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BUILDING AN APPLICATION MODEL FOR EFFICIENT RIDE BOOKING IN RIDE-HAILING INDUSTRY

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BUILDING AN APPLICATION MODEL FOR EFFICIENT RIDE BOOKING IN RIDE-HAILING INDUSTRY

A Project

Presented to the

Faculty of

California State University,

San Bernardino

In Partial Fulfillment

of the Requirements for the Degree

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in

Information Systems and Technology

by

Nikunjkumar Mukeshbhai Butani

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ABSTRACT

The purpose of this study is to develop an efficient ride-booking application in the ride-hailing sector. The objective of the research is to provide users with an easy way to book rides at reasonable prices and convenient times. This project helps to promote the ride-hailing industry by guiding the creation of real-time applications. This project answered three questions. 1. What are the technology and infrastructure requirements for developing a consolidated online application for centralized ride sharing? 2. What are other examples of application aggregators in other industries than transportation and how do they work? 3. What are the steps for developing an online application that integrates the current ride-sharing applications? This project used the Java programming language to design an Android application in Android Studio that compares different ride fares, wait time and car types. The application made use of a dummy dataset in JSON format that included time, cost, and car type details. The software allows users to enter their origin and destination, and it then presents information on availability, waiting times, estimated costs, and car types. The application development process includes the creation of the dataset, setup of the Android Studio project, data retrieval and merging using Java programming, and tabular data display on a mobile screen. The developed application helps users compare various ride-sharing services, informs riders of available ride charges, and offers estimates for wait times. It assists riders in booking the best ride among various available options across different ride-sharing platforms

based on their preferences. development of an efficient ride-sharing application in the ride-hailing industry, aiming to provide users with the ability to book rides at reasonable prices and suitable times. Future developments for ride-efficiency apps include multi-language support, advanced filtering, real-time API integration, ride-sharing service growth, in-app payments, user reviews, personalized suggestions, map integration, and multi-modal growth.

DEDICATION

For My Family

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CHAPTER ONE

INTRODUCTION

The ride-hailing industry has undergone a significant transformation, reshaping the way people move within cities worldwide. Through user-friendly smartphone applications, travelers can conveniently book rides from privately owned vehicles, enjoying benefits like pre-estimated costs, real-time tracking, and easy reservation management. This sector's growth is fueled by factors such as increased consumer spending power and a focus on convenience, affordability, and comfort, making it a critical player in the urban transportation landscape (Muhamad Rizki & T. Joewono, 2021).

The ride-hailing industry is an integral component of the broader Mobility as a Service (MaaS) concept, which seeks to seamlessly integrate and streamline various transportation modes through a unified digital platform, ultimately enhancing urban mobility and sustainability. Ride-hailing services represent just one facet of MaaS, delivering flexible, on-demand transportation solutions. The synergy between ride-hailing and MaaS envisions a future where these services are seamlessly integrated with public transit and other transportation modes, culminating in a comprehensive urban mobility solution (Datson. J, 2016).

Considering the complex and resource-intensive nature of MaaS, this research focuses exclusively on the ride-hailing sector, rather than the

comprehensive MaaS framework. MaaS implementation requires substantial investments and collaboration between public and private entities, and in the absence of robust public policy components, it can strain public transportation systems and potentially reduce ridership.

Furthermore, this research addresses a significant gap in the field by concentrating on the development of a user-friendly online platform that consolidates ride-sharing options and pricing, facilitating informed choices for riders. By narrowing the research scope to ride-hailing, this research project aims to provide a practical and immediate solution to urban transportation challenges, empowering riders to conveniently compare and select the most suitable ride-sharing options.

To the best of the author's knowledge, there is not a significant amount of work focusing on an online platform where riders can see all ride-sharing options, prices, and offers at once and select the best means of transportation based on their preferences and conditions. Therefore, this research is focused on designing a comprehensive mobile application that helps integrate the data over multiple applications and provides the information in a more convenient way to the riders and gives them options to compare and choose the best option.
This chapter provides an overview of Mobility-as-a-Service and the ride-hailing industry, laying the foundation for the problem statement and research questions to be explored in subsequent chapters.

Mobility as a Service (MaaS)

Mobility as a Service (MaaS) describes several forms of current transportation services that have been brought together to create a single, unified service available on demand through a digital application and a single payment stream. Whether it is a bus, metro, or private operator like ride-hailing, taxis, or ridesharing, a MaaS operator integrates several modes of transportation onto the platform and offers them on a single interface for users (Protocol, T. 2019, June 19). MaaS is described by the Transport Systems Catapult as using a digital interface to source and manage the provision of one or more transport-related services that satisfy a customer's need for mobility (Datson. J, 2016). Moving away from the current automobility system of private automobile ownership and toward a more sustainable "post-car" system is possible with the help of the MaaS concept (Maxime Audouin, 2018).

Figure 1 shows details about The Use of a single application to provide access to mobility and a single payment channel rather than multiple ticketing and payments under the MaaS concept (Protocol, T. 2019, June 19). MaaS provides users with benefits and services. Also, it introduces new business models and organizational structures for the various modes of transportation, offering benefits such as new opportunities to serve unfulfilled requirements of the users. The role of an integrator of MaaS is divided into a total of five levels 0 to 4 as it is indicated in Figure 1.

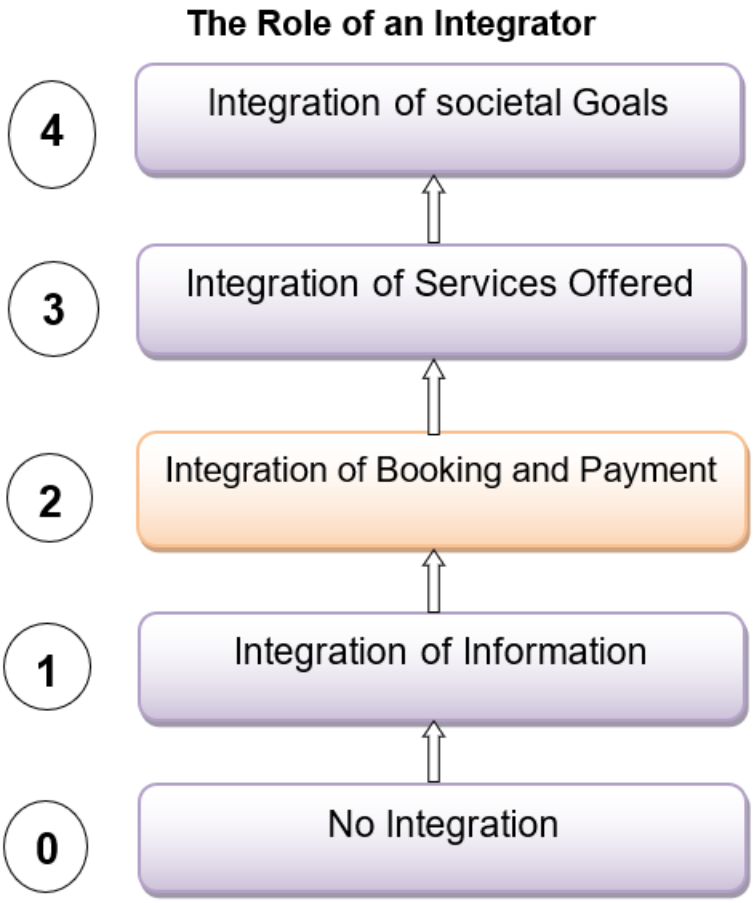


Figure 1. Five different integration levels of Maas (Protocol, T. 2019, June 19).

Level 0 No integration

This basic level describes the situation where separate services are offered for each unique mode of transportation without any sort of integration. Lyft (ride-sharing app), hertz (rental car company), and Sun Fleet (car-sharing app) are examples of this level of integration.

Level 1 Integration of information

This level of integration shows the travel information for the specific route, all available modes of transportation, journey time, and suitable route for traveling. But it does not show the cost of the travel, especially for short-distance journeys. Services offered by Google (google maps), Moovit, and Qixxit are examples of this level of integration.

Level 2 Integration of booking and payments

A Level 2 service would be a logical step for travel planners as it focuses on a single trip and helps to add public transport ticketing, taxi, and other transportation sources. GHV is an example of an application that shows all transportation public and private together for a single trip.

Level 3 Integration of services offered.

Level 3 is the all-inclusive substitute for owning a car, focusing on the customer's complete mobility requirements, and increasing the attraction of transport service providers to customers they cannot reach as single service providers. The service also provides a variety of transportation options through passes or bundles to satisfy the complete range of everyday mobility demands of individuals and families. UbiGo and Whim are two examples of this level of integration.

Level 4 Integration of societal goals

At this level, MaaS goes beyond managing the supply and demand for mobility. The added benefit is the reduction in private car ownership and creating more accessible livable cities. Currently, there is no application that offers this level of integration.

Advantages of MaaS**:** The MaaS business model has two main advantages: (1) servitization, in which the MaaS Provider develops a value proposition that consists of a "bundle" of various mobility services, and (2) data sharing, in which the MaaS Provider shares data on customer mobility needs with the Transport Operators to aid in the improvement of their services (Datson. J, 2016). Users of Maas can use a pay-as-you-go subscription for a specified period. As a result, users do not have to purchase tickets or open separate accounts for different modes of transportation (Luis Barreto & Antonio Amaral, 2018).

These services are also becoming more popular in low- and middle-income nations, where they add to a transportation network that is already complicated and only loosely organized, frequently supplied by dispersed, underfunded, and loosely controlled private operators (Joanna Moody, & B Alves, 2023). MaaS has offered better mobility solutions as compared to individual service providers such as Uber, Lyft, and local transit apps. MaaS is a better

means in terms of being a faster or more cost-effective service. In addition, MaaS service can be customized to consider specific customer preferences (Javed. J.C. Aman & J. Smith-colin, 2022).

Limitations of MaaS**:** The investment costs associated with implementing MaaS are shared by both public and private organizations. Infrastructure and technology development, testing, and implementation especially for level 3 and 4 are expensive and time-consuming processes. Many public institutions lack the necessary resources; however, several private groups offer such services to some extent (National Express Transit, 2019).

A MaaS business model that lacks the public policy component frequently puts pressure on key public transportation systems, which eventually results in decreased ridership. For instance, the introduction of car-sharing services has a measurable impact on the choice of transportation modes, in some instances, there has been a 1.7% to 3.0% annual decline in bus ridership in the United States (C.J. Ditmore & Miller, 2021). In some instances, users of MaaS app are unsure of how much they would be ready to spend on a subscription model because it is challenging for multimodal users to determine their average monthly spending related to their mobility habits (Maria Urrea Lopez, 2020).

Due to the limitations and complexities associated with implementing Mobility-as-a-Service (MaaS), it becomes evident that a focused approach on ride-hailing, rather than the entire MaaS framework, is an appropriate direction

for this project. The primary considerations for narrowing the scope of this study are rooted in the practical challenges posed by MaaS implementation.

Ride-Hailing Industry

Ride-hailing is a service that includes travelers requesting a ride from a privately owned vehicle via an online booking application (Duy Quy Nguyen-Phuoc & D. Ngoc Su, 2022). There has been a rising demand for online ride booking applications around the world (Mehta, Shah & Patel, 2022). The use of smartphones, the internet, and the availability of tracking capabilities, pre-estimated ride costs, driver contact information, arrival time information, and vehicle features on the app are increasing the ride-hailing market growth. Furthermore, to lower the costs of everyday rides, key companies are focusing on providing offers and discounts, such as monthly passes on shared rides. Such promotions can positively influence market growth. There are other reasons that are promoting new markets in this industry including the growing working-class population, increased customer spending power, and the rising popularity of road trips among younger age groups (Business Wire, 2023, January 11). Increasing attention is expected in the future for the ride-hailing industry.

