

T.C.
BAHCESEHIR UNIVERSITY
GRADUATE SCHOOL
FINANCIAL TECHNOLOGY PROGRAM



**PARKAPP AS A FINTECH INNOVATION IN URBAN PARKING FOR
MODERN MOBILITY SOLUTIONS**

MASTER'S THESIS
ABDULMONIEM DIRI

ISTANBUL 2024

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THESIS ADVISOR

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ABSTRACT

PARKAPP AS A FINTECH INNOVATION IN URBAN PARKING FOR MODERN MOBILITY SOLUTIONS

Abdulmoniem Diri

Master's Program in Financial Technology

Supervisor: Assist. Prof. Dr. Serkan Yeşilyurt

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This thesis presents; ParkApp is presented in this thesis as an innovative FinTech solution designed to address urban parking challenges by integrating AI, IoT, digital wallet, and blockchain technologies. With increasing vehicle usage and urban congestion in large cities, ParkApp optimizes parking space distribution. It improves user experience and promotes environmental sustainability. The proposed application utilizes real-time data to reduce search time, fuel consumption, and carbon emissions. It provides secure and efficient transactions through blockchain and digital wallet integration. The scalability of ParkApp allows integration with broader smart city initiatives such as public transportation, making it an essential tool for future urban management. This thesis emphasizes the potential of ParkApp to transform urban mobility, reduce traffic congestion, and promote economic efficiency in both large cities and smaller communities, making them more livable. In this way, it contributes significantly and substantially to creating sustainable urban environments.

Key Words: Smart Parking, FinTech, Blockchain, Artificial Intelligence (AI), Internet of Things (IoT).

ÖZ

MODERN MOBİLİTE ÇÖZÜMLERİ İÇİN KENTSEL OTOYERK ALANINDA BİR FINTECH YENİLİĞİ OLARAK PARKAPP

Abdulmoniem Diri

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Bu tez; ParkApp, YZ, IoT, dijital cüzdan ve blok zinciri teknolojilerini entegre ederek kentsel park zorluklarını ele almak için tasarlanmış yenilikçi bir FinTech çözümü olarak bu tez kapsamında sunulmaktadır. Büyük şehirlerdeki artan araç kullanımı ve kentsel sıkışıklık ortasında ParkApp, park alanı dağıtımını optimize etmektedir. Kullanıcı deneyimini geliştirmeyi ve çevresel sürdürülebilirliği teşvik etmektedir. Önerilen uygulama kapsamında; arama süresini, yakıt tüketimini ve karbon emisyonlarını azaltmak için gerçek zamanlı verilerden yararlanılmaktadır. Blokzincir ve dijital cüzdan entegrasyonu aracılığıyla güvenli ve verimli işlemler sağlamaktadır. ParkApp'in ölçeklenebilirliği, toplu taşıma gibi daha geniş akıllı şehir girişimleriyle entegrasyona izin vererek onu gelecekteki kentsel yönetim için önemli bir araç haline getirebilmektedir. Bu tez çalışmasında, ParkApp'in kentsel hareketliliği dönüştürme, trafik sıkışıklığını azaltma ve gerek büyük şehirlerde gerekse daha küçük topluluklarda ekonomik verimliliği teşvik etme potansiyelini vurgulayarak daha yaşanabilmektedir. Bu sayede, sürdürülebilir kentsel ortamlar yaratmaya önemli ve ciddi ölçüde katkıda bulunmaktadır.

Anahtar Kelimeler: Akıllı Park Yeri, FinTech, Blokzincir, Yapay Zeka (YZ), Nesnelerin İnterneti (IoT).

To My Family



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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
IoT	Internet of Things
GPS	Global Positioning System
RFID	Radio-Frequency Identification
EV	Electric Vehicle



Chapter 1

Introduction

Nowadays, owning and using a vehicle has become a necessity rather than a luxury. During the COVID-19 pandemic, which started in 2019 and whose effects we are still experiencing, the number of vehicles in traffic has increased due to the widespread use of personal vehicles and the decrease in the use of public transportation in crowded cities. This situation was a problem in many crowded cities before the pandemic. However, after the pandemic, it has become one of the problems that municipalities are focused on solving. Although the number of parking areas in cities has increased, it is seen that more is needed to meet the parking demand (Buldakov et al., 2020). The only reason for this is not the increase in the city population and the number of vehicles. There are many reasons, such as the ineffective use of the parking lots available in the city, inconsistency of pricing policies, and the fact that the locations of the parking areas are only sometimes known. For this reason, it has become the agenda of decision-makers that people living in cities can reach parking spaces efficiently, park quickly, and ensure fairness in pricing. A solution to this problem brings many environmental gains, including reducing carbon emissions and traffic congestion in the city.

In this study, we present a process automation application, ParkApp, as a solution from a FinTech perspective. ParkApp is designed to restore the parking supply-demand balance that has emerged due to urbanization. It aims to prevent municipalities from having to invest in more parking spaces, thereby promoting a fair and equal parking environment. By encouraging and activating smart cities and smart transportation, ParkApp ensures that everyone has an equal chance to find a parking spot, regardless of the time or location.

This solution, named ParkApp, In addition to being a FinTech application with the feature of offering a reservation, payment optimization, and mechanism, is an integrated solution that utilizes communication and localization technologies Internet of Things (IoT) technologies to collect data from sensors of smart devices such as

phones, machine learning, and Artificial Intelligence (AI) technologies for data processing and to create insights and recommendations as a result. While developing this study, the existing infrastructures used for smart cities were considered to avoid the need for duplicate or new investments. For example, today, municipalities have partially switched to smart urbanization and use a low-power vast area network (LPWAN) that increases capacity and range by considering parking, vehicles, and power consumption (Iacobescu et al., 2021). On the other hand, Bluetooth and Ultra-Wide Band (UWB) are used as positioning techniques to reduce infrastructure installation and regular maintenance costs in parking lots. The ParkApp application will be designed to use these infrastructures and easily integrate with other components.

The ParkApp system, designed within the scope of this study, comprises several key components that work together to provide a comprehensive parking solution. These components include a Digital Wallet for secure and reliable payments, IoT for real-time information exchange, and AI for optimizing parking lot usage and decision-making.

Digital Wallet: It is a FinTech application that integrates all the features of secure and reliable payment by using QR code technology, whether there is an attendant in the parking lot or not, by using information such as parking lot selection and usage time.

IoT: This component, which connects various devices, including smartphones, smart cars, and urban infrastructure sensors, provides real-time information exchange. IoT is used to determine the availability of parking lots, communicate with users through accessibility applications, and guide them to the right parking lot.

Using AI, optimizing the use of existing parking lots, implementing data-based decision-making approaches such as users' parking habits, density of parking lot usage, user satisfaction, and optimizing pricing policies are provided.

Using integrated technology, ParkApp aims to unite different actors, including the public, municipalities, and public/private parking operators. For this method to work, it is important that all stakeholders volunteer to cooperate in sharing data on parking and parking spaces and urban mobility data. For this, cybersecurity approaches should also be considered to ensure the security of the data-sharing infrastructure and data-processing platform. In this context, municipalities have an important role to play.

Through partnerships and data opening, cities are in an advantageous position to build a more tightly-knit parking ecosystem that works better for all sectors involved. This is important for the long-term scalability and sustainability of smart parking solutions.

Since ParkApp collects and processes large amounts of data from multiple sources, such as the system, users, vehicles, or infrastructure, it is essential to ensure that all this information is processed securely. Implementing blockchain technology in ParkApp could solve this problem in the future. The decentralized and immutable accounting system of blockchain provides a secure way to record transactions and data changes, reducing the risk of data breaches or unauthorized access.

As cities worldwide grapple with global warming-related issues, the adoption of sustainable technologies becomes imperative. ParkApp, with its remarkable environmental benefits, is a significant step in this direction. By reducing the time spent searching for parking, ParkApp directly contributes to the reduction of carbon emissions and fuel consumption. This, in turn, helps in the indirect reduction of air pollution. Therefore, ParkApp not only solves short-term urban parking challenges but also becomes a crucial element in future strategies focused on regional planning, making the audience feel the positive impact on the environment.

1.1 Objectives

This study aims to provide a cloud-based visible solution to introduce ParkApp, which can help manage urban parking hotels, shopping malls, and entertainment venues. It includes a parking area and management panel, account and payment module, user interface, parking expense, and analytics features on license plate amounts. ParkApp features include user identification, status recognition, location spoofing, time-based, pay-per-parking, commonly displayed license plate recognition, GPS tracking, Yahoo and Bing-based mapping system, and payment history (Griggs et al., 2015). The main focus is ParkApp dealers, parking lots, and consumers who can open accounts and book parking spaces. It provides simple services that provide users with the capacity to reserve cheap or expensive parking spaces in real time, assign payment processing obligations, expose payment authentication and decryption applications, and outsource server hosting. Since end users are optional, ParkApp credentials are less likely to be breached. For parking lot owners, ParkApp offers the potential for significant cost savings, fostering optimism and interest in the solution.

One of the significant challenges in urban areas is the need for more parking spaces, which significantly contributes to general traffic congestion. Drivers often need help finding empty parking spaces, leading to increased travel time, fuel consumption, air pollution, and a larger carbon footprint (Ionita et al., 2019). Moreover, the issue of driving from parking spaces further exacerbates the problem. A robust parking management system in urban centers is crucial to address these issues. An effective parking management infrastructure, such as ParkApp, can optimize space utilization and improve the normal functioning of a city by reducing traffic congestion in terms of quantity and severity (Liu et al., 2012).

1.2 Theoretical Framework

This Research has brought together several theoretical frameworks that address urban mobility, technologies for smart cities, and the incorporation of complex computing systems. Urban systems theory, which examines city dynamics and infrastructure management challenges in densely populated areas, can be the study's theoretical foundation. On the other hand, the smart city framework also plays an important role. This framework emphasizes using digital technologies such as IoT and AI to improve the efficiency and longevity of urban services. Furthermore, the idea of blockchain is incorporated to investigate how decentralized, immutable ledgers can provide secure and transparent data management within urban systems. ParkApp is a smart parking solution aiming to improve the city parking experience by utilizing AI, IoT, and blockchain technology. The combination of these frameworks forms the basis for creating and implementing ParkApp.

1.3 Statement of Problem

Parking management is a problem area that is attracting global attention due to the traffic congestion, environmental problems, social issues, and economic inefficiency it creates in crowded cities. New and more effective methods are being developed every day.

As smart city developments become widespread, there is an increasing need to ensure data privacy and security. This is especially true as more personal and vehicle data is collected and processed. These challenges are further compounded by the fact that current parking systems do not interact with complex technologies such as AI,

IoT, and blockchain. This highlights the need to develop creative solutions that can address the complex nature of urban parking concerns.

1.4 Purpose of Study

In this study, an innovative urban parking application and management system is being developed with the ParkApp presented. This study can also be considered as a type of process management application. Within the scope of this study, data communication, location information collection technologies, IoT, AI, and digital wallet payment approaches were examined to meet the project's needs from a FinTech perspective. A sophisticated and revolutionary solution was planned by offering many innovative technologies to the municipality, parking lot owners, and vehicle owners through a phone application. Moreover, the main output of this study is the optimum use of parking lots, reduced traffic, time savings of users, and price equality while indirectly reducing carbon emissions, social stress, and economic efficiency. The findings of this study will provide important insights for policymakers, urban planners, and technology developers. At this point, by addressing parking lot efficiency with demographics and other economic data, new study topics may also emerge for social science researchers.

