obtains management's permission to continue.

2) User design: During the user design phase, the user interacts with the systems analyst and develops models and prototypes that represent all system processes, outputs, and inputs. RAD groups or subgroups typically use a combination of JAD techniques and CASE tools to translate user requirements into a working model. User design is an interactive and continuous process that allows users to understand, modify, and ultimately agree on a system working model that meets their needs.

3) Construction: The construction phase focuses on the tasks of developing programs and applications that are similar to the SDLC. However, in RAD, users continue to participate and can still suggest changes or improvements as the actual screen or report is developed.

4) Cutover: The transition phase resembles the final tasks in the SDLC implementation phase, including data conversion, testing, switching to the new system, and user training. Compared with traditional methods, the whole process is compressed. As a result, new systems are built, shipped, and put into operation more quickly.

The Software Development Method using the RAD (Rapid Application Development) model has several advantages compared to other software development methods, especially in the context of project-based software development which requires flexibility, speed and high response to changing needs. Here are some of the advantages of RAD:

1) Rapid development: As the name suggests, RAD emphasizes on rapid development. In this model, the main focus is to produce a usable prototype or application quickly.

2) High customer engagement: RAD promotes active customer or stakeholder engagement.

3) Flexibility: The RAD model is very flexible and can handle changing requirements well.

4) Better quality: Through repeated iterations, RAD allows teams to identify and address problems earlier in the development cycle.

5) Emphasis on reusability: RAD encourages reusable component-based development that can save time and effort in subsequent project development.

6) Cost efficiency: While there are initial costs associated with developing a prototype, long-term savings can be achieved due to the reduction in changes that must be made in later stages of the project.

7) Suitability for small-medium projects: The RAD method is generally better suited for small to medium sized projects that require quick updates or upgrades.

8) Concentrate on key functionality: RAD focuses on the key functionality required by customers, avoiding features that may be unnecessary or annoying.

9) Risk reduction: By having prototypes that can be tested and evaluated, project risks can be reduced as problems can be identified early.

10)Improved team collaboration: RAD encourages active collaboration among development team members and stakeholders. This can result in a better understanding of needs and desired solutions.

In addition to the system development method using the Rapid Application Development (RAD) method, this study also uses Unified Modeling Language (UML) Diagrams as a tool in the analysis process and also in system design.

IV. Result and Discussion

A. Business Process Analysis

Based on the results of the data collection stages, the business processes in this research activity can be seen in the flowmap in Fig. 6 to Fig. 9 below:

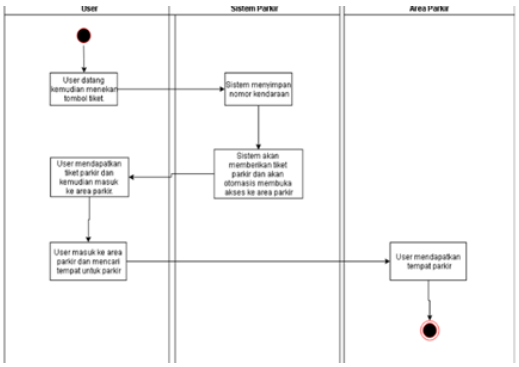

Fig. 6. Business process runs from manual parking entry process.

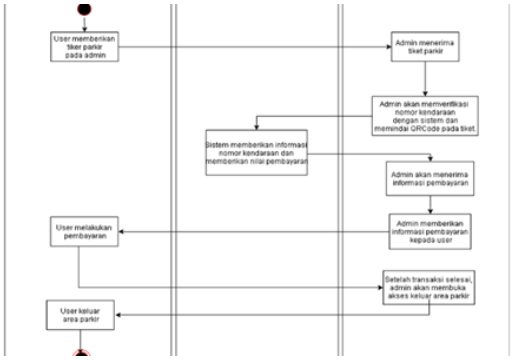

Fig. 7. Business process running from manual parking exit process.