Advantages of Ride-Hailing**:** There are several benefits behind the increasing market growth of ride-hailing industries such as gaining the flexibility of private transportation without having the added difficulty of locating parking

spaces and paying parking fees, as well as reducing the customer wait time in the case of public transportation (Muhamad Rizki & T. Joewono, 2021). According to a report by Business Wire (Business Wire. 2023, January 11), such ride-hailing companies provide point-to-point and door-to-door services, making it easy for customers to make changes and cancel reservations via mobile applications. In addition, these applications are becoming more popular in urban areas because of their affordability, convenience, and comfort.

There has been a rising demand for online cab booking applications around the world (Mehta, shah & Patel, 2022). The use of smartphones, the internet, and the availability of tracking capabilities, pre-estimated ride costs, driver contact information, arrival time information, and vehicle features on the app are increasing the ride-hailing market growth. There are publications existing that are focused on building application models for different purposes, Nadia Dahmani & Suja A, (2022) have designed and implemented a blockchain-based web application for car booking named Welcome Wagons. K. A. Kamaruddin and N. R. M. Rozlis, (2019) designed and developed a campus ride-sharing mobile application named UiTM share ride.

Limitations of Ride-Hailing: Despite the various advantages of the ride-hailing industry, it comes with its limitations. One significant constraint lies in the need for users to engage with multiple applications to determine which service offers the most favorable quality, pricing, and promotions. As passengers

frequently turn to various ride-hailing platforms, each with its distinct offerings, the process can become time-consuming and, at times, less straightforward. The absence of centralized information makes it challenging for riders to make well-informed choices based on their preferences and current circumstances.

There is not a significant amount of work focusing on an online platform where riders can see all ride-sharing options, prices, and offers at once and select the best way of transportation based on their particular preferences and conditions. Therefore, this research is focused on designing a comprehensive mobile application that helps integrate the data over multiple applications and provides the information in a more convenient way to the riders in order to give them the opportunity to compare and choose the best option.

Problem Statement

Currently, customers tend to use online ride-sharing applications to book their rides. Users have to open multiple taxi booking applications to compare fares and estimated arrival times when they want to book a taxi. Lack of time to compare multiple services can result in higher charges and longer waiting times for the customer. To address this inconvenience, a new application could be created that consolidates all available services, rates, arrival times, discounts, and promotions in one place.

Research Questions

This project aims to find answers to the following research questions:

1. What are the technology and infrastructure requirements for developing a consolidated online application for centralized ride sharing?
2. What are other examples of application aggregators in other industries than transportation and how do they work?
3. What are the steps for developing an online application that integrates the current ride-sharing applications?

Objective

In order to understand how to develop a ride-sharing application integrator, the project will take a three-step research approach. First, an investigation of technology and infrastructure requirements for developing an online application for centralized ride sharing will be conducted. This will entail researching the literature and finding applications other than transportation companies' aggregators such as Airbnb and Expedia. This will provide real examples of what it takes to develop a new platform that could consolidate all available services, rates, arrival times, discounts, and promotions in one place.

Finally, the steps of the developed application will be explained to draw conclusions and provide recommendations for future research.

Organization of Study

This project is organized as follows: Chapter 2 covers a review of the literature on the research topic. Chapter 3 covers the technology and infrastructure requirements of developing an integrator platform for ride-sharing applications and discusses several relevant case studies in other industries. Chapter 4 Covers development of an application part and analysis and findings of how the prototypes work. Chapter 5 contains the summary, recommendations, conclusions and future studies.

CHAPTER TWO

LITERATURE REVIEW

In this chapter, a brief review of scholarly articles is provided which have some intersection with this project's topic of study. The primary sources of literature are peer-reviewed journals and articles found via the CSU library's One Search tool and Google Scholar.

Mobility as a Service (MaaS) Literature Review

Protocol, T. (2019, June 19) provided details about using a single application to provide access to different modes of transportation and a single payment channel for ticketing and payments. MaaS provides users with benefits and services. Also, it introduces new business models and organizational structures for the various modes of transportation, offering benefits such as better user interface to meet users' needs, and new opportunities to serve unfulfilled requirements.

Yale Z. Wong & David A. Hensher (2019) propose a revised approach to improve urban transportation, based on a conceptual framework situating both existing and emerging modes of transport around spatial and temporal dimensions. They proposed linking urban land using characteristics of travel price and modal efficiency to improve the broader transport system and guide the sustainable development of the cities. They also proposed a government-

contracted model for MaaS, where road pricing is incorporated as input into the package price. This proposal is intricately linked to the regulation of autonomous vehicles as they come online, and the geometric realities of cities as a dense urban environment.

Luke Butler & Tan Yigitcanlar (2020) have studied Barriers and risks of MaaS adoption in cities in a systemic review of the literature. MaaS is an integrated system that enables commuters to plan, book, and pay for trips using a range of mobility providers, making it a potential alternative to provide vehicle ownership. This paper examined barriers and risks related to MaaS adoption in cities, finding that the desired outcomes are associated with reduced vehicle kilometers traveled, increased trip awareness, reduced parking, reduced ownership, and improved social equity.

Henrik Becker & Milos Balac (26 September 2019) explained that by providing transportation services that are specifically suited to each traveler's needs, MaaS aims to address market segmentation. Using Multi Agent Transportation Simulation (MAT Sim), this study combined simulations of ride-hailing, vehicle sharing, and bike sharing for a city-scale transportation system. The findings indicated that less biased mode selection can cut transportation-related energy consumption by 25% and boost energy efficiency by up to 7%.

Valeria Caiati & Soora Rasouli (September 27, 2019) utilized a choice model based on a Dutch stated preference survey to estimate the latent demand for MaaS. Two mixed logit models are estimated to capture unobserved

heterogeneity in individual preferences. The findings show that although respondents are not yet prepared to sign up for this new service, public transit is still their favorite means of travel. Sociodemographic profiles and an individual's transportation-related traits strongly influence the decision to subscribe and which modes of transportation to include in the bundle.

Marc Hasselwander & Joao F. Bigotte (December 24, 2021) indicated that MaaS is becoming increasingly popular in industrialized nations and has the potential to affect people's mobility habits. A growing Asian megacity, Metro Manila (Philippines) was the subject of this case study, which examines how its residents feel about MaaS and how it can affect their mobility habits. Reliability and cost savings are the key drivers of adoption, and they may cause a change in users' mobility habits in favor of more environmentally friendly forms of transportation. They also highlighted the future research directions and policy implications.

Wong, Y. Z., & Hensher, D. A. (May 7, 2020) mentioned that although MaaS promises seamless mobility, the supply side is not well understood. In this study, mode-agnostic mobility contracts were tested to connect specialized firms. To determine the significance of contract qualities, data were gathered from 202 organizations in 28 different countries. Then, to determine the possible value proposition of a mobility broker/aggregator, willingness-to-pay estimations were developed.

Based on the above literatures review, researchers have investigated various aspects, including MaaS benefits, revised urban transportation approaches, barriers and risks to MaaS adoption, energy efficiency enhancements, demand considerations, and the influence of MaaS on mobility habits. Their studies contribute to a comprehensive understanding of MaaS and its implications for urban transportation. In addition, MaaS alters transportation practices, improves reliability, and encourages environmentally beneficial choices. It helps connect public and private transportation and benefit riders and drivers.

The ride-hailing industry is an integral component of MaaS. This research focuses on showing how the integration of data and information in the private ride-sharing industry can benefit users. The next subsection includes ride-hailing industry literature review.

Ride-Hailing Literature Review

Sujan Sikder (June 25, 2019) explained how land use and socio-demographic characteristics influence the adoption and usage of ride-hailing services in the United States. According to the findings, African Americans are less likely to adopt and frequently use these services, full-time workers with flexible schedules are more likely, people in households with insufficient vehicles are more likely, and having kids, elderly family members, or both, in the home is likely to have a negative impact. They argue that cooperation between ride-

hailing companies and transit authorities could aid in the creation of an integrated transportation system.

According to Mischa Young and Steven Farber (December 13, 2018), the ease of use and reasonable prices of ride-hailing services like Uber and Lyft have led to their growing popularity. Their impact on other transport options, such as public transportation and taxis, is still being studied. They found that ride-hailing is a rich younger generation problem with a significant reduction in taxi usage and an increase in active modes of transportation by comparing the socioeconomic and trip characteristics of ride-hailing customers to those of other mode users. They believe ride-hailing could be a useful tool in the struggle against drunk driving and that as its use grows, it would impact other modes' ridership more sharply.

Suman Kumar Mitra & Youngeun Bae (March 13, 2019) examined the adoption and usage patterns of on-demand ride-hailing services among older persons. According to their findings, older people who are middle aged, less educated, or careless are more likely to be frequent users than younger people, living alone, highly educated, wealthier, or male with a medical condition. They explained that using a smartphone is a significant factor in adoption behavior.

Yi Hou & Venu Garikapati (May 1, 2020) investigated the extent to which various socioeconomic, spatiotemporal, and trip factors influence willingness to pool (WTP) in ride-hailing trips. According to the results, the most significant predictors of WTP were income levels near the drop-off and pickup sites and

travels to the airport. This information can be used by transportation network companies and localities to develop strategies to expand pooled ride-hailing.

Duy Q. Nguyen-Phuoc & Phuong Thi Kim Tran (July 2021) compared the direct and indirect effects of variables such as perceived advantages of the booking method, perceived safety, involvement, and satisfaction on the loyalty of customers to ride-hailing and traditional taxi services. The findings indicated that loyalty among traditional taxi customers was most strongly influenced by satisfaction, while loyalty among users of ride-hailing services was most strongly influenced by perceptions of safety. This study provides tips on how to attract more regular consumers of traditional taxis and ride-hailing services.

Ofori, K. S. & Anyigba, H (August 27, 2021) studies the connections between consumer happiness, perceived value, and future usage intentions of ride-hailing apps in Ghana. It is discovered that whereas satisfaction is more strongly influenced by economic value, continuing usage intentions are more strongly influenced by hedonic value. The research findings can help practitioners make decisions about how clients use ride-hailing apps and inspire further discussion.

Y. G., Xiaotong Li, & Xiaohua Zeng (09 October 2019) evaluated the influence of ride-hailing platforms entering the market and facing platform competition on the purchasing of new cars. Their findings reveal that platform competition has increased sales of popular automobile brands chosen by ride-

hailing drivers, indicating that businesses' competitive tactics need to take consumer expectations and knowledge into account.

Lambros Mitropoulos & Annie Kortsari (December 07, 2021) analyzed ride-sharing research around the world to map key features of ride-hailing industry, such as online platforms, user factors, and limitations affecting ride-sharing services offered on a ride-hailing platform. They suggested that the future research should concentrate on studying the purpose of trips taken by ride-sharing users, looking into ride-sharing-related aspects both before and after adoption, and doing cross-case studies between cities and nations on the same continent.

Minne Li & Zhiwei Qin (May 2019) suggested using multi-agent reinforcement learning (MARL) to solve the order dispatching issue in peer-to-peer ride-sharing systems. Their method can allow fully distributed execution using Internet of Vehicles (IOV) and Vehicles to Network (V2N) and is more dependable than centralized methods. To make local interactions simpler, they used the mean-field approximation. Their results show reduction of traffic congestion and increase of the Accumulated Driver Income (ADI) measure.