1.5 Hypothesis and Research Questions

1.5.1 Hypothesis

- By integrating parking spaces in cities into a system that harmoniously uses integrated advanced technologies (AI et al., etc.), traffic congestion and the time spent searching for parking spaces will be minimized, ultimately leading to improved urban mobility and environmental outcomes.
- Using a priority order determined by users' bids and notes in ParkApp will increase the efficiency of parking space distribution, leading to improved user satisfaction. Moreover, this approach will create significant economic gain opportunities, fostering a sense of optimism and interest among the audience.

1.5.2 Research Questions

- Can AI-powered technologies optimize real-time parking spaces to reduce congestion and traffic congestion in large cities?

- What are the privacy and security benefits and risks of incorporating blockchain technology into urban parking systems like ParkApp?
- How does implementing smart parking systems affect life in large and densely populated areas, considering the overall environmental impact?
- How do the economic benefits of implementing a smart parking system in small to medium-sized cities compare to those in metropolitan areas?
- What should be done to improve the user experience and encourage the broader adoption of smart parking systems?

1.5.3 Significance of the Study

The factors that make this research important can be listed as follows:

It provides an alternative, low-cost solution to parking management problems that lead to traffic congestion, environmental degradation, and economic inefficiencies. This is achieved by addressing major challenges in urban mobility. It uses innovative technologies to improve parking space use, which has the potential to be implemented in cities around the world.

The results of this research have the potential to impact urban planning and policy regarding the design and implementation of smart cities. Insights gathered from ParkApp's economic, environmental, and social impacts can assist policymakers in the process of evidence-based planning and application development.

This research makes a significant contribution to both theoretical and practical knowledge in this field. By integrating advanced technologies in real-time and urban contexts, it provides practical solutions to the challenges of urban mobility and parking management.

This research reveals that the demands and concerns of city dwellers should be addressed when implementing new technologies by focusing on user experience and data security. This approach emphasizes the importance of user experience.

1.6 Challenges in Implementing ParkApp

ParkApp's implementation, which goes beyond academic work, not only identifies urban parking problems and offers solutions to them but also identifies challenges that need to be systematically addressed to ensure its success. These multifaceted challenges are accelerating the use of complex technologies such as blockchain, AI, and real-time data processing to make existing municipal and city

infrastructures smart. However, it's not just about technology. The project also involves meticulous strategic planning to protect user data, follow legal and regulatory frameworks, and manage high initial installation costs. This emphasis on strategic planning underscores the project's thoroughness and its commitment to user data protection and legal compliance. Moreover, its gradual adoption by users and all stakeholders involves creating a smooth transition plan and enabling well-planned education, information, and stakeholder engagement to ensure widespread adoption.

- **Integration with Existing Infrastructure:** A prominent challenge is scaling ParkApp with existing infrastructures, such as public parking systems and municipal databases, without requiring new investments.
- **Protecting User Data Security and Privacy:** Ensuring the security and privacy of user data while processing real-time and large amounts of data from multiple sources is always a challenge for such integrated technologies. Blockchain can mitigate some of these risks, but it will still take time for the technology to be accepted by the public.
- **Extended Time for Adoption of the Technology by Users and Stakeholders:** The advanced ParkApp technology may require a learning and trusting process for users and municipalities. This is called a learning curve, and for such behavior-changing applications, this curve may rise slowly. Learning and adoption incentives such as training, informative workshops, and events where stakeholders are involved will be required to encourage widespread and rapid application adoption.
- **Legal and Regulatory Barriers:** Data privacy, blockchain usage, and smart city infrastructure regulations all affect the use of this application and the mechanisms to generate revenue through this application, which may sometimes require legal advice. Barriers or facilitators should be identified, especially in different countries or regions.
- **Implementation Costs:** The advanced technology stack makes the initial cost of setting up ParkApp higher than simpler parking solutions. Therefore, it is necessary to correctly analyze the benefits it will provide and prevent early withdrawals.

Chapter 2

Literature Review of ParkApp Features

2.1 Outdoor & Indoor Parking Solution

The proposed system can be effectively used in various outdoor and indoor parking lots to assist drivers and increase their comfort. For example, it helps visitors save time without searching for parking spaces and without long queues in parking areas. The system also supports drivers in finding a specific parking space with the features they need according to the occupied or empty spaces and making a reservation there within certain time limits. Many smart parking systems have already been tested in different countries, and a successful trial in Turkey has yet to be conducted. Unlike other examples, it differs in functionality, capacity, efficiency, and centralization of the proposed parking system.

In the literature research, emerging technologies, systems, and their features and comparison criteria during the development phase of this study were important. The indoor parking solution also helps drivers find and reserve spaces with features such as car wash, battery charging, tire parking, and parking near elevators inside huge buildings such as cinemas, shopping malls, or hotel buildings. This system leads to easy control of indoor parking spaces. A smart urban parking strategy with visible occupancy status in parking areas, reservation application, and payment options through a digital wallet application improves the user experience. It complements existing smart parking systems (Fahim et al., 2021). An architectural plan should be prepared for technical assistance and mechanisms to expand it to metropolitan and small parts of Smart Cities (Chandrasekaran et al., 2021). Design aligned with the principles of accessibility and inclusiveness contributes to developing a flexible, scalable, and integrated smart parking ecosystem (Iacobescu et al., 2021).

2.2 AI Integration

In order to ensure the order and management of parking supply in cities, studies on digital mobile parking applications are increasing as of 2022 to transparently and efficiently manage excess capacity in a global context. These parking applications are not ordinary applications but rather digital platforms. Because they collect and process

data and, accordingly, provide recommendations and decisions to users, parking lot owners, and local governments. They benefit from AI technologies while doing this. AI enables digital parking applications to optimize the use of these mobile inventory management platforms and assign the empty parking space supply digitally. The dynamic use of urban parked assets using AI in digital parking applications may be the most critical component of post-pandemic parking systems.

The change in human behavior and social distancing, which has become a social culture with the COVID-19 pandemic, has radically changed city community behavior (Dalla Chiara et al., 2022). Estimates in some studies suggest that more than 30% of available parking spaces were left empty during the pandemic (H. et al., 2022). Parking applications stand out as a significant opportunity to reuse and repurpose these urban spaces to help revitalize public life (Sutjarittham, 2021). In particular, nearly abandoned parking areas open up opportunities to repurpose parking spaces for broader public use, such as creating dedicated pick-up and drop-off (PUDO) zones or expanding café and business operations into park streets.

2.3 Digital Wallet

Digital wallets can be defined as an online service provider and computer program. They function as electronic devices that allow users to make electronic transactions by exchanging digital currency for goods and services between parties. Traditional wallets have almost started to disappear, but digital wallets have started to be used in many applications, including ParkApp. Digital wallets significantly reduce transaction and fraud costs and stand out by facilitating payments.

The increasing desire of users for convenience, speed, and privacy, combined with a race to design customer-friendly experiences by key market players, has led to the rapid adoption of digital wallets. In ParkApp, a digital wallet is used to integrate payments. The digital wallet application allows the user to securely transfer money to another person or business and quickly pay their parking bill in a short time by opening ParkApp and choosing to pay their bill. The digital wallet application allows you to make electronic transactions, including parking payments, through digital money. It connects to a user's bank account or credit card and sends encrypted data to transfer money from the payer to the recipient during a transaction (H. et al., 2022). The digital wallet in your ParkApp securely stores payment cards, rewards cards, and loyalty

cards. It is used to enable in-app payments and customer purchase details. The user must fill in the card details once, and the digital wallet is responsible for securely managing the details for future transactions. It also allows the user to shop online and offline using the apps or websites of businesses that accept the wallet.

Smart parking applications are a pivotal part of the transition to smart cities and the evolution of innovative data-driven systems. Cities and municipalities are increasingly adopting advanced wireless parking solutions with robust analytics to better manage parking resources, promote economic development, and enhance citizen services (A. et al., 2020). Today's mobile technology offers solutions that help users find parking spaces and connect vehicles and people to various parking operators via mobile apps or the Internet (Iacobescu et al., 2021). ParkApp, similar to Turo, BMW, Ford, and Nissan, is dedicated to reducing emissions from passenger cars by facilitating the sharing of parking spaces, a particularly important initiative in European Union countries.

2.4 Real-Time Availability

The electronic product code RFID and EPC consist of an embedded wireless sensor tag that can obtain and broadcast real-time information about the location of indoor or outdoor parking spaces, for example, at frequencies of 2.45 GHz to 5.8 GHz, and IoT-based devices; for example, indoor or outdoor parking space location, which is more critical with low speed or real-time parking space availability and fee amount.

Real-time parking space availability; In cities, parking spaces can be disorganized. Parking spaces can mainly consist of personal vehicles parked in various public spaces (Iacobescu et al., 2021). A significant disadvantage of parking spaces in the city is that they cause excessive congestion and negatively affect public freedom and manually controlled road channels. The real-time problem of parking spaces in the city needs to be solved. Parking systems that cannot provide real-time availability information act like improperly located security systems (Liu et al., 2012). Plaza, UCSD parking lot and Sotera parking are planned smart parking systems. Various indoor parking systems and technologies are being developed, but not limited to, to deal with indoor parking problems such as noise barriers, pollutants, and architectural challenges (Sutjarittham, 2021). Mohammad Alaei et al. propose a transformative

design for parking facilities in which they detect available parking spaces using computer vision methods and provide real-time facilities.

2.5 Secure Payment

In one of the experiments in the literature, the parking fee was applied linearly or exponentially according to the distance from the parking area to the nearest E-bike charging station. The results of the experiments showed that parking space applications occurred approximately three-quarters of the time. When the exponential form was used, the parking space application occurred throughout time. The practical experiment conducted in four areas in the city center of Łódź, Pol, proved itself in several areas by collecting E-bikes from severely restricted areas more than 20 times. The evaluation of the E-bike parking count showed that the number of parking events for one of the parking fee forms was close to the maximum value.

Users verify their payments through secure transactions with personal identification numbers such as PINs (Yan et al., 2023). It can also be considered as a web3 application due to the use of blockchain-based smart contracts. The smart contract was developed in the Solidity programming language and can be responsible for financial transactions on the Ropsten Ethereum test network. The smart contract manages three different types of transactions, relParking, namely parking fees, suspension, and resumption of E-bike rental, using an inteParking fee policy when a user parks his E-bike in a restricted area. Suspension and resumption of an E-bike rental realize the implementation of the restricted area parking zone. It supports E-bike theft detection and usage rate optimization. A similar approach is also planned to be used in car parking systems.

Secure payment is a key function of applications that aim to optimize the use of parking spaces and reduce the problem of parking space scarcity (Zhao et al., 2023). A simulation study determined a combination of markets and agreements through Game Theory as the most efficient parking space allocation mechanism. Kwanbae Park et al. proposes a parking space finding and allocation system that can handle price-quantity agreements and changing numbers and order quantities, thus maximizing the social welfare of suppliers and demanders. In terms of payment security, in the future, U-Park Token (UPT), which is the payment currency in parking applications, is envisaged to operate using the Metamask Software Development Kit.

2.6 Benefits of Parking Applications

Reliable smart parking applications and platforms like ParkApp offer numerous advantages. For city dwellers, a significant reduction in parking space searches is often seen at the beginning of meetings (Chandrasekaran et al., 2021). Other advantages associated with digital platforms are that they provide users with control over the final cost they will incur, reduce malware, provide more information about the status of available parking spaces and the accessibility and inclusiveness services of the parking space before arrival, and ensure that payment is automatically provided.

