Integration of convenient parking

Integration von Komfortparkplätzen

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Abstract — Machine learning is a branch of artificial intelligence (AI) and computer science that focuses on using data and algorithms to mimic the way humans learn by gradually improving its accuracy. Machine learning is an important component of the growing field of data science. Through the use of statistical methods, algorithms are trained to make classifications or predictions and reveal key insights into the data mining projects.

Zusammenfassung — Maschinelles Lernen ist ein Zweig der künstlichen Intelligenz (KI) und der Informatik, der sich auf die Verwendung von Daten und Algorithmen konzentriert, um die Art und Weise, wie Menschen lernen, durch schrittweise Verbesserung der Genauigkeit nachzuahmen. Maschinelles Lernen ist ein wichtiger Bestandteil des wachsenden Bereichs der Datenwissenschaft. Mithilfe statistischer Methoden werden Algorithmen darauf trainiert, Klassifizierungen oder Vorhersagen zu treffen und wichtige Erkenntnisse über die Data-Mining-Projekte zu gewinnen.

I. INTRODUCTION

The participation of technology in the daily life of each user fundamentally changes everyday activities. Developers and designers work hard to create new systems and improve older ones to cover more and more user needs. Human needs increase with the advancement of technology. Nowadays, the progress we make with the development of various applications, software and programs happens along with the development of the world. Automation is involved in medicine, the production of products, the breeding of animals in large farmyards and many other activities from which we produce food or products as consumables. We began to introduce into programs and automations more and more functions that would resemble the work of a human. Such an innovative technology is artificial intelligence.

Machine learning is a branch of artificial intelligence (AI) and computer science that focuses on using data and algorithms to mimic the way humans learn by gradually improving its accuracy. Machine learning is an important component of the growing field of data science. Through the use of statistical methods, algorithms are trained to make classifications or predictions and reveal key insights into the data mining projects. Subsequently, they drive decision-making in applications and businesses, ideally influencing key growth indicators. As large databases continue to expand and grow, the market demand for data scientists will increase. They will be required to assist in identifying the most relevant business questions and the data to answer them. Machine learning algorithms are typically created using frameworks that accelerate the development of solutions. [1]

Artificial intelligence is a human product that foreshadows the complete automation of everyday activities familiar to us. On the one hand, it is a sign of the evolution of the world and can bring many benefits for both businesses and workers. Through the automation of various processes, annoying repetitive actions on the part of the worker can be avoided and they can invest their time and skills in the direction of personal and business development. For example, every company has large amounts of data that are processed daily for monitoring purposes or for the preparation. of various reports. They contain repetitive information that the person systematically processes, and often this leads to mental fatigue and low productivity. When processing all this data by a person, it is inevitable that mistakes will be made in the process, as the human brain is overloaded by machine work. Automation of processes can largely prevent both mistakes made and lack of productivity on the part of humans.

The fact is that artificial intelligence works for the benefit of humans, but there is also the likelihood of being abused. The machine can be trained to perform different activities, depending on the commands assigned to it. In practice, its capabilities are vast, and there are already numerous cases in which ill-wishers use it to get into very well-stored systems that are protected by hard-to-pierce cyber walls. In such situations, very large amounts of secret and confidential information can be stolen and used for various crimes such as theft of funds, personal information of users of a particular company and much more.

There are many technologies that are present in our daily lives. One such mass product of production and use is the automobile. This vehicle has played a key role in shaping our daily lives, offering convenience, mobility and economic benefits. From personal transportation to the delivery of goods and emergency services, cars have become indispensable in many aspects of our lives. Whether it's commuting, running errands or traveling, cars offer convenience, flexibility and the ability to reach destinations that may not be readily available by other means of transport.

Cities often face challenges related to congestion, limited parking infrastructure and the environmental impact of high car use. With the growth of motorization around the world comes one problem that applies mostly to large cities and that is finding parking lots with free parking spaces. The more motorization increases, the more complicated parking becomes.