Above research studies focus on several variables that affect the adoption and usage of ride-hailing services, such as trip characteristics, income levels, and populations. Younger, wealthier people choose ride-hailing, which has an impact on other forms of transportation. The loyalty of using these apps is influenced by satisfaction and perceived safety. The analyses suggest more

investigation into platform competition and usage patterns. Also, there is a scarcity in research about integrating the data and information across multiple platforms to help the users find the best option in terms of time and cost for their ride. This research is focused on developing such an application that can integrate multiple existing applications and offer value-added services to the users.

Next, examples from other industries than the ride-hailing industry are presented to show how a comprehensive application can benefit users.

Other Applications Literature Review

Khondoker Aminuzzaman & Md. Junayed Miah (2021) built the Online Home Sharing Web Application. This application is similar to Airbnb, which is used for home sharing. They explained that for tourists visiting Asian countries such as Bangladesh, there was not any home-sharing application to use. To solve that problem, they developed an online home-sharing application. This application is used as a platform to match individuals looking for a home or room to stay with those ready to rent out their homes or rooms. They have used HTML, CSS, Bootstrap, and JavaScript for the front-end side and MySQL for the back-end side for developing their website. The application aims to provide accommodation to tourists at a cheaper price. The future scope of this study is to add a criterion for food where people will be able to post ads to offer the tourists their home-made foods besides renting their houses. Also, they can implement

and add some features, for example, tourist attraction places as per people's reviews and images near users' accommodations.

M. U. Sreeja & B. C. Kovoor (2017) built a model for a multi-agent-based extended travel support system using the Java agent development (JADE) framework. This model aims for a multi-agent e-commerce system acting as a system for booking airline tickets and providing travel support. The results show that the suggested system requires the least input data from users when compared to user-based systems. The suggested system can be expanded to provide a full travel itinerary, including the standard options for hotel accommodation and transportation as well as restaurants, movie theaters, national parks, historical sites, and other points of interest, any of which may be selected by the traveler from a variety of options created specifically for them by software agents. The future scope of this study is, for example, to enter the location and date in case a user wants to attend a meeting in a particular location. The application then arranges the flight ticket and the accommodation as per the user's interest. The proposed model helps in reducing time and improving the accuracy of services. It also provides transportation services at a reasonable price by comparing available rides a scheduling the pick-up time based on users' requirements.

Nadia Dahmani & Suja A, (2022) designed and implemented a blockchain-based web application for car booking named Welcome Wagons. The main purpose of this web application is Ethereum for the Indian currency. Applications

built on the blockchain are decentralized and guarantee the security of all online transactions. This application allows users to hail a ride and drivers to fix prices and collect payments. It is a decentralized web application for cab booking. This web application was created using advanced tools like React and Next JS. Tailwind CSS is used for styling. As a backend, Firebase and Blockchain Web 3.0 are used. This brand-new website offers a safe payment-based car booking service. In the future, the application will be extended to other countries' currencies. This application can also be extended to new driver registration services and the smart contract will be established for allotting charges for drivers by the administrator. In the future, the web-based application can be extended as a mobile application.

K. A. Kamaruddin & N. R. M. Rozlis, (2019) designed and developed a campus ride-sharing mobile application named UiTM share ride. To solve the college's campus parking problem and for fuel saving the main goal of this application is to satisfy users and needs for environmentally friendly and practical vehicle ride sharing. They used Java programming language, android studio as the software development kit, firebase database for storing, and Google map API to find a pickup location and destination for ride requests. There has been much research done on the ride-hailing industry to showcase different benefits, risks, and challenges. In other industries also, there have been applications developed to help the users in a more efficient and effective way to find their chosen services. For example, they are multiple applications aimed at helping customers

to search among several available flights and reserve the one that is the best fit for them. People book their flights based on their specific time preferences and with reasonable prices. This concept is not currently available for the ride-sharing services. There are many ride-hailing platforms existing such as a, Uber, Lyft, DiDi, and Curb. But they operate individually, and a rider needs to check every single available application to figure out which one offers the best option. This research project's goal is to combine the available ride-hailing platforms in a single application and offer customers flexible taxi ride options at a reasonable price and time.

CHAPTER THREE

TECHNOLOGY AND INFRASTRUCTURE REQUIREMENTS FOR DEVELOPING AN ONLINE APPLICATION FOR CENTRALIZED RIDESHARING

Mobile Application Development Process

Team Invonto (April 2021) have explained the process of developing mobile applications which includes strategy, analysis & planning, design, app developing process, testing, and launching the application. These steps are especially important to build any kind of mobile applications that are explained later in this chapter. There are thousands of mobile applications available for Android and iOS. Remote computing resources are accessed by mobile applications across a network. Both making installable apps for mobile devices and implementing backend services, including data access through an API, are parts of the app development process. Another step in the process of testing the application on the intended devices.

There are two main mobile operating systems in the U.S.: Android and iOS. The Android operating system is run by Google and iOS is run by Apple. Android and iOS platforms have some similarities such as features, facilities, design background and buttons, but in the end, the applications developed on each system look similar. Developing a mobile application under each system requires a different software development kit. Many of the applications have varied sizes for iOS and Android. However, the applications output is the same

on both platforms. There are 6 steps to building mobile applications. Figure 2 shows these steps which are Strategy, Analysis & Planning, Design, App Development Process, Testing, and launching (Team Invonto, April 2021).

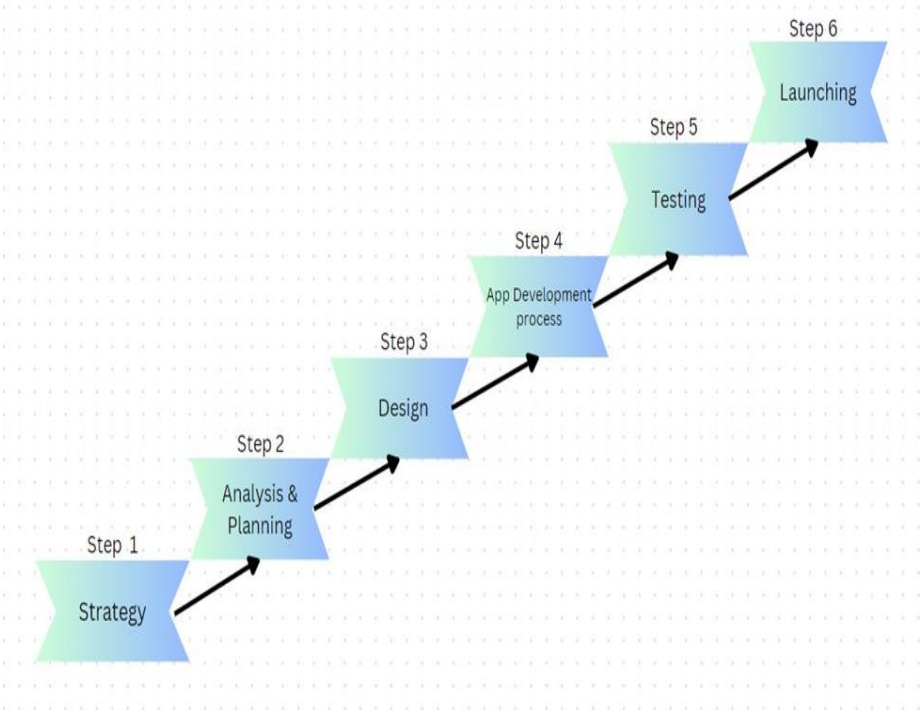


Figure 2. Six steps of developing a Mobile application (Team Invonto, April 2021)

Each step is explained in more detail below.

1. Strategy: Strategy is the first step in building a mobile application. Before building any kind of mobile application, developers should focus on some of the important factors, such as defining a purpose for building the application, identifying the public requirement, looking into other existing competitors, listing needed resources, calculating the time required to

build the application, finding out suitable platforms for advertising or marketing, and specifying the main goal of the application.

2. Analysis & planning: Creating a roadmap for the application comes next. This procedure is quite like planning and creating a thorough strategy for achieving the final objectives. The application's Minimum Viable Product (MVP) should succeed, and any potential failures should be avoided on the day the application is published. It is essential to make decisions based on the platforms (iOS or Android). The Design kit should also be selected based on the platform.
3. Design: The main goal of designing an application is to provide easy and effortless features to users. The purpose of mobile UI and UX design is to produce outstanding user experiences and interfaces that make the app engaging, simple to use, and interactive. The users' interest not only depends on their needs it is also depends on application design.
4. Development Process: When developers finish with the design step they should focus on the main stage, which is the application development process. There are two stages for application development: backend and frontend. The setup of databases and server-side objects, which are responsible for most of the app's performance, is part of the backend stage of app development. The front end of a mobile app is where users tend to interact with it the most. There are four major approaches when we are building mobile applications including Native platform, Cross-platform,

Hybrid, and Progressive web application. Native Platform Applications are designed with a particular operating system planned for best performance. Cross-platform applications that use a single codebase to run on several operating platforms, saving cost and development time. Hybrid apps balance performance and development speed by utilizing web technologies inside a native container. Progressive Web Applications (PWAs) are browser-based web applications that have functionality similar to apps but don't require installation.

5. Testing: When developers are finished with the application development process, the next step is testing the latest version of the application. In this step, they should check the app's performance, functionality, and security, especially when users are providing payment details or can pay online. These factors should be checked by the developers before launching the app.
6. Launching: When developers finish testing the last version of the application, then they can launch it. In this step, developers should check for some of the important aspects such as the size of the application, application title, search keywords, banner graphics, and better ways of marketing. Those are key factors for increasing the number of users for that application.

The official integrated development environment (IDE) for creating Android apps is called Android Studio. Xcode is Apple's official IDE for all Apple software,

including iOS (BuildFire, September 07, 2022). They offer a full range of resources, tools, and toolsets to simplify the development, testing, and deployment of Android and iOS applications. With tools like syntax highlighting, code completion, and code refactoring, Android Studio's code editor is a strong platform. For creating Android apps, it supports a variety of programming languages, including Java and Kotlin (Meet Android Studio. (n.d) Android developers, 2022).

In this project, Java programming languages is used to develop the proposed application Java programming language is one of the popular programming languages for building any kind of mobile application. As a platform based on the Java Virtual Machine (JVM), Android offers a wide range of Java functionality, making it the obvious choice for Android app development. Enterprises with significant requirements and performance always prefer to use Java. The best reason to use Java is to offer multitasking and high-level services (Editorial Team, December 05, 2022).

Hana Esmaeel, (2015) provided the structure of how an application runs in Android Studios as it is shown in Figure 3. In this study, six steps were suggested including downloading SDK; installing SDK & Android; creating an Android virtual device; creating an Android project, source code, files, and manifest; building and running an application; and testing the application.

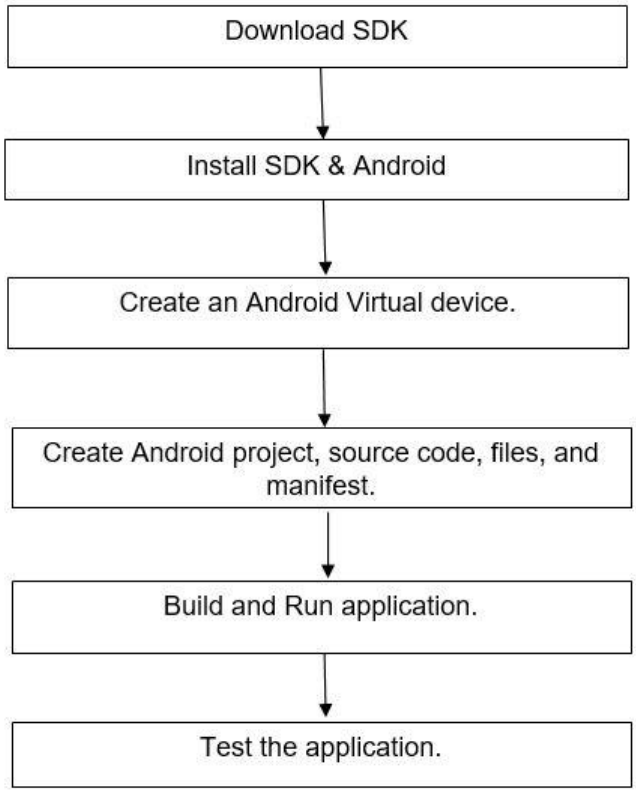


Figure 3. Structure of how an application runs in Android studios (Hana Esmaeel, 2015).

