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TOPIC: ZedTurbo: A Bus Ticket Reservation Application and its benefits on the Zambian society

By

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Declaration

I, Mulima Nchimunya Mainza do hereby declare that the contents of this paper, project and system results are entirely based on my work and I have not in any respect used another person's work without acknowledgment. During the course of this study, I was under the supervision of Mr. Alex Ng`uni. This work has not been submitted to any other academic institution for any other degree.

Abstract

The traditional method of purchasing bus tickets in Zambia is usually characterized by manual processes and physical ticket purchasing, which can be inconvenient for passengers and bus operators. It involves in-person visits to bus ticket offices like Intercity in Lusaka, which can result in challenges including long queues, dishonest pricing, and additional costs. The absence of a centralized digital platform hinders comparison, booking, and refund processes, leading to dissatisfaction and inconvenience. By leveraging digital technology, ZedTurbo aims to address these issues and provide an efficient and transparent bus ticketing experience for new or frequent travellers, tourists, students, and the elderly. This mobile application will have features that will aid this process such as filtering and recommendations. The main goal of this document is to create a mobile app called ZedTurbo that will help the Zambian society book bus tickets using online means. By doing so, we hope to make things more convenient for passengers and improve how buses operate in Zambia. Using the Scrum methodology ZedTurbo system will help bus companies improve customer satisfaction and experience, reduce operational costs, increase revenue, and increase efficiency through automation. Using questionnaires data was collected from users and later analyzed with the conclusion that such an app would be very helpful for society. Despite, Zambia having a few already existing bus ticket applications ZedTurbo aims to be a helpful tool for users regardless. In conclusion, this document consists of chapters describing the introduction, problem statement, literature review, methodology, research methods, data analysis, and system design.

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Chapter 1: Introduction

1.1: Introduction

Digital transportation refers to the use of advanced technologies and applications to enhance the efficiency, sustainability, and convenience of transportation systems. (Team, 2024). It incorporates digital payments, real-time updates, online bookings, and record storage. As a vital component, digital transportation has revolutionized the travel process, enabling logistics organizations all around the world to modernize outdated systems and improve operational processes and customer experience. (Whatfix, 2024).

With the expansion of internet connectivity and mobile technology, advanced digital solutions are being adopted across many sectors, including transportation. In recent years, digital transportation has gained prominence due to advancements in technology and the increasing demand for efficient and sustainable transportation solutions. This shift has had a significant global impact, as many countries are implementing and adopting these innovations through interactive websites or mobile applications that can streamline operations and increase revenue. Applications such as Uber and Yango; showcase the evolution and globalization of digital transportation, enabling passengers to connect with drivers via smartphones effectively eliminating traditional taxi services.

This widespread adoption of digital transportation solutions has resulted in substantial improvements in organizational efficiency and effectiveness. (Amit, 2024). Key processes, such as data entry, transactions, online reservations/bookings, data modifications, GPS tracking, and improved digital mobility services have seen significant improvements. (Schreieck, 2018). Digital transportation systems, in particular, have provided users with benefits such as reduced waiting time, enhanced user experience, automated ticketing, real-time tracking, and secure payment systems. Collectively, these benefits significantly enhance the overall travel experience for both the organization and the users.

At the core of any successful digital transportation system are several key components that ensure effective functionality. These include Global Positioning System tracking (GPS), mobile applications for users/passengers, data about the trips stored in a database, secure online transactions, secure user authentication, and visually appealing User interface (UI). Each

component is essential for the system's success, as they independently support each other to provide fully functional and reliable services to the users.

As digital transportation solutions continue to evolve, we see a variety of established applications and systems worldwide. In Zambia, local applications include the United Bus Company of Zambia (UBZ) mobile application, developed by the well-known Zambian bus company UBZ, which reached its peak of operation in the year 2020 under new management. (Safaribay, 2020). This mobile application, launched on the 8th of December, 2023, serves UBZ buses exclusively. The UBZ mobile application is not the only Zambian application that has embraced digital transportation; others include myRide, Bolt, and Unka GO. InDrive, originally from the US but operating in 46 countries (InDrive, 2024); Yango, a Russian application operating in approximately 17 countries (Yango, 2024); and redBus, an Indian web and mobile application (Sujo Thomas, 2014). These diverse digital platforms have revolutionized transportation systems, providing users with greater convenience while improving operational efficiency for service providers.

1.1.2: Project Title

The title of this project is “**ZedTurbo: A Bus Ticket Reservation Application and its Benefits on the Zambian Society**”. It will be a mobile application that will consist of features such as online booking, user interface with displayed bus companies, user profiling, and secure payment methods. This application will improve the way users purchase their bus tickets using their smart mobile devices.