In the category "most motorized nation", i.e. number of passenger cars per 1000 inhabitants, the leader is Luxembourg - 670 cars per 1000 inhabitants, followed by Italy with 625 cars per 1000 inhabitants, Finland (617 cars), Malta /613 and Cyprus (609 cars per 1000 inhabitants). With a particularly low

"motorization rate" Romania is positioned - 261 cars per 1000 inhabitants, Hungary - 355, Latvia - 360, Croatia - 390, Bulgaria - 393 cars per 1000 inhabitants. With our neighbors, the data are as follows: Greece - 500 cars per 1,000 inhabitants, North Macedonia - 200, Turkey - 150 per thousand inhabitants.

The top 5 countries with the highest number of registered cars in the EU last year was headed by Germany - 3.4 million. new registrations, United Kingdom - 2.3 million, France - 2.1 million, Italy - 1.9 million, Spain - 1.3 million.[2]

A solution to the problem of parking in cities can be found with the parking app "Find your spot". One of the significant advantages of the parking app is its ability to provide real-time information on the availability of parking spaces. Using data from parking sensors or user inputs, the application can show the number of available spaces in different parking lots or streets. This feature helps drivers save time and reduce frustration by allowing them to identify available parking options before they reach their destination.

II. FORMULATION OF THE PROBLEM

Today, a large part of the city dwellers are drivers of vehicles. In some regions, the phenomenon of "more cars than people" is observed. The infrastructure of cities is not ready to handle the sudden traffic, every day we see cars stuck on the sidewalks and on both sides of the streets.

Parking invariably contributes to the formation of traffic and congestion. In recent years, the biggest problem has been finding free spots for parking. Travelling by cars is the preferred method of transportation by the majority because of the comfort it provides.

Among the advantages of using a private car are the privacy of the owner of the vehicle, the possibility of carrying larger amounts of luggage and the convenience of not having to take into account the schedule and routes of public transport, which we must take into account if we travel with it.

Of course, not in every case, when we have to, we can trust the most convenient option for us, namely our personal car, which is located in front of our home, because we cannot predict whether finding a spot for parking will not take us more time than if we use public transport. In many cases, when we are in a hurry due to some circumstances, it happens that we do not find a parking space near our desired destination and park so far away from it that our entire trip there becomes meaningless. Finding a free parking space in the crowded city is becoming an increasingly difficult task for drivers. As cities grow and vehicle ownership increases, so does demand of parking spaces often exceeds the available supply. Problems such as limited availability, high costs and inefficient parking management are at the root of the constant search for solutions. By studying these issues, potential solutions can be made to improve the parking experience and ease the burden drivers face. For the solution of this global-scale problem, we can use technology available to every smartphone owner. The product that saves us a lot of time and embarrassing situations is an application called "Find your spot", which is available on the App Store for users of iOS-based mobile applications developed by Apple and on the Google Play Store for Android users. The purchase of the application is made for a modest amount compared to the magnitude of the daily problem we face, which is credited to the implementation and globalization of the project.

III. GROUNDING BEHIND THE SOLUTION TO THE PROBLEM

As more vehicles compete for a limited number of parking spaces, drivers often roam the streets or parking lots in search of free space. Occupancy rates in urban car parks are inflated during peak hours, causing the shortage of parking opportunities. This limited availability leads to frustration, loss of time and increased congestion as drivers move through crowded streets. The application has the function to show in real time the occupancy of the parking lots to which the user is directed at a set location and they can be notified with notifications when peak hours pass and parking spaces are available. These features prevent users from going around with their vehicles in advance, because they are provided in advance with information about the available parking spaces. Inefficient parking management also presents a challenge faced by drivers. Poorly organized parking systems, inadequate signs and outdated payment methods can all contribute to confusion and delays. Inefficient use of parking spaces, such as unauthorized parking or long-term parking in high-demand areas, further complicates the problem. The application can contribute to solving this problem because it offers an easy method for online payments and parking reservations, and the integrated parking systems through which the application receives signals help to properly park and regulate the use of parking lots.