Ride-Sharing Application Infrastructure

By offering online ride-booking services via a mobile application, several businesses around the world have provided the required infrastructure. Apps for ride-sharing services to save time and money on transportation. Developing a mobile application could advance a ride-sharing company. A company requires a smartphone app to deliver their services.

There are numerous important factors that must be considered in order to design ride-sharing apps that are unique and effective. These include carrying out a strategy plan, choosing important features, completing proper research on the market, and deciding costs. The key elements required for building a ride-sharing app are divided into two categories since there must be two basic apps required, one for passengers and one for drivers (Gupta D, 2022).

The expanding on-demand ride-sharing app industry is a profitable business concept for aspiring entrepreneurs' concept for the expanding on-demand ride-sharing app industry. It is important that it includes the elements that will set it apart from traditional taxi services in order to stay competitive in the field of social transportation. A ride-sharing app's functions must be separated into versions intended for drivers and passengers respectively. The geolocation and routing servers are the true protectors of successful ridesharing applications (Bhavika Juneja, 2023).

The main elements of Uber's data processing architecture are shown in the "Real-time Data Infrastructure at Uber" diagram. It begins with a left-side overview of the computer systems that support real-time data processing and then moves on to show off the organizational structure of these systems as well as their unique architecture. The emphasis moves to the information systems on the right, which are in charge of managing data at Uber, and then to the data management systems, which deal with storing and retrieving data. Databases and related technologies are probably used in the particular data management

system that Uber uses. Stream management, the last stage, probably refers to managing continuous data streams, which guarantees smooth data processing and flow inside Uber's real-time data infrastructure.

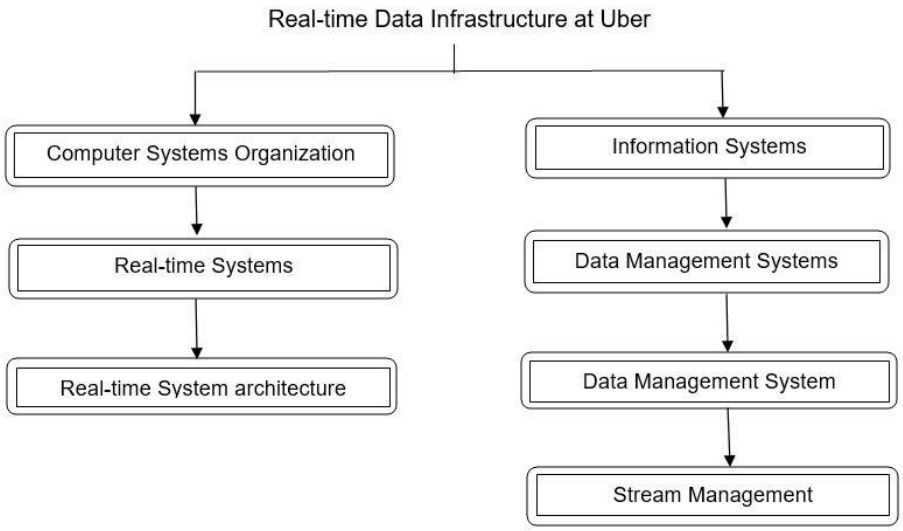


Figure 4. Real-time data infrastructure at Uber

Other Applications Business Models

Airbnb Business Model

Like the ride-hailing industry and many other businesses, Airbnb uses an aggregator business model. The business model of Airbnb differs from that of traditional accommodation networks, companies spend millions in the construction of their structures (AdminAP, A, 2023).

The Airbnb concept focuses on an online network that links hosts and travelers. Visitors can see many available options such as renting a room, a flat, an apartment, or a villa in a particular location or region. The key components of Airbnb are the hosts and the travelers. Airbnb makes it possible for transactions to be easy and affordable for the travelers while keeping them interesting for the hosts. The Airbnb business model is organized around the hosts as well as the visitors (AdminAP, A, 2023). Figure 5 shows the structure of the Airbnb business model.

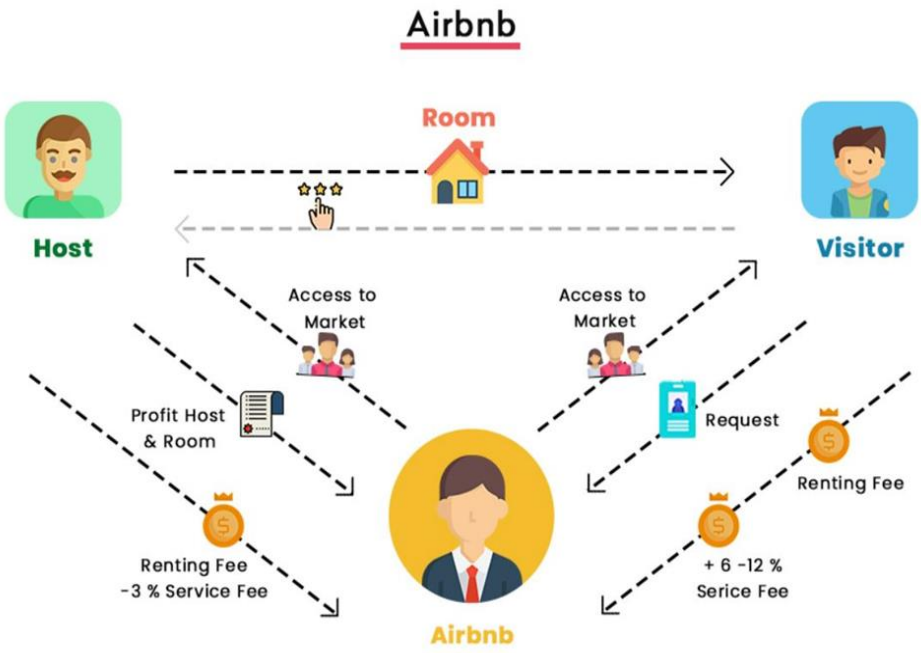


Figure 5. Structure of Airbnb Business Model (AdminAP, A, 2023)

The travelers can book the accommodation listed by hosts based on their requirement. Rent will be given to the hosts in return. By staying with locals, tourists may experience life at a whole new level. The Airbnb business model not only serves to travelers and hosts, but it also has a system for shooting high-resolution photos of the property to improve the Airbnb responses. For high-resolution photos of the property, Airbnb engages independent photographers. Airbnb pays for the highest-quality photos that earns the most bookings (Saxena p, 2022).

The main components of the Airbnb business model are hosts and travelers:

Host: A host is a person who lists their vacant accommodations on the website, if their places are booked, they will receive rent in exchange. By looking over the reviews from other hosts, hosts are free to accept or reject the travelers. Also, they can list their home along with the facilities they offer, the rental price, and the check-in and check-out times (Saxena p, 2022).

Travelers: Travelers are those who rent living space from hosts. They have the option to filter the search according to their needs. They can set the rent amount range, the minimum facilities they will require, and the number of guests. and they can book by making a payment online, which is said to be the least complicated method of booking (Saxena p, 2022).

There are several elements to look at while developing an app like Airbnb. It is important to focus on crucial components like app size, platform,

development team, and tech stack in the beginning. The app’s UI is engaging and gives priority to the most important functions needed by the hosts and travelers. The app includes services for registration, login, searching, bookmarking, conversations, profiles, payments, and booking for visitors. It also includes facilities, request management, notifications, and GPS for hosts. The price is determined by the size of the team, the platforms selected, the level of complexity, and the app's design. Multi-platform apps can be more expensive than single-platform apps, which can cost between $25,000 and $30,000 (Arora, P. 2023, May 2).

The development of a travel application entails several key steps. First, it starts with concept and planning, during which the developer establishes the app's goal, target market, and functionalities. The design phase comes next, where wireframes and mockups are made to represent the app's structure and user interface. Backend development covers infrastructure setup, trip data API integration, and server-side functionality implementation. The goal of frontend development is to create the user interface and add interactive components. The application's essential functions, including registration, search, booking, and payment mechanisms, are in place. Data from travel service providers can be accessed through API integration. The software is released to app stores after extensive testing to guarantee a seamless user experience. To address criticism and enhance the app, regular maintenance and upgrades are made (How to Develop a Successful Travel App Like Priceline, Expedia, and Airbnb, 2022).

Innovation, design, frontend, and backend development, feature implementation, API integration, testing, deployment, and maintenance are all steps in the development process for a travel app. The developers may make a successful travel app that appeals to their target market by following these guidelines and working with skilled team members.

Expedia Business Model

Expedia is an online travel agency that provides a platform for customers to search for and reserve travel-related services such as hotels, rental cars, cruises, and flights. The company uses an agency business model, where it facilitates travel bookings and represents the customer, transferring reservations made by the passenger to a suitable travel service provider (Pereira, D. May 15, 2023).

Expedia receives commissions or ticket fees from both travelers and travel suppliers. The core of Expedia's business strategy is providing online travel agencies through which customers can book flights and various types of accommodations. It promotes a certain amount of people to utilize its website to conveniently and immediately book travel by combining travel options in one location (Pereira, D. May 15, 2023). Figure 6 shows Expedia’s business model.

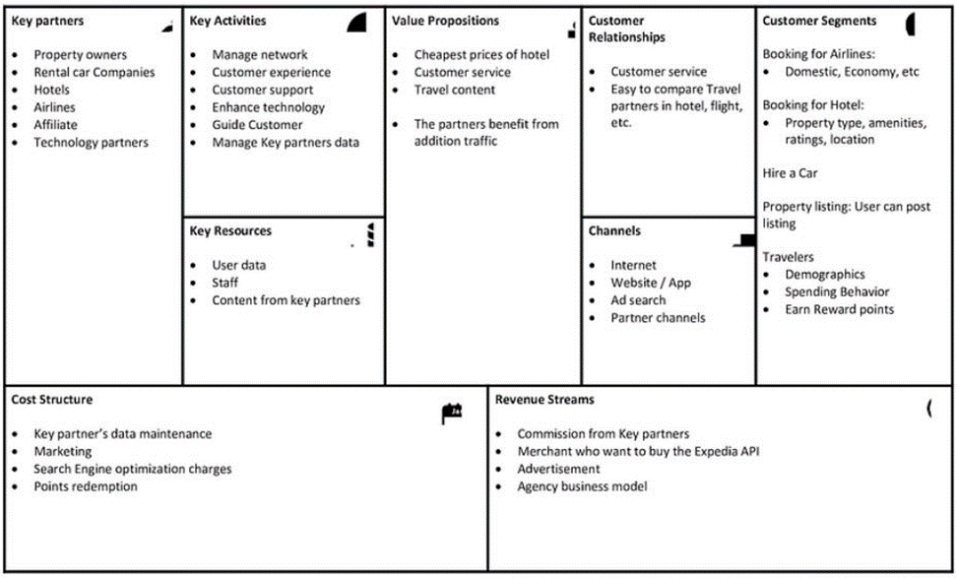


Figure 6. Expedia Business Model (SteelKiwi Inc. January 6, 2022)

Service providers that list their services on Expedia sometimes charge extra fees. Both the fees and the customers' direct view are disclosed. Fees for cancellations made more than 24 hours after making a reservation, Wi-Fi charges, costs for overweight baggage, meal costs, travel expenses incurred outside of the resort, additional fees for spas and pools, and parking fees are usually listed in the application. These are some additional payments than the basic hotel and airline charges (SteelKiwi Inc. January 6, 2022).