1.3.1: Target Reader

- This document is directed to my supervisor and advisors. These individuals will guide me through each stage of this document. They will evaluate the quality of the end product of this document.
- Students interested in such systems or students who wish to improve their knowledge of digital transportation systems can use this document as a reference or a learning tool.
- This document has been drafted to aid citizens in Zambia to have an effective mobile application that will help them find a bus company that will have favourable prices and they will be able to purchase a ticket just by logging in and picking a bus of their choice.
- This document is also for individuals who may want to create an application that is similar to or better than ZedTurbo.

1.2: Project Objective

To build a bus ticket reservation mobile application that will be used as a bus ticket reservation platform for various travellers within Zambia. This will be achieved by ensuring that users can purchase a bus ticket for their desired bus company based on their preference through their smartphones.

1.2.1: Core Functions

This application will have the following functionalities:

- **User registration and Login:** The app will have a user interface that will aid users in signing up and creating an account with basic personal information. Using email authentication, users will have a secure login system to protect user data.
- **Online Booking:** Passengers/Users will be able to easily reserve a bus ticket/s from the comfort of their office, home, or any place. Thus, eliminating the need for a physical visit to bus terminals.
- **Search and Filtering:** Users will be able to search for a certain bus company or type of bus size of their choice using the user interface. The system will filter and display to the user the relevant similar options.
- **Help:** If they are struggling with navigating the application or any query, there will be a help page and help email address they can send their queries (Papoulakis, 2016).

1.2.2: Enhanced Functions

- **User Profiling:** Users will be able to create their profiles and sign in later when they need the services of this application. This profile will have the user's name, phone number, and other necessary details.
- **Multiple bus companies:** ZedTurbo will offer a wide range of bus companies from which the user can choose. Defining explicitly for users to choose based on their desired preferences and budgets.

1.2.3: Special Features

- **Help page with bus company contacts:** Users can access a list of contacts they can reach out to if they are lost or are having trouble booking.
- **Confirmation message:** A message will be sent to the user confirming their trip.

1.2.4: Areas Not Covered by the Project

While ZedTurbo aims to be a comprehensive bus ticket reservation application, certain areas will not be covered:

- **Offline functionality:** This app will not be able to function effectively whilst offline, there will be a need for internet access.
- **International bus bookings:** While ZedTurbo could potentially expand to include international bus bookings, this may require additional partnerships and integrations with foreign bus companies from different companies.
- **Real-time traffic updates:** Providing real-time traffic updates and alternative route suggestions might be a future enhancement but may require additional data sources and algorithms.

1.4: Tangible and intangible benefits

Tangible benefits

- **Time-saving:** The application will streamline the booking process, reducing the time spent on ticket purchases.
- **Cost-effective:** Users can compare prices from different bus companies and potentially find cheaper options. Also, operational costs will be cut down for the organizations involved.
- **Reduced paper usage:** Digital tickets eliminate the need for paper tickets, contributing to environmental sustainability.
- **Access to a wider range of options:** ZedTurbo will provide access to multiple bus companies, offering users more choices and flexibility.
- **Reduced waiting times:** By booking tickets in advance, users can avoid long queues at bus terminals.

Intangible benefits

- **Enhanced user experience:** ZedTurbo will offer a user-friendly interface and personalized recommendations, improving the overall travel experience.
- **Increased convenience:** Users can book bus tickets from the comfort of their homes or offices, eliminating the need for physical visits to bus terminals.

- **Improved trust, and reliability:** With this application offering secure digital transactions customers will gain more confidence and will want to use a safe system more. Therefore, there will be customer retention.

Chapter Summary

This chapter outlines the concept of digital transportation and its relevance in improving transportation services in Zambia. The proposed mobile application called “ZedTurbo” is introduced in this chapter. Displaying its purpose, target audience, and scope, focusing on how it will enhance bus ticket reservations through digital means. The project’s objectives are outlined, along with the system’s core, enhanced, and special functions. Limitations and areas that may not be covered by this proposed system are listed as well. Finally, the chapter highlights the tangible and intangible benefits that ZedTurbo will offer, such as increased convenience, improved security, improved user experience, reduced wait times, and cost-effectiveness. In conclusion, this introduction lays the foundation and guide for the subsequent chapters where more details will be discussed, including the problem statement, literature review, development methodology, and research methods.