These revolutionary applications are the emergence of new public transportation paradigms, especially for on-street and off-street Parking, Parking, and e-parking. To explore these paradigm shifts, this paper presents a case study of the separate application of e-parking services by Engineering Ingegneria Informatica (Sutjarittham, 2021). It is accessible through a web application designed for the service portal and a mobile application for iOS and Android phones. In recent years, transportation in cities has been provided by a change such that shared services are increasingly used for individual mobility (Huang et al., 2021).

2.6.1 Improved Urban Mobility

In response to the COVID-19 pandemic and efforts to rebuild the economy more inclusively, sustainably, and resiliently, Australia is targeting policies and practices focused on the economy as part of its smart cities' strategic transport plans. This forward-looking approach includes leveraging a range of technologies to facilitate public transport, active transport, and car and ride-sharing routes. These technologies, such as matching apps and parking finder apps, are empowering ordinary Australians to prepare for a financially sustainable, socially active, and environmentally friendly future. For instance, ParkApp, a community-based app, is making significant strides in improving traffic and deliveries. The latest RAC Report highlighted that the availability of safe parking was one of the top barriers preventing respondents from cycling to work, with 36% identifying this as a critical deterrent. To address this, the paper proposes innovative parking demand management strategies, including smart and dynamic pricing systems (Huang et al., 2021).

Smart parking systems, a key component of our proposed strategies, harness technology to monitor parking availability. By providing drivers with real-time data on space availability, these systems significantly reduce the time spent finding a parking space. This not only eases the frustration of drivers but also has a profound impact on urban congestion and the resulting emissions. Dynamic pricing strategies, another crucial element, aim to use market signals to manage parking demand. This includes dynamic parking fees, where parking availability varies by time of day, with higher prices during peak demand periods to shift parking demand to low hours, or parking allocation that varies over time based on supply and demand (Hafiz Hasan et al., 2019).

2.6.2 Technological Advancement

For the first time, it combines information about non-specific parking facilities to create a request; an approach that reduces parking search and fees is mentioned. Distributed parking networks create designated state-of-the-art parking areas, offering a level of convenience that was previously unheard of. Widgets communicate and exchange data with street-side devices, further enhancing the user experience. Distributed parking networks are allocated closer to the holiday destination, and it is argued that the current reserve fees are tight as they are available for a certain period. Since the allocated parking space distributes the vehicles equally, traffic passes through the parking area. Vehicle owners are motivated to like non-dense places and to be closer to many residences by the tight and false information funds of the reserve costs.

Technological progress plays an important role in today's world, especially in the realm of parking systems. Real-time development has been shown in the parking area, where customers are offered more refined and increasing facilities. Parking networks and good fee programs are IT products that make parking systems more systematic and user-friendly (Shen et al., 2024). After an application such as ParkApp is installed on a good mobile phone, it gets the locations of all nearby parking spaces and its image is proven. Each vendor is considered a master server in Adri Labs for the parking management system. Each parking vendor coasts its own server. On its local server, the vendor performs daily transactions, waiting entries, activation and billing in retail.

Smart Parking applications increase the efficiency of the parking system by combining computerized information expertise to minimize space loss or high-quality time in searching for available parking spaces. The entrance management uses an intelligent parking management system to determine availability and provide fast parking and driving opportunities. Parking data is presented to the operator, and reservations can be made. The traditional parking system has become redundant due to the need for greater integration with technology (A. et al., 2020). Vendors provide their information to other developers so they can integrate this information with their systems. However, more satisfactory solutions can be found for end users. A unified network is created that requires an infrastructure and information exchange with different vendors. The parking platform consists of the controller server and the local server of the parking vendors. The network of vendors in the system creates a parking contract with users (Iacobescu et al., 2021).

2.6.3 Economic Benefits

It is not easy to find parking in most major cities, and the conditions are similar in the Australian cities we have considered as an example. One reason for this is that there are many cars on the roads. Such a design is important to facilitate vehicle use in cities. One of the advantages of this situation is that users can get to where they want to go in a relatively short time. Therefore, individuals have started to use private cars, and the number of cars circulating has increased (Huang et al., 2021). Suppose vehicle users start to use public transportation, even if the number of cars on the roads and the parking problem in the city decreases. In that case, this has only sometimes been activated. This situation has become even more clear after the pandemic. Therefore, the ease of finding parking, the safety of the car, and the establishment of correct behavior can be targeted. Therefore, the establishment of the right parking policy is a critical issue.

In order to achieve better fairness in parking pricing, the maintenance of management measures is transformed into more regulatory measures and actions based on parking data. Mobile online payment is the primary way to run a parking pricing system effectively. The automated parking system can monitor and manage the parking fee of the Fee Control Department. In addition, sensing and prediction

technology can help detect the parking time of the vehicles and customers in the parking lot (Yu et al., 2022). Moreover, real-time navigation makes it easier for consumers to understand everything. With real-time guidance, it is easier for customers to find a suitable parking lot. Pricing is very important to regulate parking usage and promote efficient use. Various and flexible parking pricing plans can be designed to reduce the inefficiency of finding and using parking spaces. Parking pricing can be divided into peak and off-peak pricing. Peak pricing can balance demand and supply over time and increase parking occupancy. Thus, parking resources are saved, reducing parking congestion (Fulman & Benenson, 2019). The impact of pricing on the urban environment is significant. However, this approach ignores individual fairness and focuses on transportation efficiency.

2.6.4 User Convenience

One solution for comparing parking experiences is to offer the waiver of fees through the provider for the lowest fee. Public parking lots in Weiz have various ownership structures and political obstacles, such as the need for a municipal decision to provide discounted parking (Chou et al., 2021). It is envisaged that implementing a smart parking management system in a more oversized garage of this shopping and event center in Austria could reduce the need for personnel (Ionita et al., 2019).

A parking solution used on a smartphone improves the user experience in an electromobility environment. In the city of Weiz, a parking guidance system shows the user the number of parking spaces in three available garages. Another application called ParkVia is another example platform that allows drivers to pre-book parking spaces in garages, hotels, or airports and search for available spaces in their surroundings. Innovative parking solutions are attracting global attention to reduce the resources wasted by vehicles and their users searching for parking spaces (Fahim et al., 2021). The essential features that make the user ecosystem more effective are reservations, reliable information, appropriate equipment, and ease of use. To increase user comfort, parking solutions with innovative technologies often combine information about the surrounding infrastructure, such as charging points or current traffic conditions.

The article published by Ahad et al. (2022) argues that the relationship between current mobile parking applications and social sustainability is reflected in the

transportation issue in cities. The study is based on the idea that mobile applications can promote social networks. It pushes the boundaries to examine the contribution of social networks formed around Mobile Crowd Platform (MCP) applications to sustainable mobility in cities. This article contributes to the existing literature on MCP applications by investigating the relevant social capital, which has been neglected for a long time. The research results show that MCP applications can enable many aspects that characterize social capital information exchange, communication and commitment, time-saving, and coordination (Ahad et al., 2022). These elements are important for better traffic flow and improved parking management.

As another comprehensive survey, Buhari, Ahmad, and Nordin, a research study, provides an overview of smart parking applications in Malaysia through mobile applications and their types and methods from the design review. In doing so, they highlight the need for flexible approaches combining architecture, innovation, and de-technology strategies to solve explicitly urban challenges such as excessive congestion. This paper discusses implementing a new sensor approach for SPS based on its development and implementation. A small single-board computer such as RPi or Arduino is connected to the cloud via battery using proximity sensors, a camera, and, thus, an LED signaling buzzer (Buhari et al., 2024). SPS consists of 3 primary components: data collection using sensors, a mobile application, and a monitoring center.

Hadi, George, and Ahmed provide a detailed review in their paper on computer vision-based approaches to smart parking systems (SPS) that aim to realize potential benefits for intelligent transportation systems (ITS). The authors acknowledge that SPS is a rapidly evolving field, given the many nuances associated with improving parking space provision and management in urban environments. This research focuses on improving smart parking systems by utilizing computer vision approaches. These systems process visual data to provide up-to-date information about where suitable parking lots are available for selection, thus helping to utilize city space and reduce pollution intelligently. In addition to using computer vision approaches, they list some of the datasets commonly used to train and test SPS in their experiments and a literature review (Hadi et al., 2024). Ahad, Song, Li, and Rahman's 2022 research paper explores how social capital connects to sustainable transportation by utilizing studies to develop MCP applications. Their research provides insights into the under-

researched area of social capital in mobile applications, which is an aspect related to helping people implement sustainable practices during their urban mobility journeys. Previously presented studies have identified the creation of social networks among users through mobile applications.

On the other hand, an investigation is presented on the contribution of these networks to transportation sustainability, together with their components in terms of social capital. The results show that these variables are crucial to achieving sustainable transportation goals by increasing integration and efficiency in parking management offerings. The findings complement established social capital network approaches that emphasize the dimensions of bonding, bridging, and networking while introducing new aspects related to urban mobility (Ahad et al., 2022).

In their 2022 article, Lopes et al. present a methodological framework for revitalizing urban green spaces structured as an integrated network representing sustainable urban greenways. One of these initiatives centers around Curitiba, the capital of Estado do Paraná (Brazil), a historical example of progressive urban planning and environmental protection. This research aimed to investigate the possibility of overcoming barriers to biodiversity conservation and ecological functioning within an urban matrix by implementing a network of greenways connecting green spaces throughout Edmonton alone. The study is concentrated in the mainly urban areas of Curitiba.

Chapter 3

ParkApp Implementation

Applications for dynamic parking information and algorithms used to collect and interpret parking information, especially processing real-time parking information, are proposed. In addition, assigned protocols can be modeled to control parking systems. In addition, various energy-saving measures are presented to parking lot managers and parking customers' terminals. This situation provides energy savings of up to 19.5%-21.7% when there is a dynamic daily parking rate of 45.5%-55%. A proposed parking meter concept and an intelligent parking system are designed. The important contribution of the literature to these studies is:

- i. Modeling the parking application and assigned protocol.
- ii. A Real-time dynamic parking space information capture algorithm is proposed, and an allocation mechanism is determined.
- iii. Energy-saving measures are presented to parking lot managers and parking customers' terminals.

3.1 Development Process

Existing parking lot systems can be divided into two categories. At this point, BiNetWork and Multi-GNSS databases emerge. ParkApp uses BiNetWork and Multi-GNSS, which provide parking lot and database information for parkers.

According to (Sutjarittham, 2021), various smart parking systems can be noticed according to their development and deployment in the global context. Many parking users use PGIS (Parking Guidance and Information System) and transit-based information systems. Smart city authorities use information technology developments to collect, analyze and transmit parking data to parkers. With these embedded wireless sensors and edge technologies, dynamic parking information, innovative payment and automatic parking systems are provided. ParkApp, a unique smart parking system, stands out from all the studies by providing dynamic parking information. It also provides the opportunity to provide static parking space information and ParkApp is suggested as a smart parking system to improve dynamic and static parking space.