The challenges of finding parking spaces also have environmental implications. Vehicles that roam in search of parking contribute to increased emissions, air pollution and fuel consumption. Parking related traffic accounts for a significant proportion of urban congestion and greenhouse gas emissions. Addressing parking challenges through sustainable solutions such as promoting public transport, deploying intelligent parking systems and promoting carpooling can help mitigate the environmental impact associated with parking demand. The app receives alerts from the intelligent parking systems integrated into the parking lots, which helps users to be able to track in real time the available parking spaces around their location and this prevents aimless driving to find spaces, which in turn helps to limit harmful emissions in the air.

IV. TOPICALITY OF THE PROBLEM

In recent years, mobility in cities aims to provide people with alternatives to private cars that allow them to travel more comfortably, safely and affordably. Cities are increasingly looking for ways to increase the use of public transport and other mobility solutions such as cycling, electric bikes and scooters to reduce car ownership. These solutions not only help solve parking problems, but can also help reduce congestion and pollution, as well as help people save money and improve their health. However, the transition to innovative mobility will only be successful if it is supported by infrastructure. If people are not going to use private cars, they need access to public transport, bike lanes, charging stations for electric vehicles and even parking spaces for their bikes. This means that governments need to invest in this type of infrastructure to encourage citizens and businesses to choose sustainable modes of transport.

In general, the app aims to help solve parking problems, but also to influence responsible driving. When the user receives information from the application that all parking spaces are occupied and there are no parking options available, they can choose public transport options or other alternatives such as bicycle, electric bicycles and more.

A. *Database design and structure*

A relational database (MySQL) is used to implement the system. Relational databases are databases in which information is stored in tables that are composed of records and attributes (properties/fields).

The database consists of 5 tables (users, user_information, parking_spot, company, parking_spot_reservation). The users table contains information about the username, password and user access. It refers to the table user_information. The information table contains information about the name and surname of the user, the enamel and the company in which they work. Because some of the users can only be customers of the system, the value of the field "company_id" is zero and therefore the table does not refer to the company table.

The table "parking_spot" describes the identification number of the parking space, the name of the parking space and the status of the parking space (vacant, occupied or under repair). The table is related to the tables company and "parking_spot_reservation". The company table contains information about the name of a company and its address. The table "parking_spot_reservation" contains information about the identification number of the parking space, the beginning and end of the reservation and the number of the car for which the parking space is reserved.
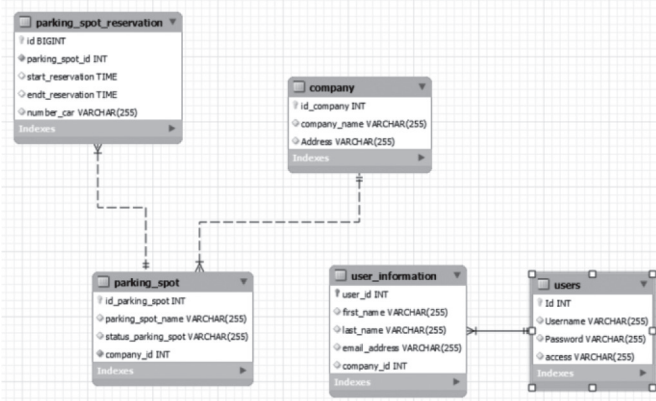

Figure 1. UML Database Diagram

[1] Features of the program implementation

A server designed with Spring Boot technology is used for the implementation of the system. The server is equipped with an Android Studio application and a (WPF) desktop application developed in C#.

Spring Boot is an open Java application development framework. It is based on the Spring Framework platform and aims to facilitate and speed up the process of creating stand-alone, ready-to-use applications.