Chapter 2: Problem Statement

Zambia's transportation system involves waterways, railways, airways, and road-based. Due to it being a landlocked country, the most common means of transportation is road-based (Gael Raballand, 2008). Zambia consists of a network of highways and secondary roads connecting provinces, towns, and cities. Therefore, public transportation in Zambia is largely reliant on buses, minibuses, and taxis. Buses and minibuses are often overcrowded and lack formal procedures. The absence of digitalization in bus ticketing is a significant challenge, because with the evolution of digitalization, processes are being optimized and improved, for example, the booking and payment process. Other countries have embraced digital ticketing though Zambia's process of purchasing tickets remains traditional and manual, from conductors or at bus stations. Leading to long queues, dishonest prices, early-morning starts to secure their desired seats and opportunities for fraud.

In Zambia, this is a major challenge for many passengers who venture into this process and receive poor service. This lack of digitalization also hinders the ability to track passenger numbers, optimize routes, and improve overall service quality.

Manual ticketing is time-consuming which results in delays and inefficiency. Some bus companies struggle to process the full revenue because of their conductor's dishonesty. The lack of a convenient and reliable ticketing system diminishes the overall passenger experience. Hence, there is a need for a safer and more convenient way for travellers to purchase their bus tickets (Tembo, 2024). To enhance, optimize and shorten the process of waiting in long queues when passengers want to purchase bus tickets, by opting to choose digital solutions.

2.1: What is the issue at hand?

The Bus ticket purchasing process in Zambia is often a very slow process for many bus companies. It has mostly involved the process of travellers going to bus terminals or offices and purchasing their tickets physically (Gupta, 2021) . This is often very inconveniencing for people who have very bus schedules and responsibilities because it will be cumbersome for them to squeeze one small trip of going to a place in town for example in Lusaka, you must go to Intercity and buy a bus ticket from one of the bus company offices there. Most individuals in this generation do not have that time hence that process is more like a waste of time. Though they still need to travel so they find themselves sending someone or just going very early on the same day they ought to travel just to ensure they have reserved a ticket on a good and well-trusted bus. This can be quite frustrating for individuals with no patience and spare time,

especially in this era where everything is digitalized. Furthermore, the lack of centralized platforms for bus ticket reservations can make it difficult for travellers to compare options and actually select the most recommended and suitable bus company and ensure timely bookings. Also, bus companies mostly struggle with refunds after cancellations and problems related to confusion regarding bus fares (Wan, 2018) . Leading some passengers not being refunded their money.

2.2: The main challenge faced by passengers

Passengers have to go physically to buy bus tickets and often complain about how it is a waste of time. When it comes to bus fares, some individuals in charge of that sector often can be dishonest about the actual price to steal some of the passenger's money. Passengers mostly find themselves unhappy about their bus trip, to the point of others preferring to move by flight or by their own means. That has harmed bus company businesses in Zambia.

2.3: When do they encounter such problems

These problems are encountered on a day-to-day basis when individuals wish to travel, though, there is no fixed period as to when passengers encounter these issues because people travel every day. Passengers often move up and about the nation either for business or just for mere visits, while others travel for school purposes. Hence, these problems could be encountered once schools open (either high school or university), during the festive season, during weekends, and during university graduation periods.

Other students from other provinces do not know where to find the bus terminals, therefore having an application to aid their ticketing process can help them. Frequent and first-time travellers as well can find this application very vital.

2.4: Reasons to believe

According to Oded Cats (2017), they stated that many people rely on public transportation (Oded Cats et al, 2017). Public transportation can involve buses or trains, these are statistics from Tallinn in Finland. Therefore, they have a successful bus ticketing system called “FLiXBUS” which has been a vital component in their transportation sector. This system has helped improve efficiency for both the bus company and the passengers by offering good services to provide safety and an environmentally friendly place for their passengers.