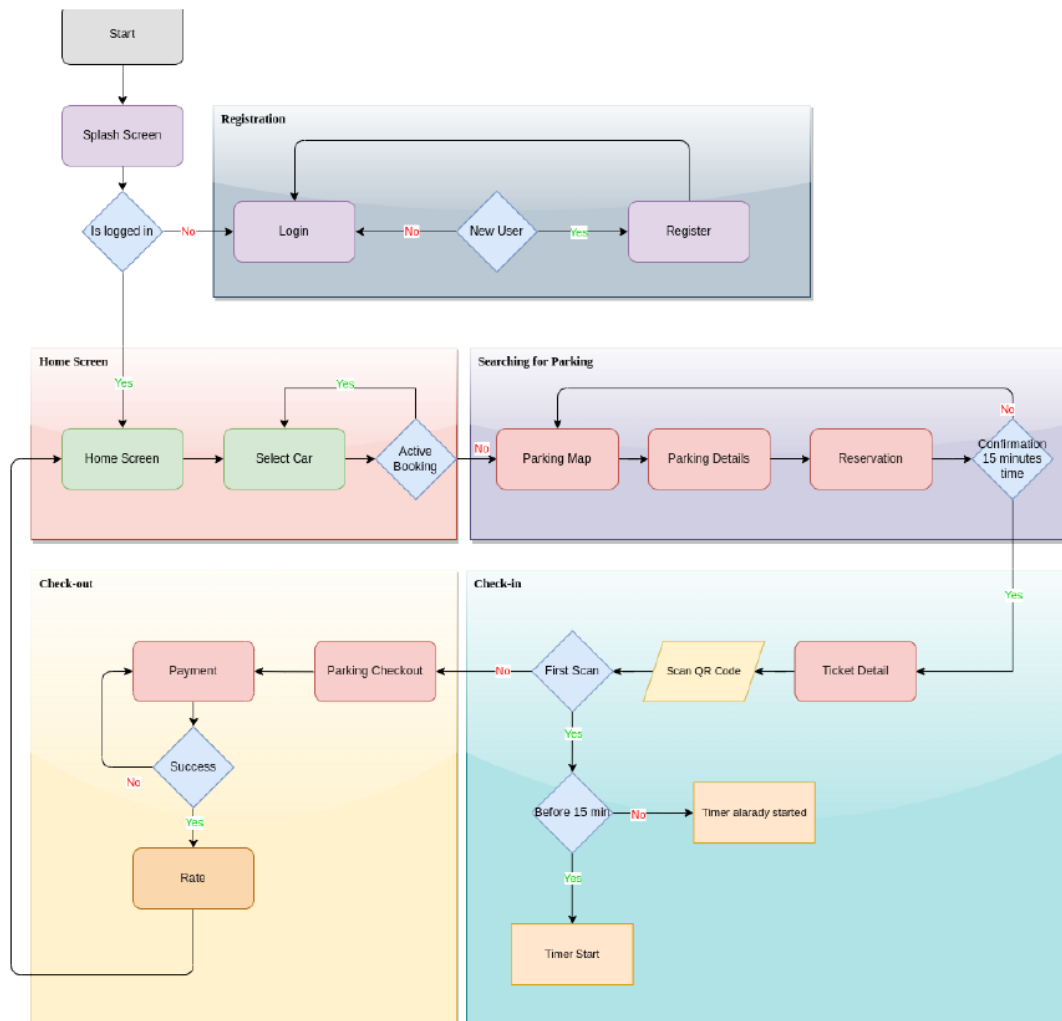


Figure 1 Overall ParkApp Flow Chart

3.2 Testing Phase

When requests to the parking application are made simultaneously, it is necessary to check how the database works, the capacity to accept requests and the behavior when the capacity to accept requests is exceeded. There are two segments in the server. The first is the database of entries, and the second is the segment communicating with ParkAPP users. ParkApp stores the details of all users in the database, and each time the data is stored, the transaction procedure is performed through a DNS server. The defined DNS ensures that the procedure is applied separately to the relevant area without congestion due to increased capacity. DNS servers are defined together to define a suitable security mechanism. Because if one server is down, the other automatically takes over. In this case, the servers that record the occupancy rate of parking spaces or the transactions of customers or users using

ParkApp will be closed or available. PANIDS blocking will close access for users with the same IP addresses. If a user reconnects to ParkWIFI and accesses a ParkApp, it will be automatically directed to the same DNS server if defined on an Android or iOS device.

After the application is completed, the testing phase is started. Initial tests were conducted in the developer's work environment to check the features and requirements of the application. The test confirmed that ParkApp works correctly on both platforms, iOS and Android, for which it was intended. The application presented as ParkApp is designed to work on smartphones and tablets and requires a location to be opened. As a result of the tests, it was confirmed that ParkApp works successfully and provides customer service (Li, 2023). After ParkApp is reviewed, the literature recommends server testing involving end users (Liao et al., 2016). This can be considered as the stage before the application goes into production. Stress tests are always planned to be conducted at this stage. Other security tests are also ongoing, adding other encryptions, parameterized security, and other security protections as we deem necessary, if necessary.

3.2 Deployment Phase

The problems addressed throughout the study were designed to be available 24/7, easy to use, innovative, location-based, and allow users to compare available parking options through the ParkApp application. Users can reserve a parking space with various payment technology options by choosing ParkApp. Electronic tolls can be paid, and a built-in map and navigation system can be used to verify location accuracy and get turn-by-turn directions. ParkApp also stands out by allowing users to rent parking spaces for a certain period. In addition, payment is allowed after the user arrives at the parking spot. On the other hand, it creates a suggestion system for parking spaces based on users' past data and helps them find parking spaces.

Parking is a mandatory action for vehicle owners in cities. It is thought that a person living in a city spends an average of 106 days looking for a parking space. These statistics argue that parking is a critical component of the travel process. Losing time in parking queues, fear of fines due to incorrect parking, and high parking fees are significant sources of stress for those driving in the city. Despite various structural

studies and articles on parking, parking remains a critical problem in urban areas. Parking space selection is caused by fatigue after a long drive, lack of trust in location-based information, lack of various payment options, and lack of parking space comparability (Iacobescu et al., 2021).

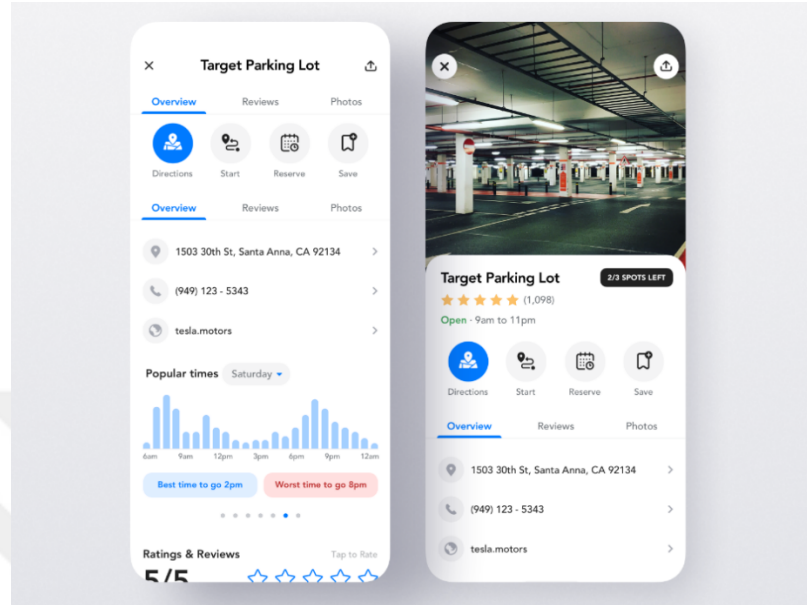


Figure 2 ParkApp for Finding EV Charge Station

ParkCloud is a global airport parking consolidator that solves parking problems in more than 400 parking lots in 40 countries and 78 airports, saving an average of 50%. This solution is a major inspiration for this study and involves passengers booking parking spaces online before their trip or upon arrival at their destination. Despite the buffer provided by ParkCloud, ParkCloud must solve parking challenges in urban areas (Ortigueira et al., 2016). The ParkApp application we developed to improve ParkCloud's current offerings is presented. ParkApp offers various services, including indoor and outdoor parking, valet parking, EV charging stations, and monthly parking subscriptions (H. et al., 2022).

3.3 SWOT Analysis of ParkApp

The ParkApp's SWOT analysis aims to provide a comprehensive overview of its strengths, weaknesses, opportunities, and threats. It demonstrates the app's potential to change the paradigm for urban parking through FinTech innovations. With this analysis in mind, it highlights ParkApp's strategic positioning, instilling confidence in

its ability to overcome urban mobility challenges and support the delivery of sustainable city environments.

3.3.1 Strengths

- **Technological Integration:** ParkApp stands out with its innovative use of AI, IoT, blockchain, and digital wallets. This cutting-edge technology equips ParkApp to address urban parking challenges with real-time and secure payment methods, sparking excitement about its potential.
- **Environmental Impact:** ParkApp's optimization of parking space distribution and reduction of vehicles' time in traffic not only improves urban mobility but also significantly reduces carbon emissions and fuel consumption, inspiring stakeholders with its contribution to sustainability.
- **User Experience:** ParkApp provides enhanced convenience through real-time usability, including specific examples of real-time usability, and secure, easy payment solutions. These features ensure a seamless and user-friendly experience for our customers.
- **Scalability:** The system can be integrated into broader smart city initiatives such as public transportation systems and has the potential to contribute to sustainable urban mobility.

3.3.2 Weaknesses

- **High Initial Cost:** Implementing such a technologically advanced system requires significant financial and collaborative investment, especially in integrating AI and blockchain.
- **Dependence on Municipal Collaboration:** ParkApp's success largely depends on partnerships with public and private parking operators, municipalities, and other urban stakeholders in Türkiye and many other countries.
- **Data Privacy Concerns:** ParkApp takes data privacy seriously and has implemented robust measures to protect user and vehicle data, including specific technologies. The system is committed to maintaining the highest data security and privacy standards, especially with the implementation of blockchain and the IoT.

3.3.3 Opportunities

- **Expansion to New Markets:** ParkApp has the potential to be rolled out to different urban areas or smaller communities that face similar parking challenges.
- **Government Partnerships:** Smart city initiatives and government interest in reducing traffic congestion and environmental impact present a critical opportunity for ParkApp to grow.
- **Integration with Electric Vehicle (EV) Infrastructure:** ParkApp can be integrated with EV charging stations and partnerships with these companies to further contribute to environmental sustainability.

3.3.4 Threats

- **Technological Failures:** Dependence on technology can lead to challenges such as system failures or errors, potentially impacting user trust and engagement.
- **Market Competition:** The smart parking industry is competitive, and other companies could develop similar applications.
- **Adoption Resistance:** Users and municipalities may resist adopting new technology, preferring traditional parking solutions. It may take time to convince them of ParkApp's benefits and to encourage the participation of other stakeholders.