Spring Boot provides many useful features that assist developers in the process of creating applications. It automatically configures many of the necessary settings, such as diffidence management, configuration management and a built-in web server. This allows developers to focus on the business logic of the application, instead of dealing with the details of the setup.

Spring Boot also offers built-in support for many different technologies and tools, such as databases, security, microservices, and much more. This makes the framework very flexible and suitable for different types of applications.

The Spring framework consists of several modules that can be categorized into four main areas: Core Container, Data Ac-

cess/Integration, Web and Miscellaneous. The core container provides the core functionality of the Spring Framework, including the IoC container and ApplicationContext. The Data Access/Integration area provides support for integration with databases and other data sources. The web zone provides support for building web applications, including the Spring MVC and Spring WebFlux modules.[3]

V. SERVER IMPLEMENTATION

The parking management system server is implemented with a REST architecture that uses the Spring Boot framework using a built-in Tomcat web server. Server communicates with a MySQL database. The server is written in Java version (17.0.8 2023-07-18 LTS). Spring Initializer is used to create it. Before generating the project, the following dependencies (MySQL Driver, Spring Web and Spring Data JPA) are added.

Tomcat is a web server developed by the Apache Software Foundation. It is one of the most popular servers used to run Java web applications. It implements Java Servlet and JavaServer Pages (JSP) and supports Java Servlet API and JavaServer Pages specifications. It can be used to run dynamic web applications that are based on Java technologies. Tomcat provides a web application execution environment by providing server and JSP lifecycle management, HTTP request and response processing, session management, security configuration, and other functionalities related to the execution of web applications.

Tomcat is based on an architecture called "container-servlet". This means that Tomcat provides a container that manages the lifecycle of servettes and JSPs. It can be integrated with various technologies and frameworks, such as Spring Framework, Hibernate, Apache Struts and others. This allows you to develop and run web applications that use different tools and technologies.

VI. CONNECTION TO DATABASE

Spring Boot provides convenient mechanisms for interacting with databases. It integrates Spring Data JPA, which is part of the Spring Framework and provides an easy and powerful way to work with relational databases. [4]

To connect the server to a MySQL database, you need to set up the configuration to access the database. This includes specifying the URL, user name, password, and other settings that are required to connect to the database.

To connect to the database, a class is required to access the table that is needed. In the class, the annotations '@Entity', '@Id', '@GeneratedValue' and '@GenerationType' , which are part of JPA and are used to define data models and their attributes, are added.

- The annotation '@Entity' is used to mark a class as corresponding to a table in the relational database. This means that objects of this class can be saved and loaded from the database.

- Annotation '@Id' is used to mark a field as an identifier of the object. This field usually corresponds to a column in the table that represents the class.

- The annotation "@GeneratedValue" is used to indicate how to generate the values for the identifiers of the objects. This can be automatic generation from the database or manual assignment of values.

- The annotation "@GenerationType" is used to indicate the specific type of generation of the values for the identifiers.

These annotations and others in JPA allow to define data mo-

dels on the server and convert them to and from the relational database in a convenient way, without having to write SQL queries manually.

After the creation of the class, a repository is created that contains user records. The repository is created by an interface that expands with the "JpaRepository" or "CrudRepository" interface.

JpaRepository and CrudRepository provide ready-made methods for frequently used operations on data, such as creating, reading, refreshing, and deleting, as well as various methods for filtering and sorting data. Some of the methods they provide are:

- 'findAll()': Returns all objects from the database.
- 'findById(ID id)': Returns the object with a given identifier (ID) from the database.
- 'save(T entity)': Saves (creates or refreshes) an object in the database.
- 'deleteById(ID id)': Deletes the object with a given identifier (ID) from the database.

Spring Data JPA automatically generates an implementation of 'JpaRepository'. This allows to use ready-made methods for the operations on the data associated with JPA without having to write SQL queries manually.