In advance of the introduction of aggregators such as Expedia and Booking.com, tourists had to make multiple website visits to plan their trips, sometimes as many as seven to ten. The tourism and travel sector has been modified by aggregators. Since customers can use a single platform to meet all

their travel needs, the booking and reservation experiences for users will be simpler. Large online travel agencies are highly open to data exchange. APIs have evolved into control panels used by developers to join software components without interfering with the source code, connecting different data streams between separate applications. It is a must to integrate multiple APIs while creating an online travel agency website so consumers can make hotel reservations, purchase airline tickets, and arrange vehicle rentals directly from the app.

The five primary reservation types that websites like Expedia need APIs for are flights, hotels, and other forms of accommodations; cruises and ferries; car rentals; and railroads. Global distribution systems, or GDSs, are the most current way for online travel agencies to gather travel information from various business owners in the sector. Online travel businesses can avoid having direct relationships with hotels, airlines, train stations, and tour operators to collect data using Geographic Data Systems. GDSs offer agencies APIs so that customers can make online reservations through a single aggregator rather than numerous apps (SteelKiwi Inc. January 6, 2022).

CHAPTER FOUR

RIDE EFFICIENCY APPLICATION DESIGN AND ANALYSIS

Mobile Application Initial Setup

For building a mobile application, the first step is to decide about the design kit and preferred programming language. In this research, the Android Studio is used to develop the application. To start a new project in Android Studio, one can go to "File” >” New” > “New project”. Then, one can configure their project settings by following a series of steps provided by the Android Studio. It is required to give the app a name example name and the domain name for its package, such as com., and then save the project location. The next important step is selecting a programming language to develop the app. Java programming language has been used in this research to develop the application. Figure 7 shows a screenshot of the application setup of this project.

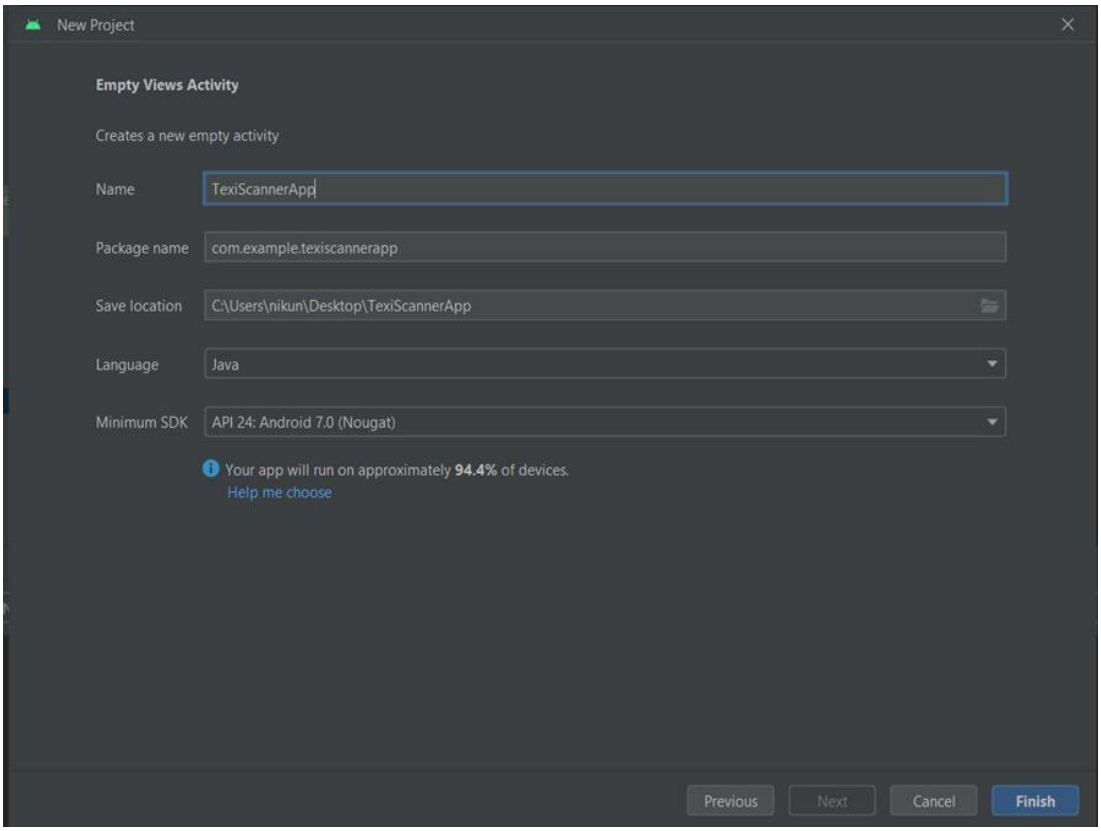


Figure 7. Developing application step 1

After finishing the setup, it is possible to see the project directory where one can create the code files. In the first step of designing the application, one can select the “main activity” and click on the designing button where drag and drop tools and mobile screen are available. After that, it is possible to drag the elements and create the line edits, both buttons (pick up and destination) and view area. Figure 8 shows these steps.

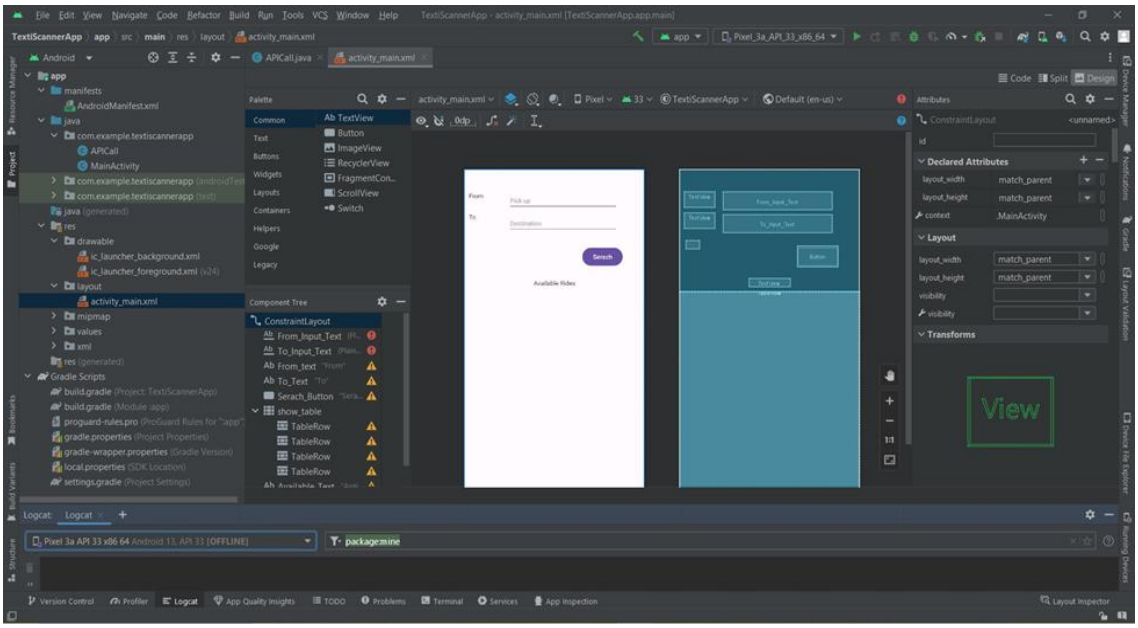


Figure 8. Developing application step 2

Once the "Pick up" and "Destination" buttons have been created, it is critical to design an error-handling system that encourages users to complete the necessary fields if they forget to enter either the pick-up location or the destination. This error message will clearly instruct users to enter their pick-up location or destination accurately. Following thorough testing of these functionalities, the next crucial step is to obtain the necessary APIs from all relevant ride-sharing companies. These APIs will enable seamless integration of the ride-sharing services within the application, facilitating smooth booking and ride management processes. Figure 9 shows the error message if one enters the information incorrectly.

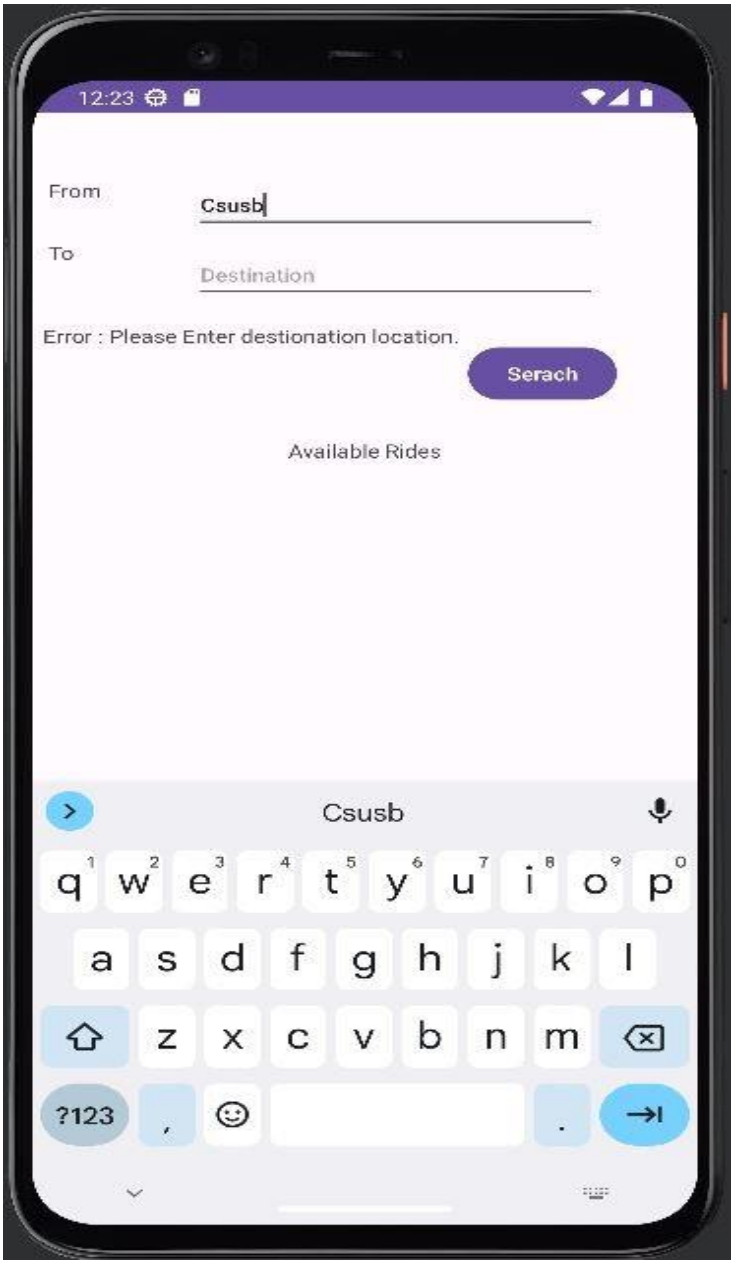


Figure 9. The application showing error message

API (Application Programming Interface)

A set of established guidelines known as an API, or application programming interface, allows various apps to communicate with one another. Companies are able to open their application data and functionality to external third-party developers, business partners, and internal departments within their company owing to this intermediary layer, which handles data transfers across systems.