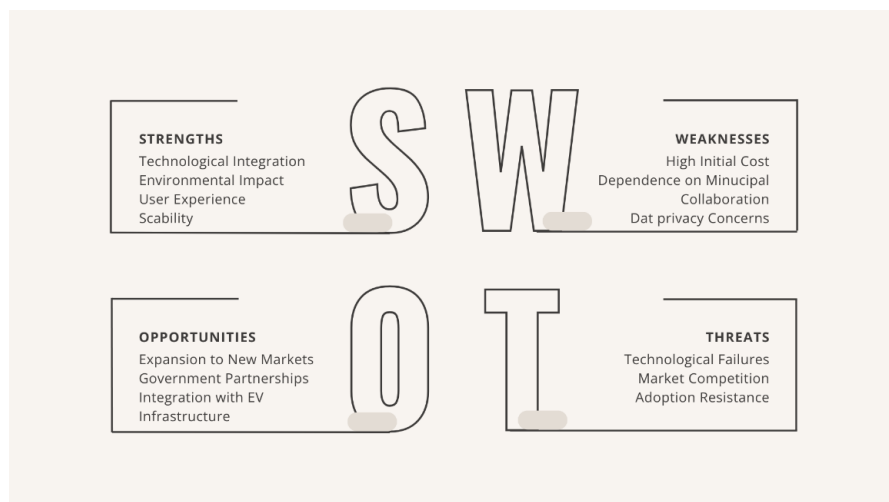


Figure 3 Summary of SWOT Analysis

Chapter 4

AI-Driven Recommendations

To emphasize the application of the study and its relationship with AI through an example, access points to schools are usually the scene of heavy traffic in the morning hours of the day. Small and medium-sized parking lots located within the campuses of educational institutions are filled long before regular classes begin. Due to this overloading of the parking facility, it is determined that visitors cannot take their places in the required parking area for their vehicles, and the people living in the city cannot benefit from their daily rights, including the right to education. Some visitors prefer to park their vehicles inappropriately on the side of narrow roads in order not to have parking problems and not to disrupt regular traffic. This situation creates another concern for traffic on the campus, and it has been noticed that it can be reflected to people as traffic fines. In order to prevent these problems and increase the quality of service for faculty members and other employees of the institutions, a Smart Parking System has been designed. However, the implementation of such a system comes with its own set of challenges, including the initial cost of installation, the need for continuous maintenance, and the potential for technical glitches. Despite these challenges, the benefits of the system in improving urban traffic management are significant.

Agent-based simulations benefit from understanding real traffic data and visualizing urban traffic evolution due to parking management. It uses various parking strategies and implementation levels. The parking strategy is determined by the number of vehicles entering or exiting the parking lots over time, the choice of parking type, and the choice of parking space (To Sum Ho et al., 2019).

More recently, studies have examined reserved parking options to address parking providers' decreasing service quality. To be fair, some systems also aim to maximize the revenues of parking lot owners or operators (Arhab et al., 2022).

By using AI-supported approaches and technologies, a smart parking platform can analyze historical data to predict future occupancy with minimal search time. This not only saves time for drivers but also ensures efficient use of parking spaces. To

achieve this, discrete-time queuing theory is used as an important stage of the study to formulate predictive models that predict the probability of future vacant parking spaces. Vehicles can make decisions based on these predictions and instantaneous observations. This seamless interaction between the management of parking structures and driver engineering, as demonstrated by Griggs et al. in 2015, reassures us of the effectiveness of AI in urban traffic management.

4.1 Optimization of Parking Space

Various algorithms and their limits have been determined within the scope of this study. Effective use of parking areas cannot be accepted as a solution to the problem of changing the existing parking space or determining the parking space. Expanding outside the parking area quickly causes calculation and visual problems; therefore, the parking simulation has limitations (Jemmali et al., 2022). In order to prevent these problems, the parking space search platform aims to create an MCSS system consisting of smart vehicles and parking spaces. For this purpose, cars are parked without following a specific arrangement. On the other hand, risks and costs are minimized in these scenarios, and thousands of cars can be parked in the parking models created by ParkApp for each experiment.

ParkApp is designed as a space-sharing platform to facilitate access to public and private parking facilities. There are basically two large parking areas in metropolitan cities: on-street and off-street areas. ParkApp offers a solution for off-street parking areas in big cities, where people can park their cars in already-constructed parking areas and make them accessible to others. Therefore, ParkApp adopts a parallel search for any available parking space, which makes the algorithm more efficient (Li, 2023).

Parking is defined as a nonlinear optimization problem. An important advantage of this problem is that it allows experiments to be conducted in a simulation environment. The solution of an optimization problem that affects the quality of the solutions of the problem solved simultaneously provides the basis for the use of the genetic algorithm (Varyaftsis, 2012). The integrated use of various methods and approaches for parking space selection has made it possible to minimize the error in drivers' prediction of parking space selection (Ionita et al., 2019).

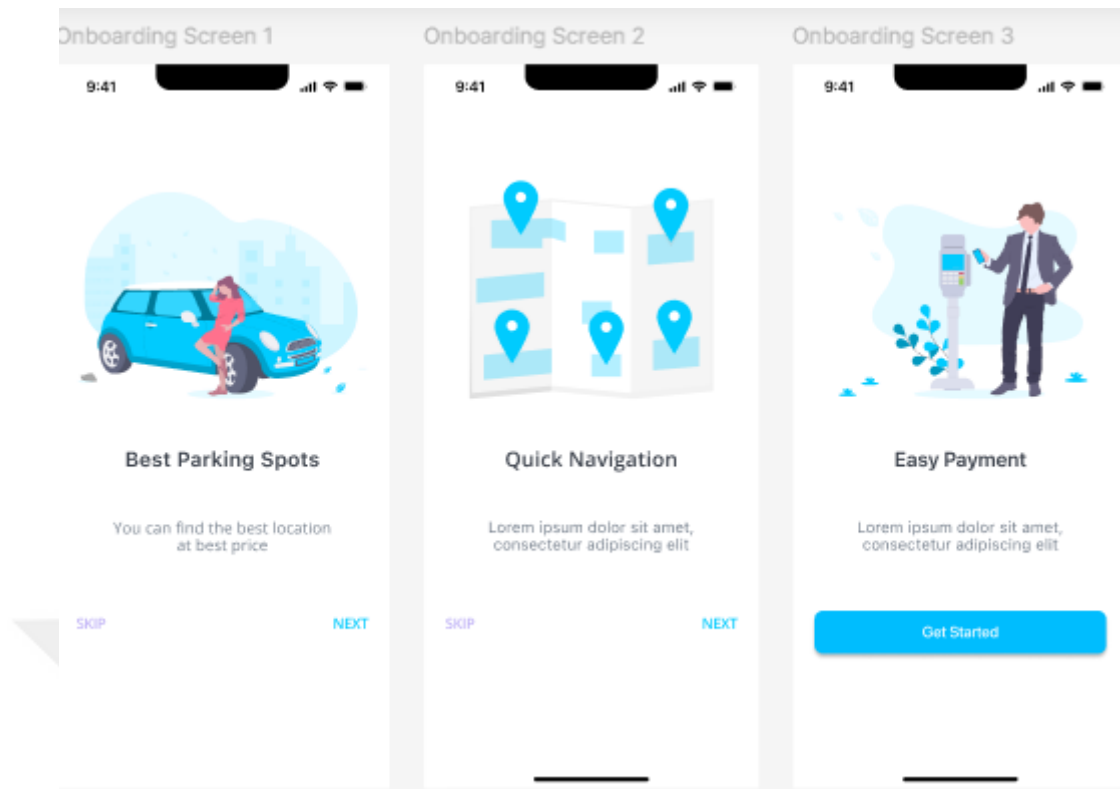


Figure 4 UX Case Study-Parking Space Finder

4.2 Reduction in Search Times

In general, advances in reducing the stress experienced by drivers regarding parking deserve praise. Research and studies conducted to date have consistently argued that smart parking systems can reduce the time spent by drivers on parking. They focus on optimizing parking space selection and directing vehicles to available parking spaces, thereby reducing parking space search times. For example, the introduction of electronic parking guidance and information has been presented as leading to a 43% reduction in parking space search times in Germany (Chandrasekaran et al., 2021). This platform is estimated to reduce the task time of searching for a parking space for each event from 8.6 minutes to 5.4 minutes. However, the lack of empirical data on the effects of smart parking systems on parking space search times and drivers' behavior, in general, indicates that more academic research is needed in this area and that this still needs to be explored (H. et al., 2022).

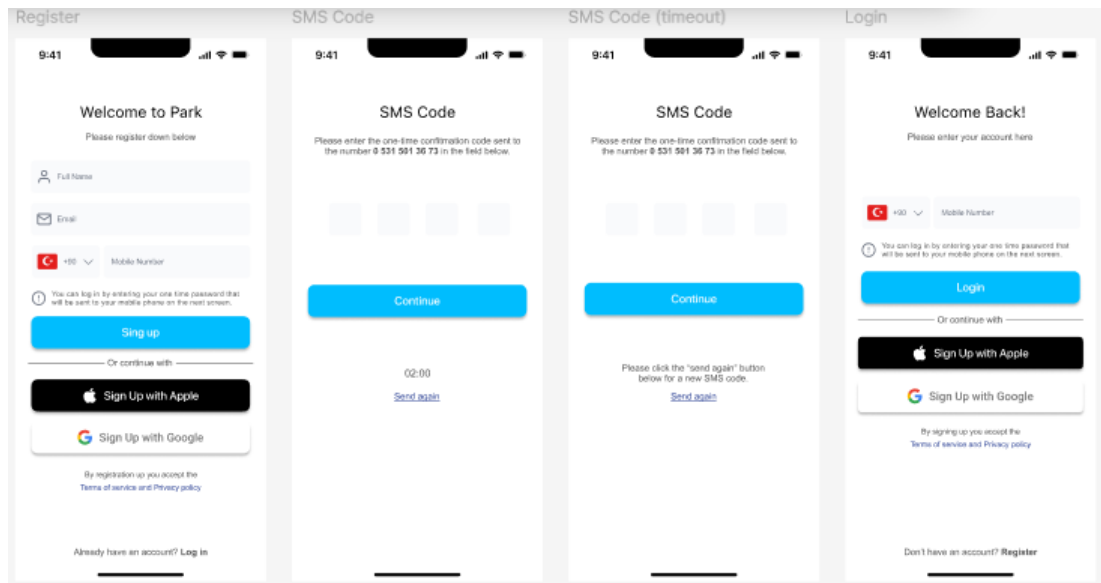


Figure 5 User Registration and Login Process in ParkApp

The literature on this subject agrees that drivers spend a significant amount of time searching for a parking space. For example, studies in the United States have found that drivers spend 17 and 14 hours per year searching for on-street and off-street parking, respectively.

Under the title "Smart Parking Technologies," the article on systematic requirements mapping argues that smart parking systems' main benefit is maximizing the available on-street parking capacity and reducing the time spent by drivers (A. et al., 2021). The latter also contributes to reducing air and noise pollution.

4.3 Decrease in Traffic Congestion

While drivers are looking for the most suitable parking options, different drivers can often choose the same route. Please optimize and distribute this information correctly here to avoid congestion and pollution. It is planned to prevent such difficulties by notifying the driver in advance. On the other hand, payment is made electronically, saving the driver's time at this point. In addition, the highest level of AQ feature is achieved with the camera and other sensors rich in additional features. All License Plate Recognition (LPR) systems that can be applied to low, medium, or high-level applications have video analysis and analytics, parking guidance, and retrieval features.

Parking applications are an important solution in urban areas, as they can reduce traffic congestion, fuel consumption, and energy consumption and improve economic

and health opportunities. A smart parking system using IoT can provide data on the status and availability of parking spaces (Li, 2023).

Zero carbon emissions is a problem that ranks high on the agendas of growing cities. Some states and cities are exploring implementing smart parking systems to optimize parking spaces, their carbon emissions, and Green Deal principles (Griggs et al., 2015). Applications such as ParkApp are examples of optimization and avoiding unnecessary crowding in parking spaces (Hassani et al., 2019).

4.4 System of Operation

The following is an explanation of how this system operates.