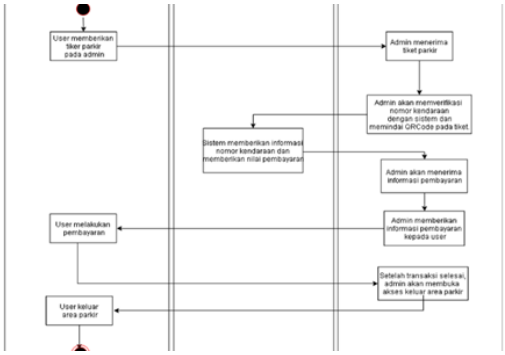

Fig. 8. Business process proposed from manual parking entry process.

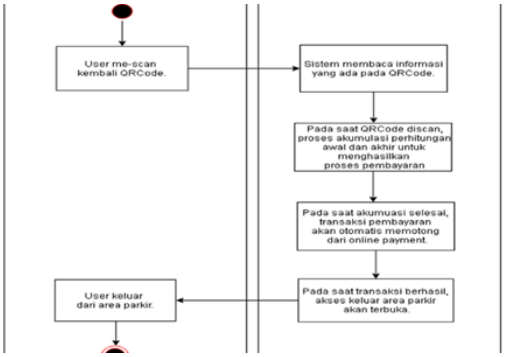

Fig. 9. Business process proposed from manual parking exit process.

In general, the differences between current and proposed business processes based on Fig. 6 to Fig. 9 above are:

1) Manual parking business processes:

a) Ticket Issuance: In manual parking processes, when a vehicle arrives at the parking lot, a physical parking ticket is issued.

b) Finding a Parking Spot: The driver must manually find an available parking spot within the parking facility, which can sometimes be a time-consuming process, especially in crowded parking areas.

c) Payment: When leaving the parking area, the driver approaches a payment booth where they must provide the physical parking ticket and make the payment in cash or by card.

d) Ticket Validation: The parking ticket is manually validated by an attendant, and the gate is opened to allow the vehicle to exit the parking area.

e) Manual parking processes can face challenges such as ticket paper shortages, malfunctioning ticket machines, and extended waiting times, resulting in a less efficient and user-friendly experience.

2) Application of REST API in Ordering Tickets Online Using a Mobile Device QR Code:

a) Ticket Ordering via Mobile App: With the application of the REST API, users can order parking tickets online through a mobile app.

b) QR Code Generation: Upon ordering a parking ticket, a QR code is generated, typically displayed on the user's mobile device. This QR code serves as a digital ticket for entry and exit.

c) Efficient Entry: To enter the parking area, users simply need to display the QR code on their mobile device, which is then scanned by a QR code reader at the entrance gate.

d) Online Payment: Payment for parking can also be made online through the mobile app, reducing the need for cash payments and further expediting the process.

e) QR Code Validation: At the exit gate, the QR code is scanned again for validation, and the gate is opened for the user to exit.

f) Implementing REST API and QR Code technology offers several advantages, including faster entry and exit, reduced queues, reduced reliance on paper, and improved user convenience.

B. Gap Analysis

Below is a GAP Analysis table that describes the current and expected business processes. GAP analysis can be seen in Table I below:

TABLE I. GAP ANALYSIS

No	Business Process	Currently	Expected
1	Parking Process	Manual parking process, to do parking, the user must be in the parking lot to press the ticket button and then park.	Automatic process where the previous parking process can make a booking to get a parking ticket.
2	Parking Ticket	Parking tickets currently still use paper a lot.	The expected parking ticket at this time is in addition to reducing paper in the form of a QR Code.

In summary, manual parking business processes involve physical ticket issuance, manual search for parking spots, and payment at the booth, while the application of REST API with QR Codes allows for a more streamlined and efficient online ticket ordering process using mobile devices, reducing the reliance on physical tickets and facilitating quicker entry and exit from the parking facility.

C. Functional Modelling Analysis

This functional modeling analysis will use the Unified Modeling Language (UML) as follows:

1) Use case diagram: Use Case Diagrams are used to find out what functions are in an information system and who has the right to use those functions [11]. Use Case Diagram can be seen in Fig. 10.