The difference between CrudRepository and JpaRepository is that JpaRepository is specific to JPA (Java Persistence API), while CrudRepository is a more general interface that can be used with various data access technologies. CrudRepository provides the basic operations for creating, reading, updating and deleting data, regardless of the specific database access technology. It is more abstract and common to different types of repositories. JpaRepository, on the other hand, is specific to JPA and provides additional methods that are specific to work with JPA and corresponding ORM (Object-relational mapping) operations. These methods include, for example, data filtering, sorting and retrieval capabilities that are convenient to work with JPA. The server uses JPA as a database access technology, and it is recommended to use 'JpaRepository' because it provides additional JPA-specific functionalities.

A. *REST architecture*

A REST (Representational State Transfer) service is a type of service that is provided by using REST Architecture. RESTful services use the HTTP protocol for communication and offer an easily usable and flexible API (Application Programming Interface) for data exchange between client and server applications.

RESTful services are based on several basic principles:

- Use of HTTP methods: RESTful services use standard HTTP methods such as GET, POST, PUT and DELETE to send requests to the server. Each query has a certain meaning and purpose, GET is used to query a resource, POST to create a new resource, PUT to refresh an existing resource, and DELETE to delete a resource.

Using URIs (Uniform Resource Identifier): RESTful services use URIs to identify the resources being worked with. The URI serves as an address that can be used by the client to send a request to the server and receive a response.

- Use of data exchange formats: RESTful services use different data exchange formats, such as JSON (JavaScript Object Notation) or XML (eXtensible Markup Language). These formats are used to represent the data that is sent from the server to the client and vice versa.

- Condition independence: RESTful services are characterized by being stateless. This means that each request contains all the necessary information on how to process it without requiring server state storage.

RESTful services are extremely popular in the software industry as they provide simple and effective ways to communicate between different applications and systems. They are used in a wide range of fields, including web development, mobile applications, IoT (Internet of Things) and many others.

Two classes of "ParkingSpotController" and "UsersController" are used to implement the REST architecture. In the "UsersController" class, all HTTP methods for working with the data from the users and "user_information" tables are implemented. In the "ParkingSpotController" class, all HTTP methods for working with data from "parking_spot_reservation," "parking_spot" and Company.

B. *Description of the different methods:*

- The "getAllParkingSpot" method - This method receives a username and password as parameters. Initially, it retrieves the user information from the database by checking that the username and password match a record in the database. After that, the method checks whether the user has access to the parking spaces. This can be done by checking whether the user is an administrator or has certain permissions. If the user has access, the method extracts the information about all parking spaces available to him from the database and returns them as a result.

- The "GetCompanyInformation" method - This method returns a list of information about all companies. It extracts the data from the database by including the company name, address and contact information. The method returns this data as a result.

- The "getParkingSpot" method - This method makes a reservation of a parking space for a company. It receives parameters such as company name, period and car number. Initially, the method verifies the availability of free parking spaces for the company by extracting the information from the database. If there is a parking space available, the method creates a reservation by entering the company information, period and vehicle number in the database. After successful booking, the method returns a confirmation message.

- The "getParkingSpotInformation" method - This method returns information about booking a parking space for a car. It gets a car number as a parameter. The method searches for the reservation by this number in the database and, if it finds a corresponding reservation, retrieves the information about the parking space and the company where the reservation was made. This information is returned as a result.

- The "getParkingSpotInfo" method - This method returns information about a specific parking space by its ID. It receives a parking space ID as a parameter and extracts the parking space information from the database. This information includes parking space number, status, company and other details. The method returns this information as a result.

- The "UpdateStatusParkingSpot" method - This method changes the status of a parking space by its ID. It receives a parking space ID and the new status. The method refreshes the status information in the database using the provided ID. After the successful status change, the method returns a confirmation of a successful operation.