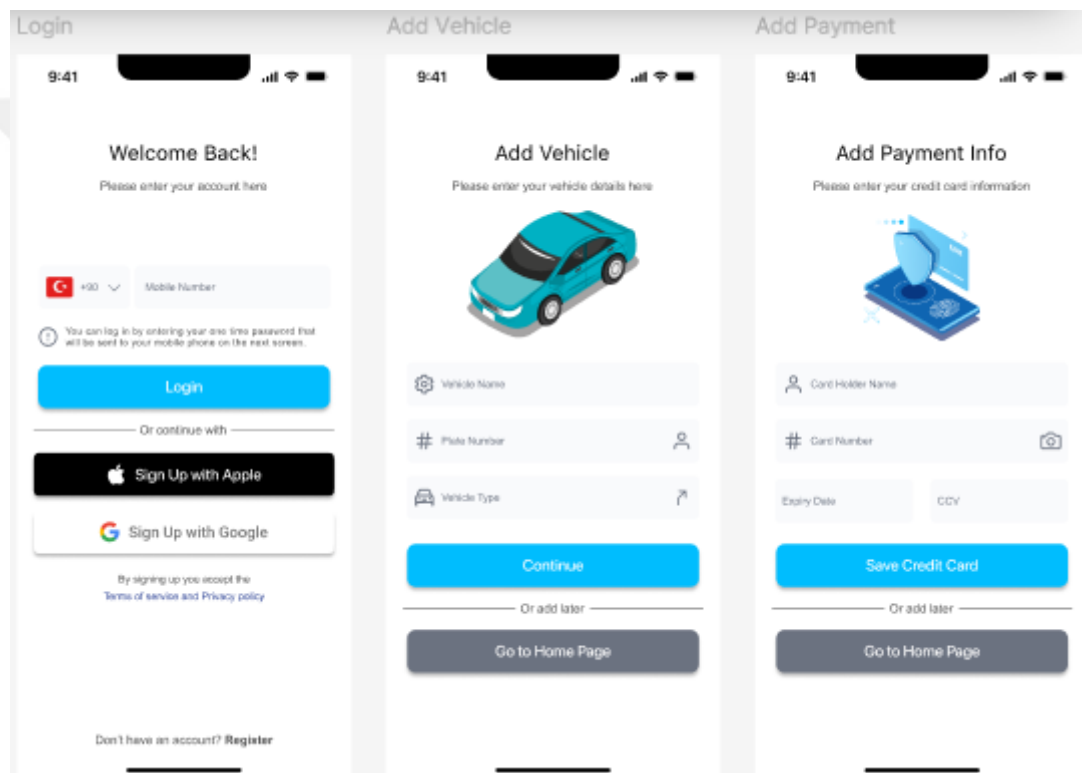


Figure 6 User Account and Profile Management

Parking applications log in using their user and mobile phone numbers or social profiles to ensure that parking transactions are replicated smoothly. They ensure they enter information about their vehicles and securely store payments. After logging in, users operate their accounts and manage their parking sessions and payments.

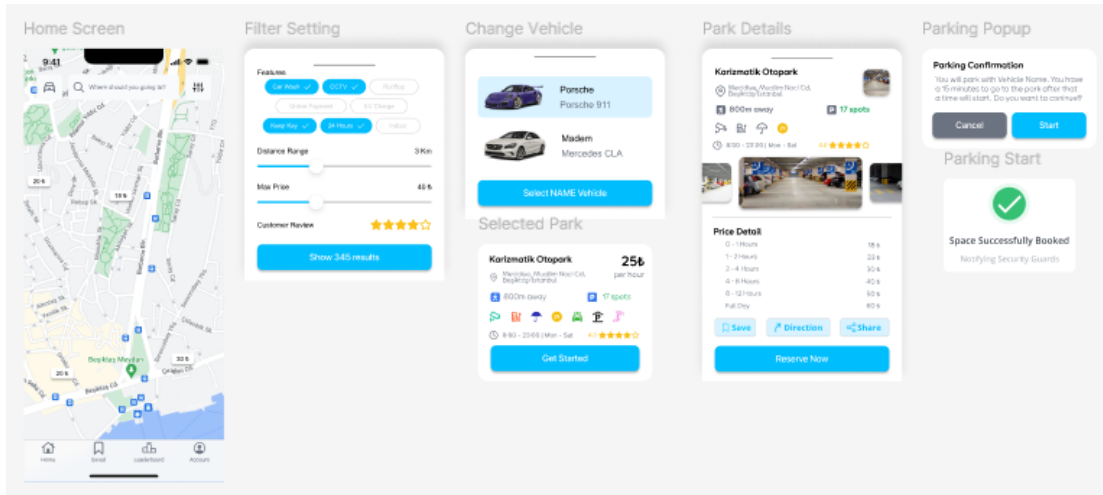


Figure 7 Home Screen and Parking Search Process

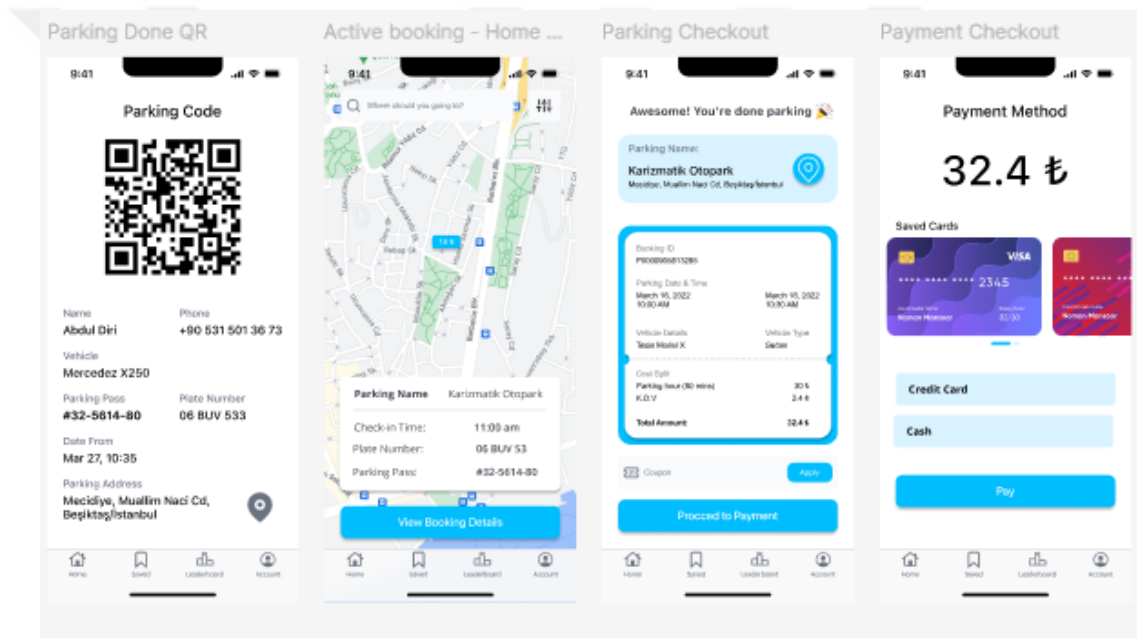


Figure 8 Vehicle Registration and Payment Setup

This parking application is listed as a QR code scan for parking, review of existing reservations on a map, and proceed to payment quickly. Thanks to the application, parking transactions can be reviewed through the application, a payment option can be decided, and the transaction can be successfully concluded.