An API's definitions and standards allow businesses to connect to the many different apps they use on a daily basis, saving staff time and reducing limitations that affect innovation and cooperation. The interface for communication between apps is provided through API documentation for developers, which makes the integration of applications simpler.

The next step would be to create a developer account on the developer portals of the relevant ride-sharing companies to start the process of obtaining the required APIs. The application developer should submit their business name as part of this procedure, and the ride-sharing company will look into the request to see whether the developer is eligible. Once approved, they will provide the developer with an API access token, which will then be integrated into the application. With the use of this access token, the developed application will be able to safely access and use the necessary ride-sharing services, resulting in improved usability.

Ride-sharing companies only provide the API to businesses. Unfortunately, it was not possible to get API access to this project, therefore, a dummy dataset has been created and used for this project. A predefined dummy dataset that was saved in JSON format was fetched as part of the application's main functionality. When the process of data collection was finished, the program provided the user access to the data in a tabular format. This tabular representation enhanced the readability and accessibility of the data, allowing users to easily compare the fares, waiting times, and available car types offered by any ride-sharing services for their selected routes. In this project, Uber and Lyft are used as the baseline for developing the integrated platform. Overall, the developed application in this research provides users with a simple and effective way to compare taxi fares between Uber and Lyft, enabling them to make informed decisions based on factors including price, waiting time, and car type. These features have been utilized as an example. It is possible to add any other feature that ride-sharing applications offer to their users. This was implemented by using Java programming's capabilities and integrating the dummy dataset.

Figure 10 shows an example of selected origin, destination, and different options offered by the developed application, which integrates Uber and Lyft data and shows it to the user to select the best option.

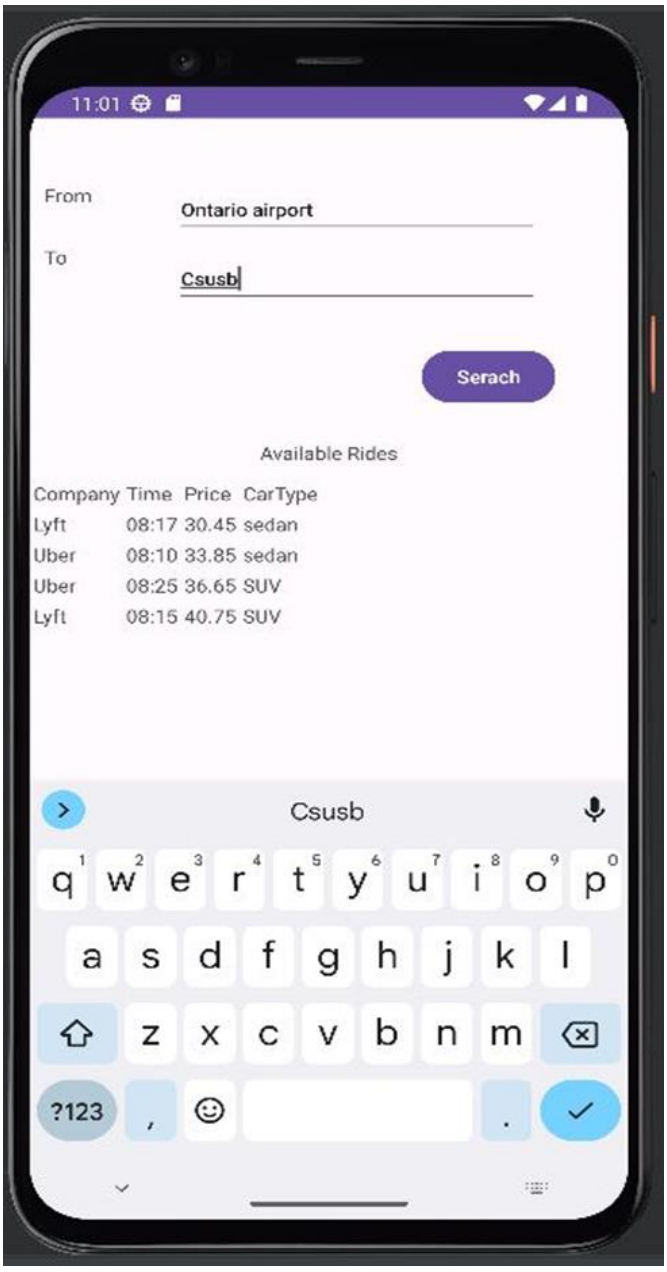


Figure 10. The application output showing different options for an example from Ontario airport to CSUSB

In this example, both Uber and Lyft offer multiple options to travel from Ontario Airport to CSUSB (California State University, San Bernardino). The app offers a variety of ride possibilities. There are two Lyft alternatives available: one at 08:17 for $30.45 with a sedan car (5 seaters) type, and one at 08:15 for $40.75 with an SUV (8 Seaters) car type. Uber has two options as well, one at 08:10 for $33.85 with a sedan car type, and one at 08:25 for $36.65 with an SUV car type. In accordance with their needs, users can select from the options that are presented. There are 7 minutes of a difference between the times when Lyft and Uber trips are available, with Lyft starting at 8:17 and Uber starting at 8:10. In this example, also, there is a significant price difference between Lyft and Uber, which is $30.45 vs. $33.85, respectively. If the rider is in a hurry, they may be more likely to select Uber in this situation because of the reduced time difference and less difference in price. If the rider has price sensitivity, they can select Lyft.

In another example, a rider requests a ride from the UPS store to a nearby Walmart. There are both Lyft and Uber options available. However, not all car types are available for the rider. Lyft provides two options in this example: an SUV at 11:45 costs $16.85, and a sedan at 11:49 costs $10.15. Uber, on the other hand, offers just one choice at 11:40 for $11.45 with a sedan car type. Users can evaluate the options offered by Lyft and Uber and make their choice accordingly. In a comparison of the prices for Lyft and Uber rides, Lyft offers a sedan option at 11:49 for $10.15, while Uber offers a sedan option at 11:40 for

$11.45. Although there is a little time difference in this instance as well, Lyft offers a substantially lower cost. As a result, users may choose Lyft in this situation. Figure 11 shows this example application output.

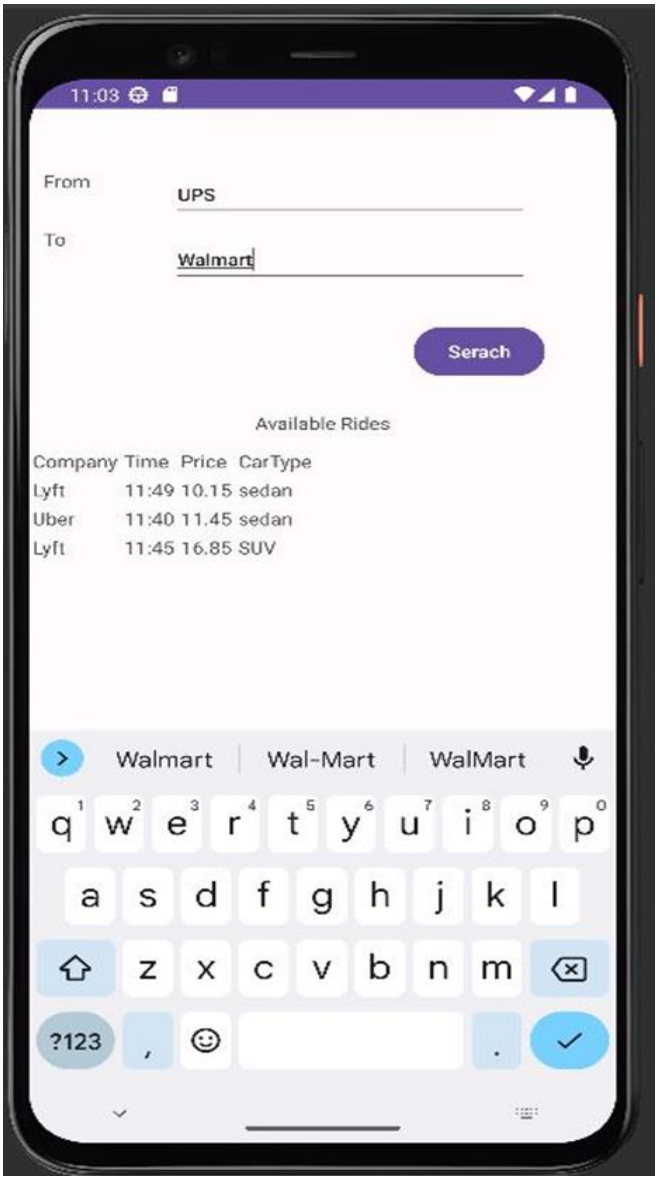


Figure 11. The application output showing different options for an example from UPS to Walmart store

In another example, where the origin is CSUSB and the destination is the UPS store, only Uber is available with both SUV and sedan car types. Two alternatives are shown by the application: one at 12:45, which costs $12.00 and is for a sedan car type; the other at 12:48, which is for an SUV car type; it costs $17.65. Depending on their interests and needs, riders can select one of these two Uber choices. Users must consider the time and cost differences between the sedan and SUV alternatives since only Uber rides are available in this situation. With the sedan becoming available at 12:45 and the SUV at 12:48, the difference in time is minuscule. The SUV costs $17.65 whereas the sedan costs $12.00, which is a significant price difference. Users may choose the sedan choice in this scenario due to the lower cost and the availability of both car types. Figure 12 shows this example.

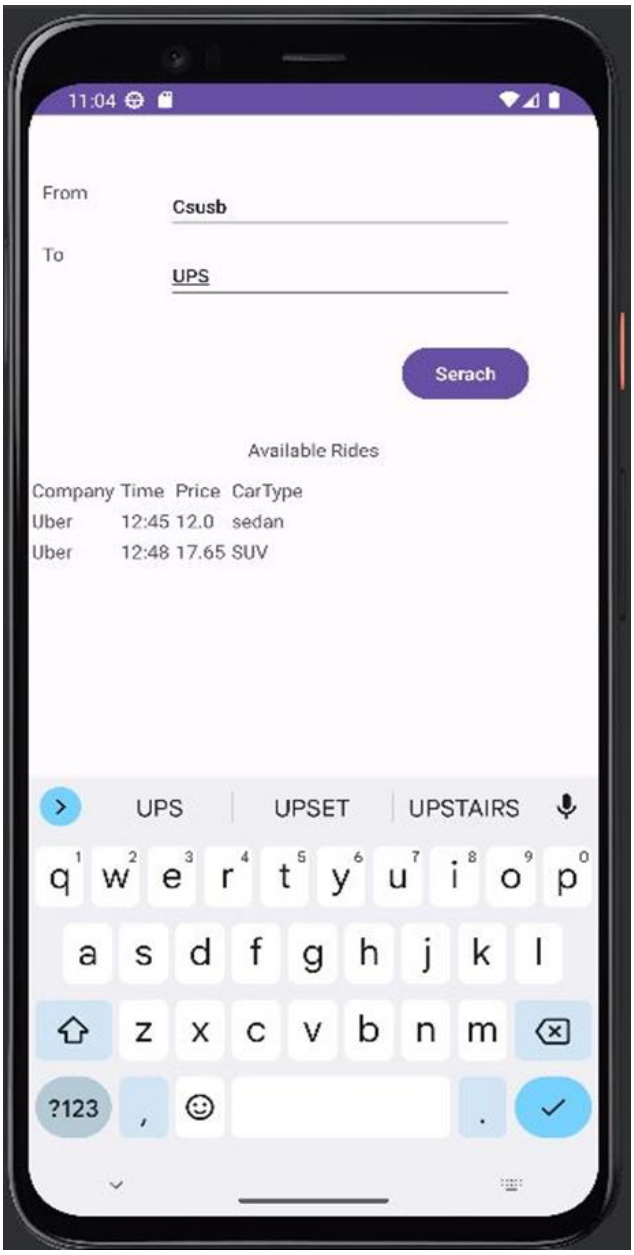


Figure 12. The application output showing different options for an example from CSUSB to the UPS store

Table 1 Shows the key component of Ride Efficiency application. Users' ride selection process is made easier with the help of the Ride Efficiency application,

which is created in Android Studio and developed using Java. Important features of the app include buttons for the pick-up and destination, an effective error-handling system, and a ride comparison tool. Using dummy datasets as its data source, it allows users to carry out necessary functions such as registering, logging in, searching for rides, comparing costs and arrival times, and accessing full ride details. To improve users' entire ride experience, the application's main objective is to give users a quick and easy way to assess and choose the best ride option depending on their preferences.