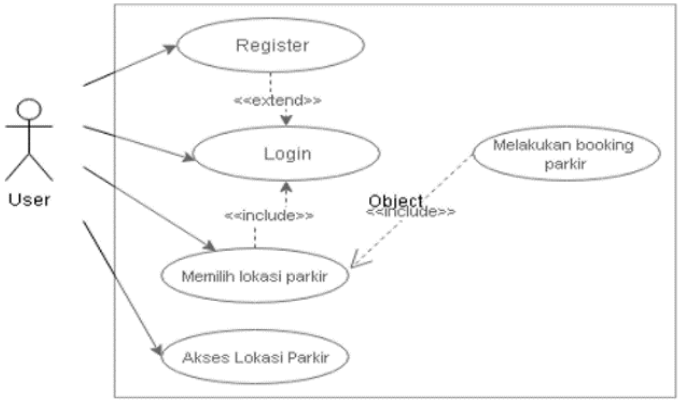

Fig. 10. Use case diagram.

2) Class diagram: The use of this class diagram will describe the structure in terms of defining the classes that will be created to build the system. Classes have what are called attributes and methods or operations [11]. Class Diagram can be seen in Fig. 11.

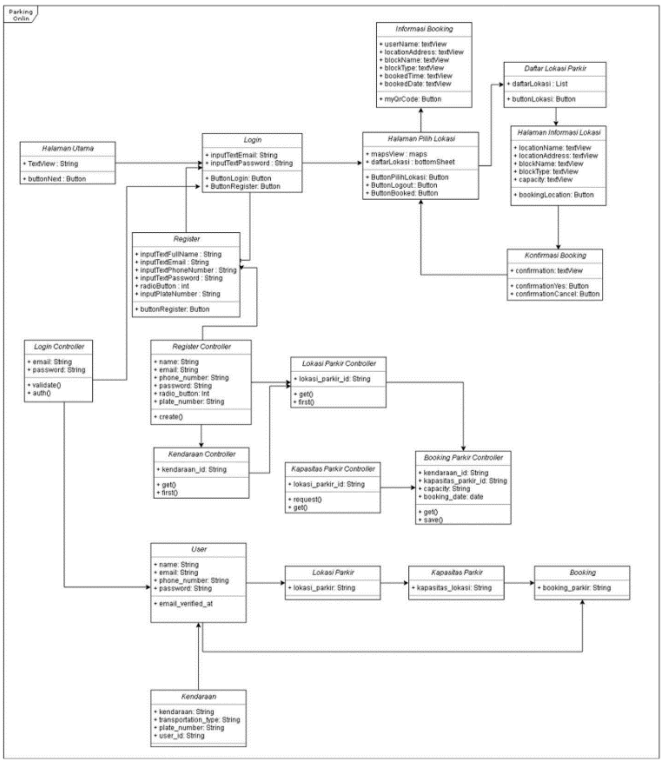

Fig. 11. Class diagram.

D. Menu Structure Design

The design of this menu structure is a tool that is expected to make it easier for users to get to know this system better. The design of the menu structure of this system can be seen in Fig. 12.

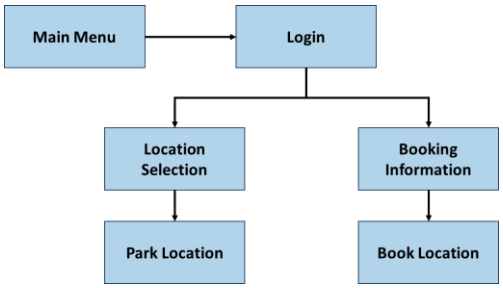

Fig. 12. Menu structure design.

E. Interface Implementation

Implementation of the interface of this system can be seen from the description of the following points:

1) Maps page: Maps page that is displayed when the application is accessed, and the user has logged in. The display of this map page can be seen in Fig. 13.

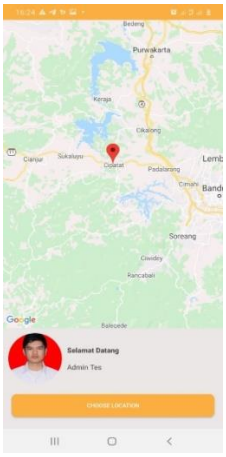

Fig. 13. Menu structure design.