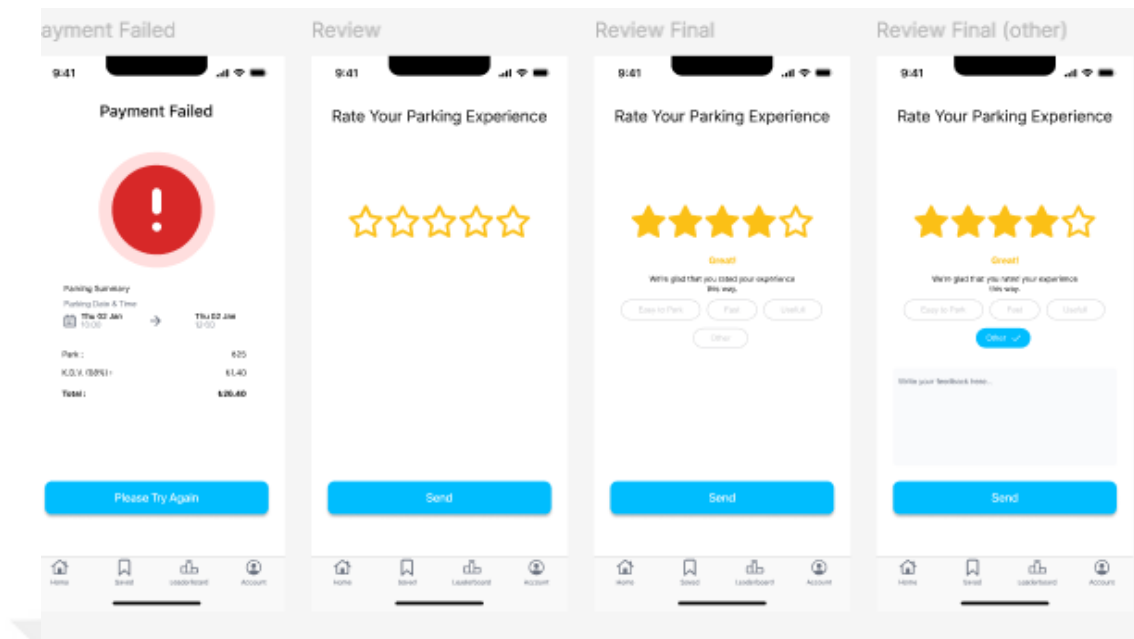


Figure 9 User Feedback and Rating Process

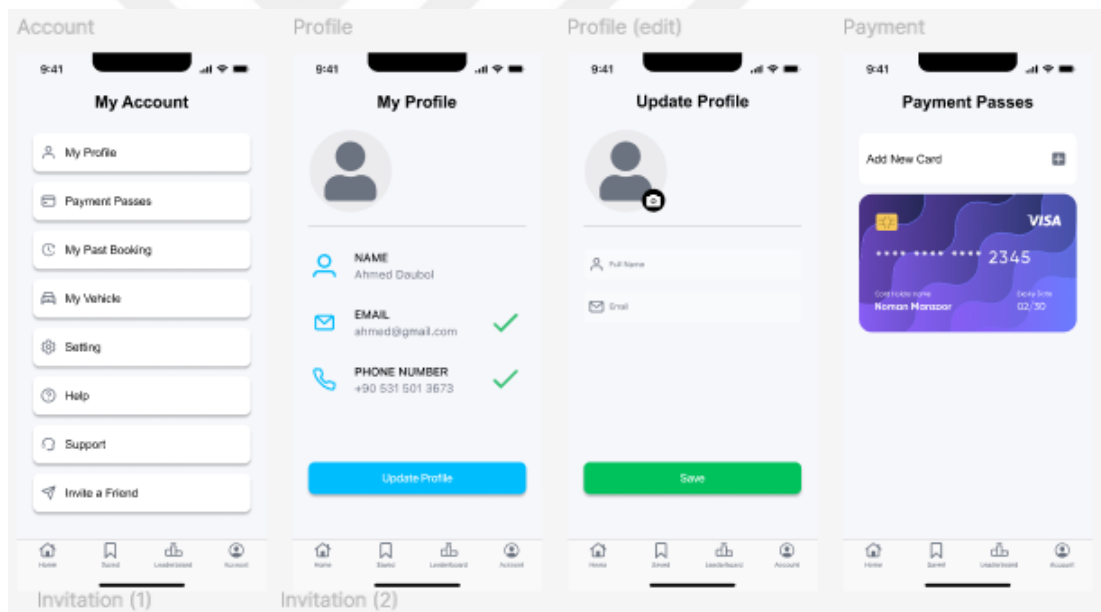


Figure 10 Booking Confirmation and Payment Checkout

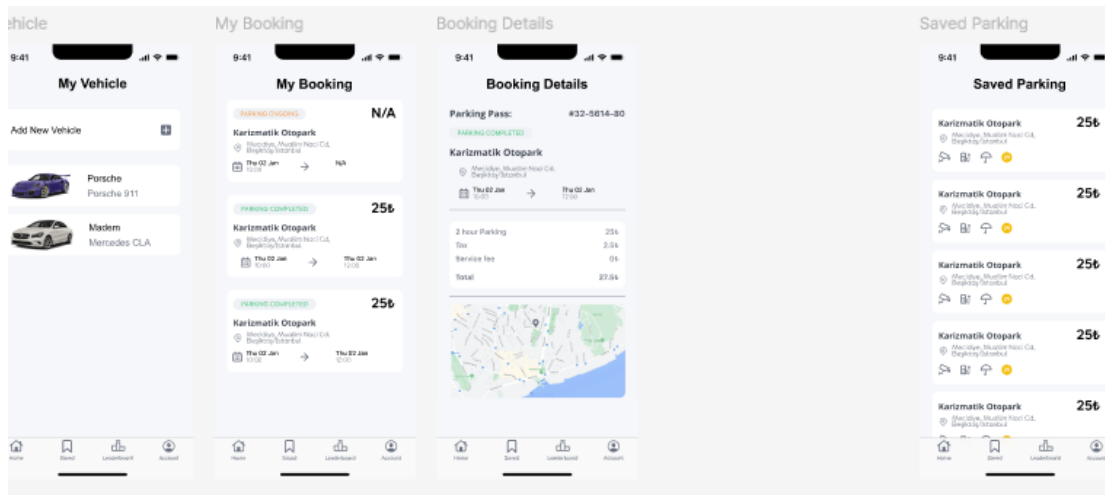


Figure 11 Image for Selecting the Right Parking



Chapter 5

Conclusion and Future Implications

The deployment of ParkApp in city centers, particularly in financial hubs, is a strategic move. It's a step towards sustainable travel methods that can significantly improve the environment, economy, equity, health, safety, and planning in cities (Huang et al., 2021). The reduction in carbon emissions, thanks to cleaner transportation, is a promising environmental outcome. The shift towards pedestrian-oriented commuting, potential reduction in street parking spaces, and decreased city revenue from parking meters are all part of the positive economic outcomes. The increased accessibility to the center and neighboring areas through public transportation, active modes, and the option to travel by taxi are equity outcomes (Sutjarittham, 2021), (Li, 2023).

The improved congestion and vehicle conflict, potential reduction in personal automobile collisions due to personal automobile traffic, and the prospect of less severe collisions are all health and safety outcomes. The preliminary model outcomes suggest a potential shift in trip generation to other parts of the city. This could lead to reductions in required off-street parking and street parking facility requirements, which are positive planning outcomes. However, it's important to note that microsimulations of the mission population are being incorporated into sub-regional, second-level models in some urban areas to investigate at least the prospective and significant driver of new trips resulting from its work or operations.

5.1. Advancements in FinTech

Electric Vehicles (EVs) not only identify parking spaces but also limit the availability of EV charging points, for example, the average time to charge an EV battery and the estimated power demand of charging stations, with the current parking occupancy data, as a near-term goal. A potential business plan is being developed B2B with the help of the EV charging company on the B2C model. On the other hand, it promotes increasing parking occupancy and branding using data mining and machine learning for location-based advertising or consumer behavior predictions. In another more recent research, our immediate focus will be to use parking history data

adequately to detect any unusual physical behavior anywhere in the parking area. In other words, it can also assist law enforcement when necessary.

Parking space-finding platforms for modern cities use parking occupancy data to optimize arrival and search time. Based on parking occupancy data and a prediction methodology, drivers' parking occupancy status is updated to guide parking in small intervals (Ionita et al., 2019).

FinTech developments are greatly improving smart parking systems by introducing IoT to provide real-time parking occupancy information (Fahim et al., 2021). This obtained data can automatically display the available parking spaces nearby for a user who wants to park in front of the destination. It can be easily obtained from the parking occupancy data in cities online (Liu et al., 2012). In addition, many developments have been achieved in urban parking research revolving around a guidance system designed for parking lots and instant parking occupancy data.

5.2. Advancements in AI

The integration of smart parking systems and in-car systems can be addressed under three main solution strategies: parking lot prediction, optimal motivation, and advanced distributed system control.

While it means that the parking lot can be predicted at the next stage and in-car systems predict the availability of a parking lot, advanced distributed system control involves the intelligent coordination of the on-board systems of vehicles. These systems are integrated into a unified control system known as the innovative parking ecosystem and control system. Traditional GNSS-based parking lot search methods always have limitations such as insufficient accuracy, high cost, and limited power resources in cities. In addition, computer vision-based systems in modern vehicles are advantageous in improving vehicle safety and driver comfort (Iacobescu et al., 2021).

5.3. Urban Living Improvements

The parking application for users is planned to be accessed from known existing application stores and is free to download and use. This application, which keeps users updated with the latest parking spaces in the regions, is earned by the application owner at a certain fee per use. It is an indispensable global application, especially when looking for a correct/suitable parking space and reducing the penalty rate for rented vehicles in a foreign country. The application offers pre-booking support to users. It

significantly helps drivers understand the destination and route before starting their journey. In the ParkApp application, a review function has been added to rate and comment on parking spaces and the user's experience so that all users can benefit from previous users' experience.

Smart parking platforms/systems and applications can provide much more than parking management and guidance (Ionita et al., 2019). The accelerating population growth in cities can benefit from parking, including reducing traffic congestion (Huang et al., 2021). It is adopted to increase compliance, improve responsiveness, and solve parking problems. It has been developed as a platform and application (Iacobescu et al., 2021). If the parking time is about to expire, it sends a notification to the users, and the parking fee collection is made more accessible and cashless.

5.4. Outcomes of ParkApp and Conclusion

ParkApp offers innovative approaches to smart parking solutions by integrating AI, IoT, digital wallet, and blockchain technologies. This application optimizes real-time parking space distribution while ensuring data privacy and security. It also supports environmental sustainability by reducing fuel consumption and emissions. The implementation of ParkApp has positively impacted urban mobility and the environment.

5.4.1. AI and Real-Time Parking Optimization

The study's findings underscore the potential of AI-driven solutions in urban infrastructure. By incorporating AI and real-time data analytics into urban parking systems, we can significantly improve the distribution of parking spaces. ParkApp, for instance, can eliminate the inefficiencies associated with traditional parking systems by dynamically responding to multiple real-time situations. Its ability to predict and distribute parking spaces effectively can lead to a significant reduction in traffic congestion in crowded cities.

5.4.2. Privacy

The proposed implementation effectively incorporates blockchain technology into ParkApp. It aims to successfully improve the security and privacy of user data and thus address the growing concerns in the context of smart city efforts. Blockchain uses an immutable and decentralized accounting system, so transactions and data transfers are guaranteed to be secure. This increases user trust and the integrity of the system.

This supports the assumption that the inclusion of blockchain technology can reduce threats to users' privacy while also improving system stability.

5.4.3. Environmental Impact

The proposed ParkApp application has led to a reduction in the amount of fuel consumption and emissions produced by cars to support global sustainability goals as a result of its adoption. This conclusion has succeeded in minimizing the time vehicles spend searching for parking spaces. This result lends credibility to the concept that it has the potential to contribute significantly to reducing the environmental footprint left behind by urban mobility.

5.4.4 Economical Implications

In this thesis, the economic impact of the proposed ParkApp application is also evaluated. It varies depending on the size of the cities. The application is shown to be an efficient and cost-effective method to meet the parking needs in large cities without the need for significant investments in other infrastructures. Moreover, the economic benefits still need to be clarified in smaller communities. Additional incentives may be needed to ensure universal adoption. Considering this new approach proposal, it is recommended that future applications take into account city-specific characteristics to optimize economic gains.

5.4.5 User Experience

Following the launch of the ParkApp application, user feedback has measured satisfaction with the application, particularly in terms of user-friendliness, increased inclusiveness and accessibility, real-time parking availability, and protected payment options. Improving the user experience is essential to the success of smart parking systems, as confirmed by the fact that the user-centric design of the system is crucial to increasing adoption. In its subsequent versions, ParkApp continues to focus on improving the user interface and expanding features designed to meet the needs of a wide range of users. The development of this platform is perceived as a life cycle.

5.5. Marketing Strategies for ParkApp

The deployment and acceptance of ParkApp hinges on a comprehensive, inclusive, and strategically designed marketing plan. This plan must align with the dynamics of modern urban environments and the expectations of users and all

participating stakeholders. In the competitive landscape of smart city technologies, effective marketing is not just about increasing awareness. It's about encouraging user participation, accelerating adoption, and establishing partnerships with metropolitan municipalities and corporate entities. The marketing strategies for ParkApp, which are discussed in this thesis, should be multifaceted. In addition to utilizing digital platforms and social media to maximize visibility, the application should establish strong partnerships with government and private sector stakeholders. This will facilitate the integration of ParkApp into public transportation systems and corporate parking facilities. Furthermore, targeted marketing campaigns, including stakeholder and participatory partnerships and referral programs, aim to sustain user acquisition by reaching both the environmentally conscious consumer base and the wider urban community. By implementing all these strategies, ParkApp aims to address the pressing challenges of urban parking and ensures it stands out as a long-term player in the broader FinTech and smart city era.

- **Leveraging Social Media and Digital Platforms:** To create awareness about ParkApp, it is necessary to ensure that platforms such as Instagram, LinkedIn and Facebook are used. Plan to produce and share engaging content, including video demos of the application in action, infographics explaining the benefits of reduced traffic congestion and environmental sustainability, and user testimonials. This content will highlight the user-friendly features of ParkApp and its positive impact on urban communities.
- **Providing Targeted Partnerships with Municipalities:** Partnerships with city governments and smart city initiatives will be established to integrate ParkApp into taxi and public transportation solutions and parking spaces. This is anticipated to increase reliability and adoption.
- **Supporting Referral and Loyalty Programs:** Introduce a referral program that rewards users who invite new people to the platform with parking credits. This, coupled with loyalty interactions and rewards, will help ParkApp spread virally among urban communities and make the users feel valued and motivated to participate.
- **Enabling Corporate Partnerships:** Partnerships will be established with businesses, shopping malls, entertainment venues, and valet services to

integrate ParkApp into their parking systems. Plan to work closely with the IT departments of these partners to ensure a smooth integration process. This will enable discounted parking opportunities and cross-promotion for customers.

- **Influencer Partnerships via Social Media:** The power of influence in shaping public perception and establishing partnerships with foundations, associations, and organizations classified as sustainability influencers. By promoting ParkApp as an environmentally friendly solution for urban congestion, these influencers will play a crucial role in driving adoption and changing how people think about urban transportation.
- **Active Participation in Smart City Conferences and Trade Shows:** Smart city events provide unique opportunities. Plan to attend, exhibit, speak, sponsor, and present ParkApp at FinTech, AI, and smart city-related conferences. This will allow us to network with potential municipal and private parking operators, paving the way for ParkApp's growth and expansion in urban communities and realizing these opportunities.