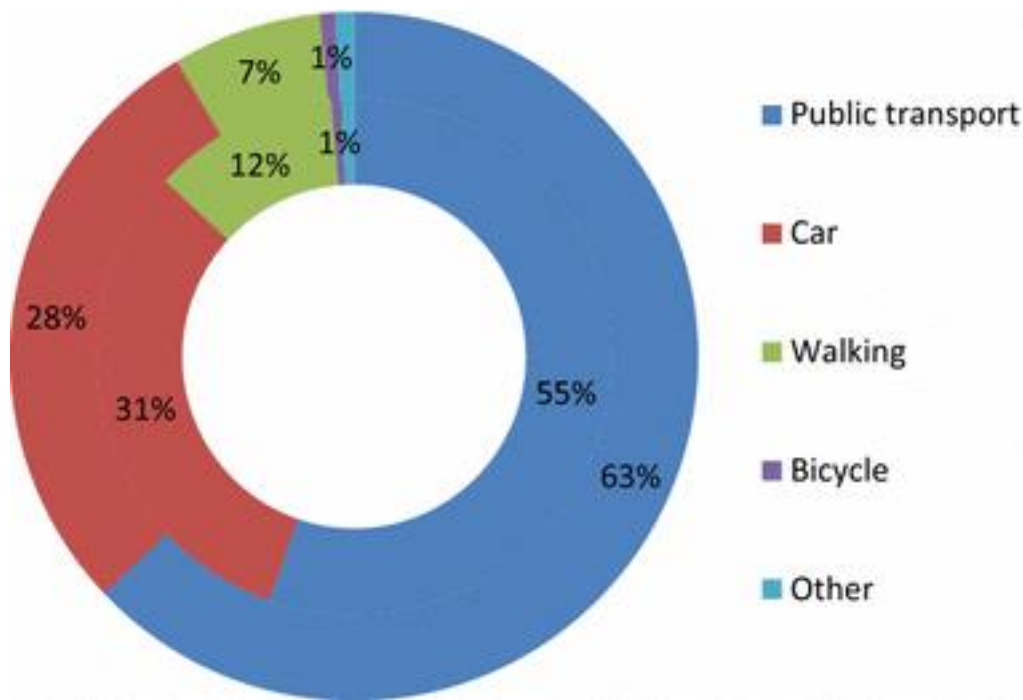


Figure 1: Common modes used

Numerous countries, such as Finland, the UK, India, and China, are currently using bus reservation systems. Simply because they allow users to quickly search for bus routes, schedules, fares, and seat availability. This process can be done anywhere and at any time by the passenger and can help them plan ahead for upcoming trips.

With the aid of digital secure payments, there is a reduced need for physical cash. This optimizes the process of payments; passengers can use mobile money or their bank cards. Other features such as GPS route tracking, real-time seat selection, weather prediction, and trip reminders have helped these systems work effectively. This has enhanced convenience and increased efficiency because:

- Passengers can purchase tickets online or through mobile apps, eliminating the need for physical queues (Transport for London, 2023). An automated fare collection reduces human error and speeds up boarding times
- In London, Oyster card usage has increased public transport ridership by 17% since its introduction.
- Real-time bus tracking and arrival notifications provide passengers with accurate information (Land Transport Authority, Singapore, 2023). The contactless EZ-Link card has reduced boarding times by 30% in Singapore.

- Seamless integration with other payment methods (e.g., mobile money) simplifies transactions (China State Railway Group, 2023).

In Zambia, public transport is used at a great scale either for mere movements or for business purposes. Implementing these technologies in the Zambian transportation sector can help improve a lot of processes such as booking and tracking. Through such a digital solution they will be able to manage their customer base easily; by seeing how many passengers they have on a daily, weekly, monthly, or yearly basis. This digital solution will reduce waiting time at bus terminals and it will allow passengers to use their mobile phones to see and find available buses faster.

2.4: Challenges in building the system

The challenges that may be encountered in the creation of such a system are incorporating a fully functional and accurate GPS tracking system. This is because, in rural areas, GPS signals may be weak or unreliable, affecting the accuracy of tracking. Users expect accurate and reliable tracking information. Inaccurate data can lead to frustration and loss of trust. Additionally, concerning user privacy users may be concerned about their privacy, especially if the app tracks their location. Transparent data privacy policies and secure data handling practices are essential.

Another challenge will be ensuring proper platform compatibility, ensuring the application functions can work on different operating systems (iOS, Android). Also maintaining optimal app performance may be an issue because not everyone is using a reliable and strong smartphone that can support all the features.

Lastly, the developer has two experiences in building mobile applications, not alone but as a group using Flutterflow and Firebase. Therefore, using any other integrated development environment (IDE) will be cumbersome and will need a lot of practice as well as familiarity.

2.5: Solution

With the above problem at hand, the appropriate digital solution is a mobile application that users can download and use to buy a digital bus ticket. Users can be able to do this process anywhere they are, even if they are busy at the office or school, they will be able to reserve a

ticket based on their preference. Acknowledging the gap in the Zambian Bus transportation process there are a few bus ticket applications that are effectively running or fully launched, for example, UBZ. Hence, ZedTurbo will be a convenient option because it will have a generic overview of well-known and trusted bus companies. Bus companies such as Euro and Power Tools, make it easier to find suitable options based on their preferences and schedules.