2) Choose a parking location page: The parking location page is the page that is displayed when the user presses the "choose location" button to select a location around them. The view of the page for choosing a parking location can be seen in the following Fig. 14.

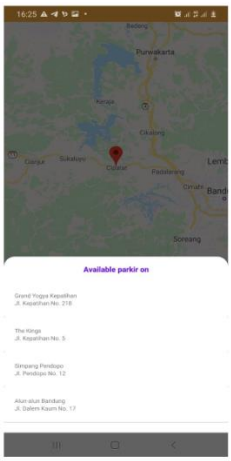

Fig. 14. Page view select parking location.

3) Parking information page: The parking information page is the page after we select a location for parking which is displayed when the application is accessed. The display of this main page can be seen in Fig. 15.

Fig. 15. Parking information page display.

4) Booking confirmation page: The booking confirmation page is a confirmation page that is displayed when the user has pressed the booking location button. The display of this booking confirmation page can be seen in Fig. 16.

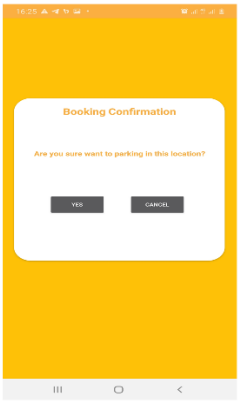

Fig. 16. Booking confirmation page preview.

5) QR code booking information page: The QR Code booking information page is the page after making a booking and the QR Code will be displayed when the user presses the QR Code button. The display of this QR code booking information can be seen in Fig. 17.

Fig. 17. Booking information page preview.

6) QR code page: The QR Code Page is intended to get parking access as a substitute for parking tickets. The display of this main page can be seen in Fig. 18.

Fig. 18. QR code page preivew.

7) QR code page: QR Code Scan Result is the result when the QR Code is scanned to get parking access. The display of these results can be seen in Fig. 19.

Fig. 19. QR code scan result.

When discussing API transfer for QR-Code reading mode and measuring delay (response time in milliseconds), keep in mind that this delay can be influenced by various factors, including the quality of the hardware and software used, environmental conditions, and the quality of the QR code itself. Below is Table II that includes several situations that may affect QR-Code reading delay:

TABLE II. FACTORS THAT HINDER THE TRANSFER OF QR CODE DATA USING THE REST API

No	Factor / Issue	Estimated Delay (ms)	Description
1	Environmental Conditions	10-100	Low light, glare, or shadows can slow down QR code reading.
2	QR Code Quality	5-50	Damaged or non-standard QR codes may require extra time for decryption.
3	Camera Hardware	20-100	The quality of the camera on mobile devices or QR code readers can affect response time.
4	Software Application	10-50	The performance of QR code reader software may vary based on the implementation and updates.
5	Processor Speed	5-20	Faster mobile device or QR code reader processors will read QR codes more quickly.
6	Network Overhead	20-100	If QR codes need to be fetched from a server over a network, network overhead can impact delay.

The values in this table are general estimates and may vary depending on the actual circumstances. Some cases may experience higher or lower delays depending on the combination of these factors. Additionally, more advanced hardware and software may experience lower delays. Implementing REST APIs for online ticket booking using QR codes on mobile devices can have various advantages and disadvantages. Here are some of them:

1) Excess:

a) Ease of Access and Use: The REST API allows users to easily access the ticket booking system using their mobile devices. This provides convenience for users in ordering public transportation tickets.

b) Scalability: The REST API allows the system to easily scale to changing demands. It can handle traffic spikes that occur during peak hours or during special events.

c) Interoperability: REST APIs typically use common data formats such as JSON, which can be easily understood by various devices and platforms. This allows various third-party applications to integrate with the ticket booking system.

d) Security: REST APIs can be configured to implement security measures such as authentication, authorization, and data encryption to protect user information and payment transactions.

e) R codes: Using QR codes simplifies the check-in process on public transportation. Users simply display their QR code on their phone screen, and officers can quickly scan it to validate the ticket.