Table 1 Prioritization Analysis for ParkApp's Marketing Strategies

Strategy 1	Leveraging Social Media and Digital Platforms
Description	Use platforms like Instagram, LinkedIn, and Facebook to raise awareness with engaging content such as videos and infographics. Vehicle users' parking lot usage behavior can be tracked, and these demographics are used to personalize the application. ParkApp users do not have to take photos in the parking lot; the exact location of their vehicle remains recorded in the app, and they do not have to search for their car in the parking area for a long time.
Priority	High
Justification	High reach and low cost. Vital for brand awareness.
Goals	Reach 1 million views on social media in 6 months.
Cost-Benefit Analysis	It has a low cost and high ROI from user engagement and brand exposure.
Risks and Mitigation	Risk: Social media trends change rapidly. Mitigation: Consistent content updates and diversification across platforms.
Theoretical Framework	Highlight the importance of the AIDA Model in content creation. This model helps grab attention, build interest, and create desire, providing content creators with a clear and purposeful guide.
Strategy 2	Providing Targeted Partnerships with Municipalities
Description	Establish partnerships with city governments to integrate ParkApp into

	public transport and parking solutions. Unique parking spaces will be ready for ParkApp users to ensure exclusivity in locations with intense parking needs.
Priority	High
Justification	Essential for scalability and credibility.
Goals	Secure five city partnerships in 1 year.
Cost-Benefit Analysis	High initial investment but long-term growth through city integration.
Risks and Mitigation	Risk: Bureaucratic delays and slow decision-making. Mitigation: Early relationship-building and pilot projects.
Theoretical Framework	Porter's Five Forces: Power of buyers (municipalities).
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Strategy 3	Supporting Referral and Loyalty Programs
Description	Introduce referral programs rewarding users with parking credits for bringing new users and loyalty rewards.
Priority	Medium
Justification	Encourages user engagement and organic growth.
Goals	Increase user base by 20% through referrals in 6 months.
Cost-Benefit Analysis	Low cost, viral growth potential, medium-term returns.
Risks and Mitigation	Risk: Referral programs may not attract enough users. Mitigation: Incentivize both referrers and new users.
Theoretical Framework	Network Effects: Incentivizing user-driven growth.
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Strategy 4	Enabling Corporate Partnerships
Description	Collaborate with businesses, shopping malls, and entertainment venues to integrate ParkApp and offer discounts.
Priority	Medium
Justification	Provides access to corporate networks and loyal customer bases.
Goals	Partner with 10 businesses and offer cross-promotions in 1 year.
Cost-Benefit Analysis	Medium cost, high returns through corporate partnerships and customer loyalty.
Risks and Mitigation	Risk: Businesses may need to adapt faster. Mitigation: Demonstrate mutual benefits and offer discounts to early adopters.
Theoretical Framework	Resource-Based View: Harnessing corporate resources to drive growth.
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Strategy 5	Influencer Partnerships via Social Media
Description	Work with sustainability influencers to market ParkApp as an eco-friendly solution for urban congestion.
Priority	Medium

Justification	Effective for targeted marketing of sustainability-focused users.
Goals	Gain 5 influencer partnerships and reach 500,000 sustainability-focused users in 6 months.
Cost-Benefit Analysis	Medium cost, high returns through influencer-driven engagement and adoption.
Risks and Mitigation	Risk: Influencers may not engage. Mitigation: Build solid relationships and select influencers aligned with sustainability.
Theoretical Framework	Influence Marketing Theory: Targeting niche markets with high-impact influencers.
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Strategy 6	Active Participation in Smart City Conferences and Trade Shows
Description	Attend and present at FinTech, AI, and smart city conferences to network with potential partners. The company using the application can legally perform all billing transactions automatically.
Priority	Low
Justification	Suitable for building long-term relationships and showcasing innovation.
Goals	Participate in 3 major industry conferences in 1 year.
Cost-Benefit Analysis	High cost, long-term returns from networking and partnerships.
Risks and Mitigation	Risk: High cost of participation. Mitigation: Focus on high-impact events with proven track records.
Theoretical Framework	Relationship Marketing: Building long-term connections with key stakeholders.
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5.6. Future Implications

5.6.1 Scaling Integration

Due to its continued expansion in large cities, the scalability of systems like ParkApp is expected to become increasingly important. In the near future, research should investigate the possibility of integrating ParkApp with other smart city efforts, such as public transportation systems. This would enable the development of a highly integrated urban infrastructure. ParkApp's effectiveness could also be further improved by expanding its capabilities to include predictive analytics and dynamic pricing models for peak demand periods.

5.6.2 Policy and Governance

Besides all the implications, it is very relevant to the existence of legal frameworks that facilitate the success of smart parking systems like ParkApp. Collaboration between local governments, technology providers, and commercial

operators is essential when establishing regulatory standards supporting data exchange and system interoperability. Further research is recommended on the role played by technical and organizational governance in the long-term viability of such systems.

5.6.3 Broder Application

Real-time data analytics, AI, IoT, digital wallet technologies, and blockchain technology have all emerged from the primary and integrated use of ParkApp. This application is not just about parking; it's about optimizing urban management, including traffic flow, public safety, and energy management. Future studies should explore these broader applications, enhancing our understanding of the impact of smart city technologies on urban life.

The proposed ParkApp application has the potential to significantly optimize urban mobility, environmental sustainability, and economic efficiency. As we look towards future innovations for ParkApp, we can be inspired by the role of smart technologies in creating more livable, efficient, and sustainable cities, motivating us to continue this important work.

REFERENCES

- A. Elsonbaty, A. & Shams, M. (2020). The Smart Parking Management System. [PDF]
- A. R. Abdeen, M., A. Nemer, I., & R. Sheltami, T. (2021). A Balanced Algorithm for In-City Parking Allocation: A Case Study of Al Madinah City. ncbi.nlm.nih.gov
- Ahad, M.T., Song, B., Li, Y. and Rahman, F.N., 2022. Aiming Sustainable Transportation Utilizing Social Capital: A Perspective of Mobile Car Park App. *Mobile Information Systems*, 2022(1), p.5606833.
- Ahad, M.T., Song, B., Li, Y. and Rahman, F.N., 2022. Research Article Aiming Sustainable Transportation Utilizing Social Capital: A Perspective of Mobile Car Park App.
- Arhab, N., Oussalah, M., & Saroar Jahan, M. (2022). Social media analysis of car parking behavior using similarity-based clustering. ncbi.nlm.nih.gov
- Buhari, A., Ahmad, H. and Nordin, S.M., 2024. A SURVEY ON MALAYSIA'S SMART PARKING MOBILE APPLICATION AND REVIEW ON TYPES & APPROACHES. *MUHAMMAD RASHAAD BAKASHMAR NOOR INAYAH YA'AKUB*, p.197.
- Buldakov, N., Khalilev, T., Distefano, S., & Mazzara, M. (2020). An Open Source Solution for Smart Contract-based Parking. [PDF]
- Chandrasekaran, S., Matthew Reginald, J., Wang, W., & Zhu, T. (2021). Computer Vision Based Parking Optimization System. [PDF]

- Choi, S. & Lee, J. (2022). Optimal Parking Planning for Shared Autonomous Vehicles. [PDF]
- Chou, S. Y., Dewabharata, A., & Eva Zulvia, F. (2021). Dynamic Space Allocation Based on Internal Demand for Optimizing Release of Shared Parking. ncbi.nlm.nih.gov
- Dalla Chiara, G., Fiete Krutein, K., Ranjbari, A., & Goodchild, A. (2022). Providing curb availability information to delivery drivers reduces cruisesParking Parking. ncbi.nlm.nih.gov
- Fahim, A., Hasan, M., & Alam Chowdhury, M. (2021). Smart parking systems: a comprehensive review based on various aspects. ncbi.nlm.nih.gov
- Fulman, N. & Benenson, I. (2019). Establishing and assessing adaptive parking prices in a city: Algorithms, software, and examples. [PDF]
- Griggs, W., Yuan Yu, J., Wirth, F., Haeusler, F., & Shorten, R. (2015). On the Design of Campus Parking Systems with QoS guarantees. [PDF]
- H. C. Borges, L. & A. Barone, F. (2022). Features of planar Lee-Wick electrostatics. [PDF]
- Hadi, R.A., George, L.E. and Ahmed, Z.J., 2024. Computer Vision-based Approaches, Datasets, and Applications of Smart Parking Systems: A Review. *Iraqi Journal of Science*, pp.979-1000.
- Hafiz Hasan, M., Van Hentenryck, P., & Legrain, A. (2019). The Commute Trip Sharing Problem. [PDF]
- Hassani, A., Medvedev, A., Delir Haghghi, P., Ling, S., Zaslavsky, A., & Prakash Jayaraman, P. (2019). Context Definition and Query Language: Conceptual Specification, Implementation, and Evaluation. ncbi.nlm.nih.gov
- Huang, D., Dodson, J., Curtis, C., Ashmore, D., Woodcock, I., & Kovacs, S. (2021). Innovative responses to urban transportation: current practice in Australian cities. osf.io

- Iacobescu, C., Oltean, G., Florea, C., & Burtea, B. (2021). Unified InterPlanetary Smart Parking Network for Maximum End-User Flexibility. ncbi.nlm.nih.gov
- Ionita, A., Pomp, A., Cochez, M., Meisen, T., & Decker, S. (2019). Transferring knowledge from monitored to unmonitored areas for forecasting parking spaces. [PDF]
- Jemmali, M., Kayed B. Melhim, L., T. Alharbi, M., Bajahzar, A., & Nazih Omri, M. (2022). Smart-parking management algorithms in a smart city. ncbi.nlm.nih.gov
- Li, W. (2023). Exploration of the Assessment for AVP Algorithm Training in Underground Parking Garages Simulation Scenario. [PDF]
- Liao, R., Roman, C., Ball, P., Ou, S., & Chen, L. (2016). Crowdsourcing On-street Parking Space Detection. [PDF]
- Liu, J., Chen, R., Chen, Y., Pei, L., & Chen, L. (2012). iParking: An Intelligent Indoor Location-Based Smartphone Parking Service. ncbi.nlm.nih.gov
- Lopes, I., Biondi, D., DALLACORTE, A.P., REIS, A. and OLIVEIRA, T.G., A Methodological Framework to Create an Urban Greenway Network: A Case Study of Curitiba City. *Available at SSRN 4131199*.
- Ortigueira, M., F. M. Torres, D., & Trujillo, J. (2016). Exponentials and Laplace transforms on nonuniform time scales. [PDF]
- Shen, X., Choi, Y., Wong, A., Borrelli, F., Moura, S., & Woo, S. (2024). Parking of Connected Automated Vehicles: Vehicle Control, Parking Assignment, and Multi-agent Simulation. [PDF]
- Sutjarittham, T. (2021). Modeling and Optimisation of Resource Usage in an IoT-Enabled Smart Campus. [PDF]
- To Sum Ho, G., Po Tsang, Y., Ho Wu, C., Hung Wong, W., & Lun Choy, K. (2019). A Computer Vision-Based Roadside Occupation Surveillance System for Intelligent Transport in Smart Cities. ncbi.nlm.nih.gov

Yan, S., D. Murthy, R., E. O'Connor, N., & Liu, M. (2023). U-Park: A User-Centric Smart Parking Recommendation System for Electric Shared Micromobility Services. [PDF]

Yu, S., Wang, H., & Wang, Y. (2022). Optimization Design of Street Public Space Layout on Account of Internet of Things and Deep Learning. ncbi.nlm.nih.gov

Zhao, Z., Xu, Y., Liu, J., Zhao, L., Shen, Y., & Shiratori, N. (2023). Marriage Matching-based Instant Parking Spot Sharing in Internet of Vehicles. [PDF]