Table 1. The Key Components of Ride Efficiency Application

Components	**Description**
Development Language	Java
IDE (Integrated Development Environment)	Android Studio
Functionalities	Pick-up and destination buttons, Error handling systems, Ride comparison
Data source	Dummy Datasets
Key Actions	Sign up, log in, ride search, price, and arrival time comparison, view ride details
Purpose	To provide users with a quick way to assess and choose the best ride option based on preferences

To show the system operations and steps, the use case diagram has been presented in figure 13. In this diagram, one user and one admin (system) are presented. A user is who searches for and compares cab services using the cab comparison app. The admin is a system administrator who controls the ride-sharing comparison in the application. It also manages system settings and keeps up-dated user information.

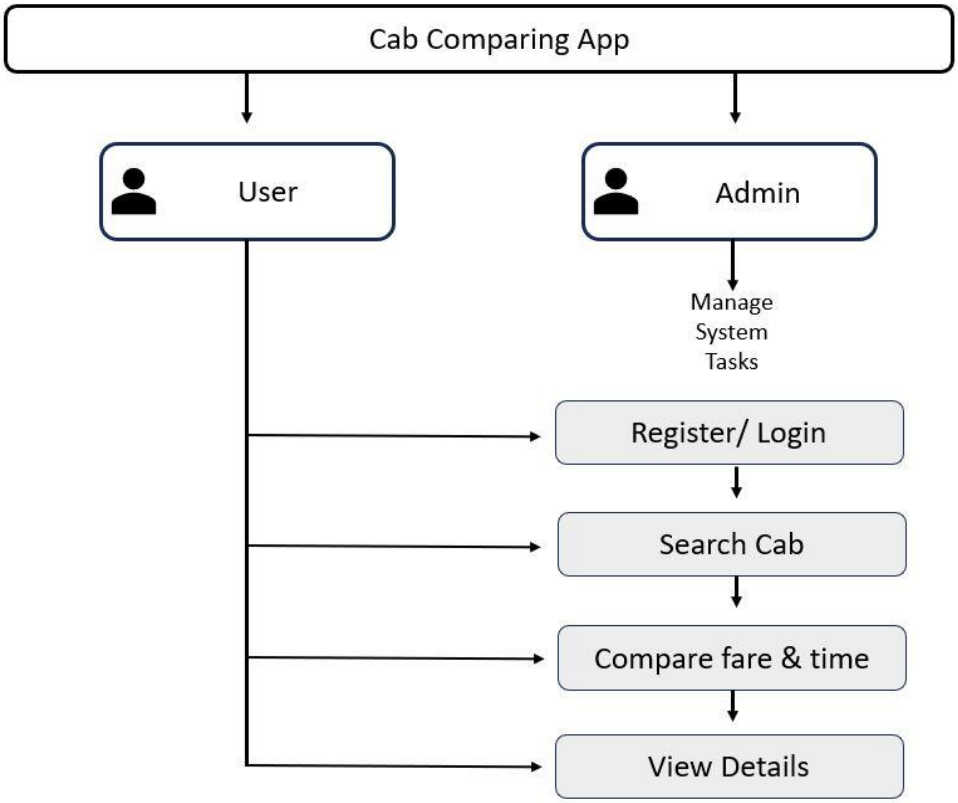


Figure 13. Use case diagram of analysis

The system's administration is represented by the tasks carried out in this use case. It includes activities such as setting up system preferences, controlling user accounts, and carrying out other administrative duties. User has access to four features including register/login, searching, comparing fares, times, and car type, and viewing the output and details of the available options.

1. Register/ login: Users can register for an account or log in to the system using this use case. Users can access more features and specific features by signing up or logging in.
2. Search for rides: With the help of this application, users can search for available taxi services depending on parameters like location, time, and fares. Users can search for different ride choices by entering their preferences.
3. Compare fares and time: Users can compare different ride options based on their price, reviews, availability, and other characteristics such as waiting period. Such an application enables consumers to compare various ride options side by side and make efficient decisions.
4. View details: Users have access to all the details about a particular ride service. This contains any additional valuable information offered by the ride-sharing platform, such as details about the car, driver ratings, and user reviews.

To summarize, the steps of developing an integrated ride-sharing application have been provided in this chapter to help the users access multiple ride options at the same time and select the best one based on their price, wait time, and car type preferences. Figure 14 shows the Class diagram of analysis.

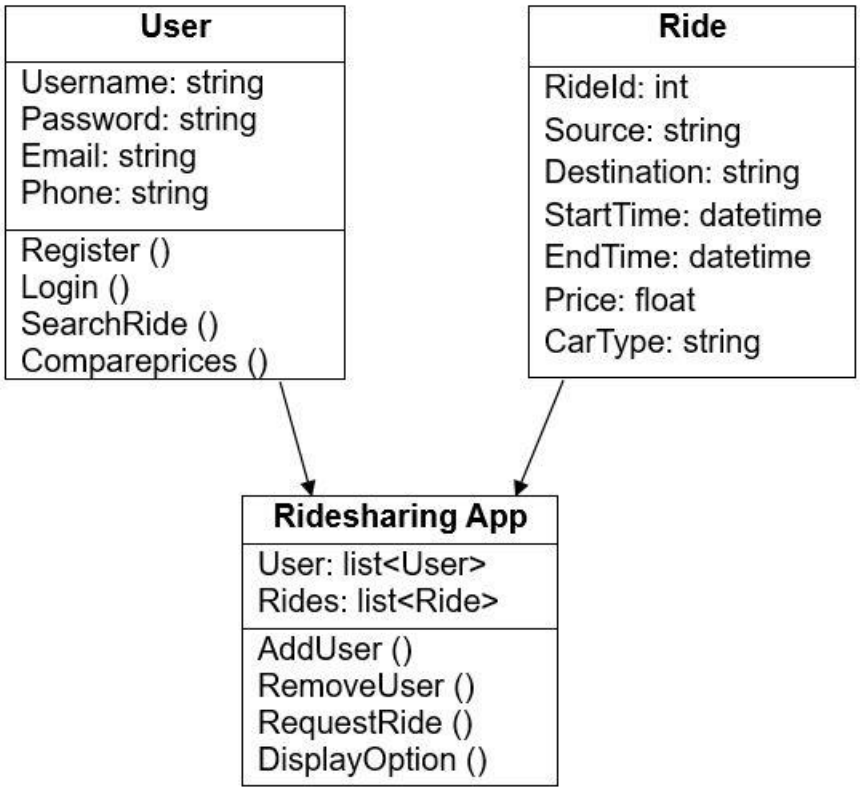


Figure 14. Class diagram of analysis

The class diagram represents the basic structure of a ride-sharing application. Important user information like username, password, email address,

and phone number are all included in the "User" class, along with related features like ride searches, price comparisons, registration, and log in. The "Ride" class records information related to a particular ride, such as the car type, price, start and end hours, source, destination, and unique ride identifier. The "Ridesharing App" class has methods to add and remove users, request rides, and present available options. It also manages the user and ride data. The connections between users, rides, and the application itself are shown by these classes collectively, which also highlight the key components and functions of the ride-sharing program.

Table 2 Shows the Ride Efficiency application development process is outlined with their priority, that highlights the following processes involved. It highlights the order of importance of the tasks, the use of Android Studio for project development, and the Selection of Java as the main programming language. Setting up the project and putting in place a user authentication system are key defines that improve security. The design phase places a particular focus on developing an efficient error-handling system and designing the primary activity using user interface (UI) components. It also recommends integrating a dummy dataset for testing. Real-time applications require Public API from ride-sharing industries. To ensure efficient application performance, the development process also includes data validation, error checking, and the implementation of a ride comparison system for effective decision-making. To

further improve the application's overall efficacy and user experience, it also proposes real-time data updates for ride availability and pricing.

Table 2. System Requirements Table

Steps	Description	Priority
Design Kit and Programming Language	Android Studio used for development	Must Have
Project Configuration in Android Studio	Configuring Project settings	Must Have
Selection of Java Programming Language	Java was chosen as the primary programming language	Must Have
Designing main activity with UI Elements	Creating main activity with drag and drop tools	Should Have
Implementing Error-Handling System	Establishing an error-handling system	Could Have
Obtaining APIs from Ride-Sharing Companies	Acquiring necessary APIs for integration	Must have
Setting Up Developer Account on Ride-Sharing Portals	Creating a developer account for API access	Could Have
Integration of Dummy Dataset	Incorporating a dummy dataset for testing	Could Have
Testing User Interface	Conduction tests for the application’s user interface	Must Have
Implementing User Authentication	Adding a user authentication system for security	Should Have
Data Validation and Error Checking	Implementing strong error-checking techniques and verifying user input	Must Have
Implementing Ride Comparison Algorithm	Developing an algorithm for efficient ride comparison	Should Have
Implementing Real-time Data Updates	Ensuring real-time updates for ride availability and pricing	Could Have

This chapter provides a detailed explanation of how to build up a mobile application for a ride efficiency solution. It begins by describing how Android Studio is used for development and why Java is the main programming language. To ensure seamless user communication, the chapter guides through the process of configuring the project, designing the primary activity with UI elements, and putting in place an efficient error-handling system. Furthermore, the application of user authentication systems for increased security and the setting up of a dummy dataset for testing are highlighted. The chapter continues to show how crucial it is to validate data, how to apply a ride comparison technique, and how real-time data updates can enhance user experience. The class diagram and use case diagram offer a thorough overview of the structure and functionalities of the system, providing a whole view of the development process.

CHAPTER FIVE

CONCLUSION AND AREAS FOR FUTURE STUDY

This project focuses on the development of an efficient ride-sharing application in the ride-hailing industry, aiming to provide users with the ability to book rides at reasonable prices and suitable times. The research compares available ride options to inform users about ride costs and provide estimates of waiting times. The study demonstrates the value of this prototype in guiding the development of real-time applications for the future, contributing to the advancement of the ride-hailing sector. This project answered three questions. 1. What are the technology and infrastructure requirements for developing a consolidated online application for centralized ride sharing? 2. What are other examples of application aggregators in other industries than transportation and how do they work? 3. What are the steps for developing an online application that integrates the current ride-sharing applications?

MaaS (mobility as a service) combines on-demand access and common payment across all types of transportation on a single platform. MaaS offers various levels of integration, from basic separation to all-inclusive solutions. Bundled services and data exchange are advantages, but implementation costs and the effect on public transportation are drawbacks of MaaS. Ride-hailing is part of the MaaS and this form of data and information integration shows the importance of developing new applications in the ride-hailing industry. Because

of smartphone use, discounts, and convenience, services of the ride-hailing companies like Uber and Lyft have expanded in recent years. They provide both affordability and flexibility.