2) Weakness:

a) Dependency on Internet Connection: REST API requires a stable internet connection. If users are in an area with a weak signal or no internet connection, they may not be able to book tickets or display their QR code.

b) Technical Errors: In the event of technical glitches or server failure, users may experience difficulty booking tickets or using QR codes. This can disrupt the user experience.

c) Data Security: Although REST APIs can be regulated with security measures, the risk of data leakage remains. Users' personal data and payment information must be guarded very strictly.

d) Development Cost: Developing and maintaining a robust and reliable REST API can require a large investment in terms of human and financial resources.

e) Need for Continuous Maintenance: APIs need to be maintained and updated regularly to maintain their reliability. This requires additional effort and costs.

f) Regulatory Compliance: Online ticket booking systems must comply with various regulations, including data privacy and financial regulations, which can add complexity and operational costs.

Implementing REST APIs in online ticket ordering using QR codes on mobile devices can provide many benefits, but also has several challenges that must be overcome to achieve success in managing public transportation in a smart city ecosystem.

V. CONCLUSION

The conclusions obtained from the activities that have been carried out include the existence of an online process that can facilitate the process of getting information about the place without having to look directly at the parking lot, making it easier for users to book a parking space. This activity can also anticipate problems in the vehicle parking process such as running out of parking tickets, jammed ticket machines that create long queues. With QR Code media as a substitute for parking tickets, it will save paper usage which is usually always thrown away after use, so this QR Code is one of the media used can replace paper tickets. Implementing the REST API in online ticket ordering using a QR code on a mobile

device is one of the best solutions for managing public transportation in the smart city ecosystem.

REFERENCES

[1] Parmar, J., Das, P., & Dave, S. M. (2020). Study on demand and characteristics of parking system in urban areas: A review. Journal of Traffic and Transportation Engineering (English Edition), 7(1), 111-124.

[2] Calderdale Council. (2023). Mitigating Circumstances For Appealing Against A Ticket, https://new.calderdale.gov.uk/parking/challenging-parking-ticket/mitigating-circumstances, Accessed October 21, 2023

[3] A. F. Harismawan, A. P. Kharisma, and T. Afrianto, "Analisis Perbandingan Performa Web Service Menggunakan Bahasa Pemrograman Python, PHP, dan Perl pada Client Berbasis Android," Jurnal Pengembanagan Teknologi Informasi dan Ilmu Komputer, vol. 2, no. 1, 2018.

[4] D. L. Puspa, I. Uce, and H. S. Yulius, "Permodelan Proses Bisnis menggunakan Activity Diagram UML dan BPMN," Universitas Kristen Petra, 2009.

[5] A. Mayasari, "A. Sistem Reservation dan Ticketing PT. Sriwijaya Air Distrik Solo," Universitas Sebelas Maret Surakarta, 2011.

[6] S. Hanief, and D. Pramana, "Pengembangan Bisnis Pariwisata Dengan Media Sistem Informasi," 2018.

[7] Herlinah, and K. H. Musliadi, "Pemrograman Aplikasi Android dengan Android Studio, Photoshop dan Audition, No. 1, pp. 2-5, 2019.

[8] Denso Wave Corporation, "QR Code Essentials," 2011.

[9] A. S. Rosa, and M. Shalahuddin, "Rekayasa Perangkat Lunak Dan Berorientasi Objek," 2016.

[10] Sitorus, L., Situmorang, J. V. M., Limbong, T., Matondang, Z. A., & Rikki, A. (2023, July). Development of quality assurance information systems at the faculty of Computer Sciences, Santo Thomas Catholic University with rapid application development (RAD) model. In AIP Conference Proceedings (Vol. 2798, No. 1). AIP Publishing.

[11] G. B. Shelly, T. J. Cashman, and H. J. Rosenblatt, "System Analysis and Design," 7th ed, Course Technology, 2008.

[12] I. Abubakar, "Pedoman Perencanaan Dan Pengoperasian Fasilitas Parkir," 1998.

[13] M. Masse, "REST API Design Rulebook," 2011.

[14] V. Brossier, "Developing Android Applications with Adobe Air," 2011.