- The "CreateParkingSpot" method - This method creates a new parking space for a company with a certain name and

status. It receives parameters such as company name, parking space name and status. Initially, the method checks whether the name of the parking space already exists in the database. If there is an existing parking space with the same name, the method returns an error message. Otherwise, the method creates the new parking space in the database by entering the company information, the name of the parking space and the status. After the successful creation of the parking space, the method returns confirmation of a successful operation.
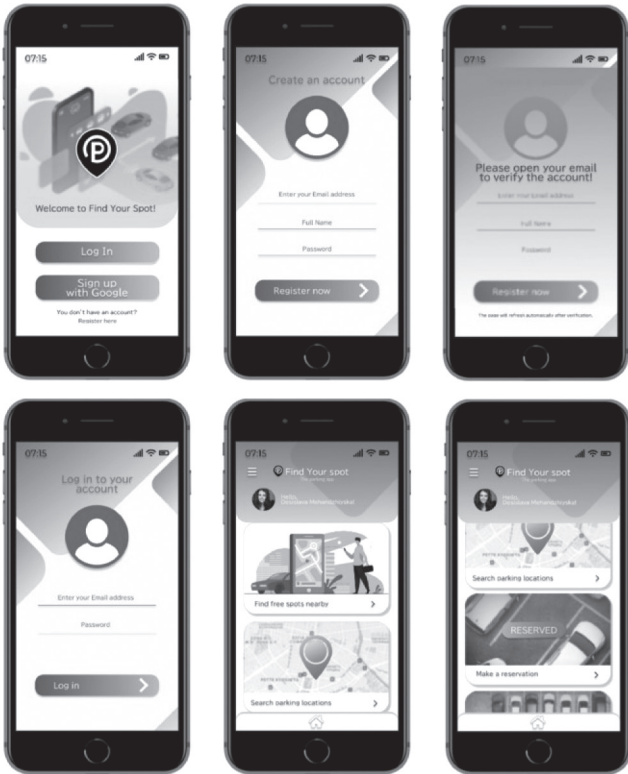
VII. "FIND YOUR SPOT" APP INTERFACE

Figure 3. App interface windows, Log in and Homepage

User experience design (UX) is a process in which design teams create products that provide an easy, meaningful, and relevant user experience. This includes the design of the entire process of product acquisition and integration, including brand aspects, design, usability and functions. What UX designers do is much more than just the UI design itself. "User Experience Design" is often used in conjunction with terms such as "User Interface Design" and "Usability." However, user interface (UI) usability and design are important aspects of UX design and are part of it. UX design covers a wide range of different other areas. It covers the entire process of acquiring and integrating a product, including aspects of brand, design, usability and features. This is a process that begins before the product is in the hands of the consumer. It is important to emphasize that the satisfaction of user needs must also meet company goals. No product is self-contained. The product is much more. It is a combined, integrated set of experiences. All stages a product or service goes through – from initial intent through subsequent changes or from first use to subsequent assistance, service and support. Going through all these stages should be seamless, easy and accessible to the user.
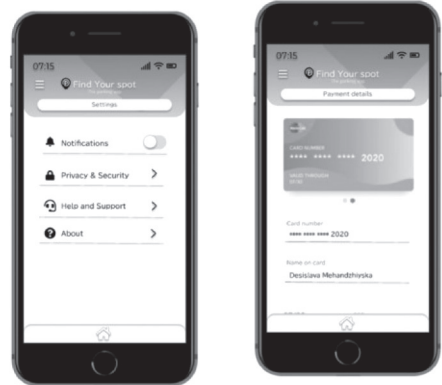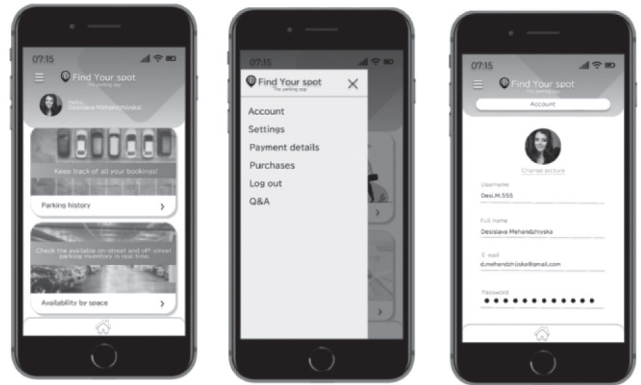