In this research, various studies of several aspects of MaaS and ride-hailing industry have been investigated. These studies explored user characteristics and socioeconomic issues as factors influencing the adoption of ride-sharing services. Studies have also looked at the effects of the ride-hailing industry on more conventional modes of transportation including taxis and public transportation. The ride-hailing advantages including user satisfaction, loyalty, and future usage plans have been presented as well. The literature review of academic studies helps to better comprehend the complexities, difficulties, and opportunities surrounding ride-hailing and MaaS, showing the importance of this research in developing an integrated ride-sharing application. In this research, the technology and requirements of developing a mobile application are investigated. Also, some examples from other industries besides ride-hailing such as Airbnb and Expedia are presented.

In the process of developing mobile apps, software programs are made specifically for platforms like Android and iOS. Conducting market research, considering unique features, and developing different apps for drivers and riders are requirements for establishing ride-sharing apps. Ride-sharing apps must have geolocation and routing servers to function properly. Java is a popular programming language for creating Android applications. In this research, a new

application has been developed to integrate the information from available ride-sharing applications into one place and help the riders to find the best option in terms of price, wait time and car type. The steps of developing a mobile application have been provided in this study.

The process for developing a ride efficiency application involves choosing Java as the development language and designing the mobile application using Android Studio. The pick-up and destination buttons on the application are designed, along with an error-handling system. A dummy dataset is used to show the display result on a mobile screen. Users can compare ride prices, wait times, and car types between services like Uber and Lyft using the app. A use case diagram is presented to display user actions such as sign-up and login, ride search, comparing prices and arrival times, and detail viewing. The purpose of such an app is to give people a quick way to assess and choose the best ride option that meets with their preferences.

Recommendations and Future Study

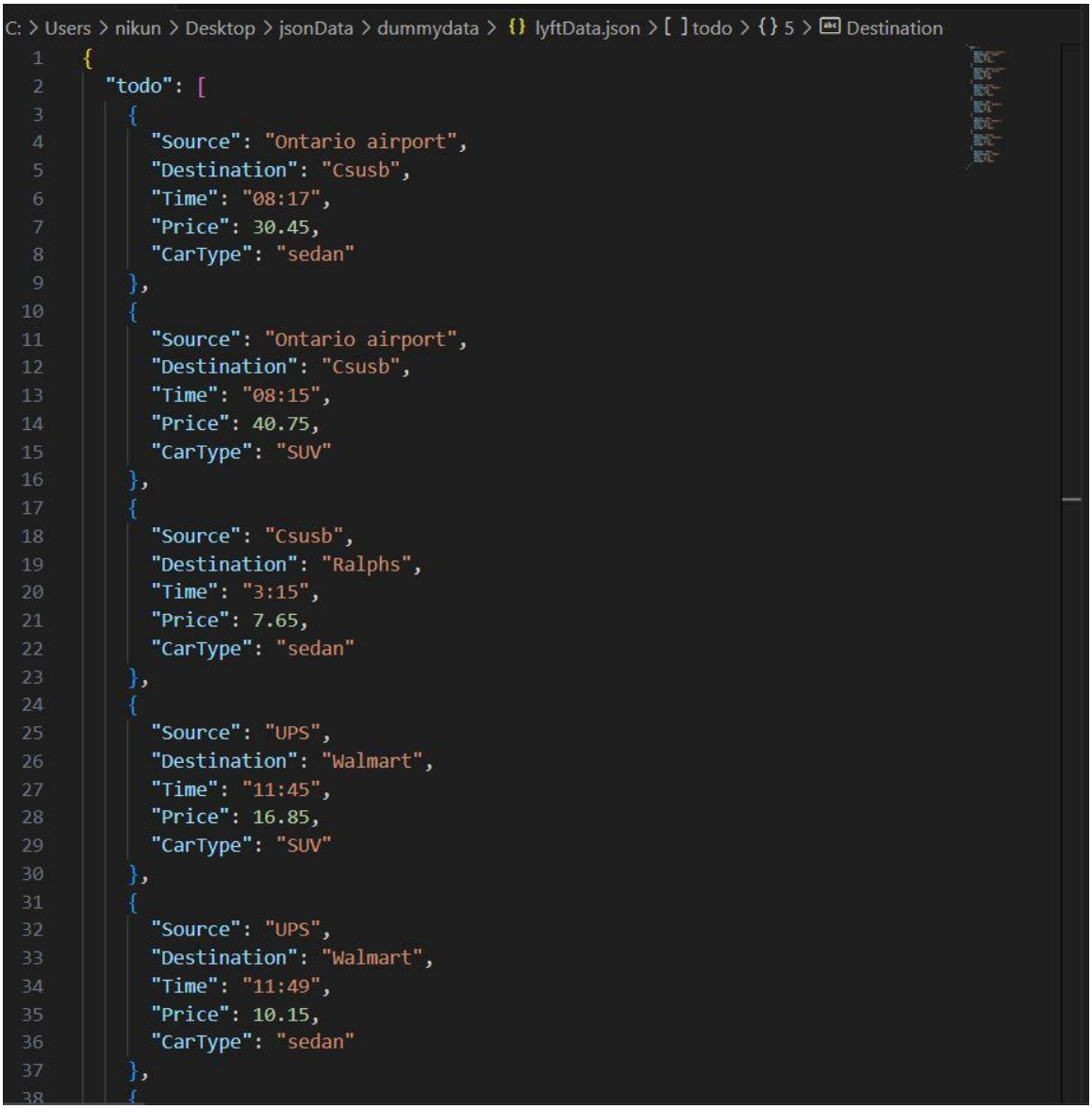
In this research, a dummy dataset is used to show how to employ the developed integrated application. Companies such as Lyft and Uber share their APIs only with business. Therefore, using a dummy dataset is the limitation of this study. In future, it will be possible to use the real time public API from ride-hailing industry to build a real time application.

A ride efficiency app's potential future developments include integrating with more ride-sharing services, implementing real-time data updates, implementing advanced filtering, and sorting options, supporting multiple languages, integrating in-app payments, combining user reviews and ratings, integrating with navigation services, personalizing recommendations, implementing reward systems and benefits, and expanding to other modes of transportation. With these changes, the user experience will be improved, more options will be available, convenience will be increased, and the application will be more useful and effective in the growing ride-sharing market.

APPENDIX A

DATASETS

C: > Users > nikun > Desktop > jsonData > dummydata > {} lyftData.json > [ ] todo > {} 5 > Destination



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{
  "todo": [
    {
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      "Destination": "Csusb",
      "Time": "08:17",
      "Price": 30.45,
      "CarType": "sedan"
    },
    {
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      "Destination": "Csusb",
      "Time": "08:15",
      "Price": 40.75,
      "CarType": "SUV"
    },
    {
      "Source": "Csusb",
      "Destination": "Ralphs",
      "Time": "3:15",
      "Price": 7.65,
      "CarType": "sedan"
    },
    {
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      "Destination": "Walmart",
      "Time": "11:45",
      "Price": 16.85,
      "CarType": "SUV"
    },
    {
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      "Time": "11:49",
      "Price": 10.15,
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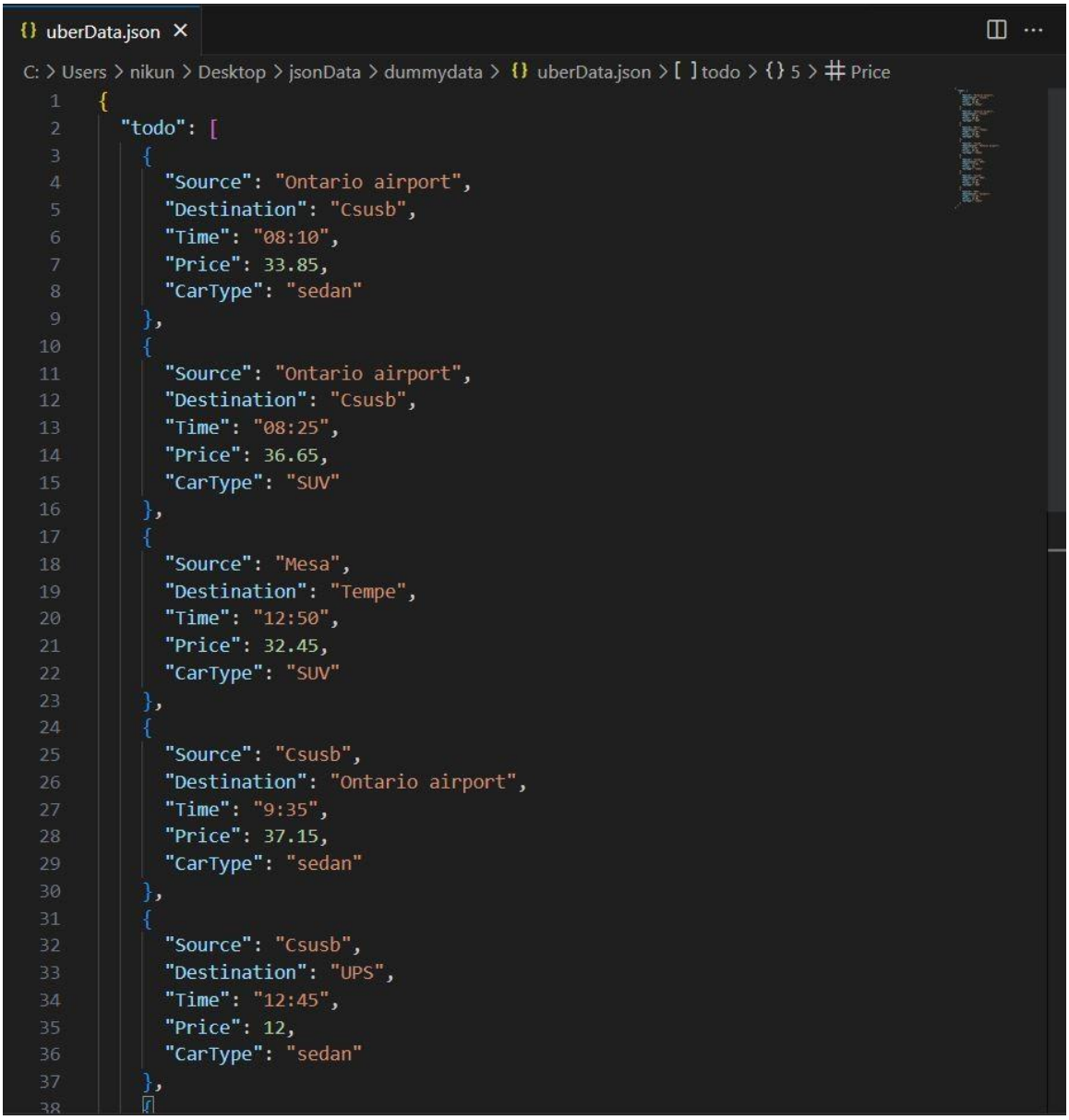
    },
    {
```


uberData.json
C: > Users > nikun > Desktop > jsonData > dummydata > uberData.json > [ ] todo > {} 5 > # Price
{
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"Price": 33.85,
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},
{
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},
{
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"Time": "12:50",
"Price": 32.45,
"CarType": "SUV"
},
{
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"Time": "9:35",
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},
{
"Source": "Csusb",
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"Time": "12:45",
"Price": 12,
"CarType": "sedan"
},

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