Figure 4. Visualization on the interface on the concept behind the design, page with menus, settings, details behind the payment system

Figure 5. Visualization of three types of maps integrated into the app, offering a variety of features

VIII. FEATURES OF THE APPLICATION

A. *Two-stage unlock protection*

Drivers must authorize the use of a login password via email or phone number to ensure appropriate data protection.

B. *Location*

For the convenience of users, geo-location helps drivers find their car, vacancies and see the distance to the parking lot. Calculating the position of the location of users if the GPS signal is unstable or unavailable is mandatory, especially during travel.

C. *Search*

When business owners think about how to create a parking app, this feature sits at the top of the list. The parking platform provides search for nearby spaces in a certain area in seconds.

D. *Time range*

This feature helps users calculate when parking time expires and how much money is needed to pay for a parking ticket. What's more, this option allows calculating the time it takes to reach parking from the current destination.

E. *Reservation*

Really a must-have feature, the app provides is an option to book seats in advance. When people travel to preferred places, this option can save their day.

F. *Multiple payment methods*

Users should have a choice between a variety of options such as Visa, MasterCard, Apple Pay, Google Pay or cash. It is important to offer multiple payment methods in the development of a mobile car parking app to cover a wider audience.

G. *History of parking*

Adding a parking history will allow users not to remember addresses and paid expenses, but to save them in favorites and simply return to them. This saves time and increases customer satisfaction.

H. *Rating/Reviews*

Sometimes customer expectations do not correspond to reality. Users should have the ability to leave ratings and reviews so that drivers can share their feedback on specific options to help others make decisions.

I. *Customer Support*

Customers should be able to receive immediate customer support in case of an emergency or if they just want to share their experience with the business. Over 65% of millennial users expect real-time interactions and responses, while more than 60% are willing to share their data to improve their experience. No less, and 75% of total customers expect to get help within five minutes, and 72% share positive experiences with others.

J. *Push-notifications*

This feature informs customers about vacancies, service updates and available discounts. Push notifications can increase user engagement by up to 88% and increase retention rates by three to ten times.

IX. CONCLUSION

Launching a parking app on the market requires careful planning, thorough research and strategic implementation. By understanding the challenges people face when searching for parking spaces and tackling them through innovative solutions, parking applications have the potential to significantly improve the parking experience for users. By integrating advanced features such as real-time availability, reservation systems, and navigation assistance, these apps can improve convenience, reduce stress, and save driver's valuable time.

To ensure a successful launch of the application, it is crucial to develop a comprehensive marketing strategy that includes effective promotional campaigns, user engagement initiatives and partnerships with relevant stakeholders in the parking industry. Through the use of digital marketing channels, social media platforms and targeted advertising, app developers can create awareness, generate interest and drive adoption among their target audience.

Additionally, continually analyzing user feedback and app performance metrics will provide valuable insights into ongoing improvements and updates. Regular updates, bug fixes, and the addition of new features based on user needs and preferences will help maintain user satisfaction and improve the overall user experience.

Successful application launch requires a holistic approach that encompasses market research, marketing efforts, consumer engagement and ongoing analysis. Taking into account the specific needs of users, collaborating with relevant stakeholders and continually striving for improvement, parking apps have the potential to revolutionize the way people find and manage parking spaces, making the whole process more efficient, convenient and stress-free.

In rapidly evolving urban mobility, the launch of a parking application that responds to the challenges faced by drivers can have a profound impact on improving urban congestion, reducing pollution and improving the overall quality of life in cities. Embracing technological advances and harnessing the power of mobile apps, the future of parking management looks promising, offering innovative solutions that transform the way we park our vehicles.

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