It will provide key functionalities like secure payments, online ticket purchasing, and seat selection. Those functionalities will provide a user-friendly platform; users will have a better experience navigating through the application using their mobile devices. Enhancing user satisfaction, loyalty, and user retention. While eliminating the problems faced by passengers such as waiting in long queues and theft or dishonesty of bus fares. This application will be very vital for working-class intellectuals and students as well as pupils or foreigners who hope to move around Zambia using a bus as their mode of transportation.

ZedTurbo will have a great impact on the users by eliminating the need for physical visits to bus terminals. It offers a more convenient way to purchase bus tickets, aiding users to save time and effort. ZedTurbo will provide secure transactions that will ensure the safety of any user's financial information while offering convenience and smooth running of operations (Jamesv, 2024). As for the bus companies, this application will reduce operational costs and procedures by ensuring that the majority of the operations that were done physically can now be done digitally, increasing efficiency (Marks, 2024) . Bus companies will be able to reach a wider customer base through the app, by making it easier for users to discover and book their services. ZedTurbo will be vital for both users and the bus.

According to Simon Kemp, Zambia has 78.7 percent, which is 16.40 million of the total population (currently 21,314,956 (Review, 2024), as the UN's estimation), with active cellular mobile connected devices (Kemp, 2024), that could not necessarily be smartphones. There are 31.2 percent, which is 6.51 million internet users. This information states that there are individuals who do not have smart mobile devices or individuals with phones with basic features and lack internet access to have these applications (Kemp, 2021).

Therefore, ZedTurbo will assist a great number of individuals that have smartphones with internet connectivity. They will use them to download ZedTurbo and buy bus tickets, by navigating the systems interface. Zambia is still a developing country; hence, such technologies can help eliminate certain traditional operations.

Chapter Summary

This chapter reviews the problems faced by the Zambian society during the bus ticket purchasing process, the challenges faced, and when they encounter them. It also discusses a proposed mobile application “**ZedTurbo**”, designed to solve the challenges faced such as waiting in long queues. This app also is designed to digitize the ticketing process by offering a centralized platform where passengers can compare and book tickets for various trusted bus companies. This app addresses the need for convenience, transparent pricing, and secure payment while expanding customer reach for bus operators. Although challenges exist, such as inaccurate GPS readings in rural areas and ensuring platform compatibility across devices. ZedTurbo aims to provide a seamless ticketing experience, benefiting both passengers and bus operators in Zambia’s evolving digital landscape. While not all mobile users have smartphones, the demand for digital services is growing, especially among urban populations. In conclusion, ZedTurbo will address the current gap in the Zambian transportation sector by offering a modern, efficient ticketing solution that aligns with the country’s ongoing digitalization efforts, ultimately supporting Zambia’s transition from traditional to digital transport solutions.

Chapter 3: Literature Review

3.1: Introduction

This chapter is a comprehensive analysis and examination of scholarly books, journals, website articles, reports, theories (George, 2022), and many other research sources, that contain any type of information that is related to this bus ticket reservation system's area of focus. In this chapter we will be understanding, analysing and evaluating the existing digital bus ticketing systems in different countries. Considering the benefits and challenges faced with the existing applications, while identifying any possible gaps. Furthermore, we will articulate how ZedTurbo will benefit the passengers in Zambia, by helping them purchase digital bus tickets and eliminating the traditional ways of going physically to the bus terminals. ZedTurbo will help satisfy the Zambian society that uses buses in many ways for example, by helping them not stand in long queues. In conclusion, this chapter will cover subsections namely, existing bus ticket applications, existing tools, domain research, technical research, and development methodology.

3.1.2: Existing Applications for Bus Ticket Reservations in Zambia

1. The United Bus Company of Zambia (UBZ) is a bus company that has connected all Zambians across the country through a modern and efficient bus service (Savenda, 2020). That has been highly recognized over the years. UBZ has ventured into digitalization when comes to the process of purchasing bus tickets hence, they created a mobile application for UBZ buses only. The UBZ application currently exists and is a fully functional mobile application that is being used by many Zambians for their mobility.
2. Afrikonekta (Connecting Africa) a Finnish online intercity bus booking platform created by Tichaona Dande, a co-founder and a Finland-based Zimbabwean, who has currently expanded its operations to Zambia (Afrikonekta, 2024) . He believes that this expansion can help Zambia be linked to many countries like Botswana, South Africa, Malawi, Zimbabwe, DRC, and many more, this will be a vital component for Zambia because it is a landlocked country hence it is easy for there to be simple movements through secure buses. They have partnered with local operators and a couple of bus companies in Zambia (e.g. Likili, Power Tools, etc.) to ensure a smooth delivery of their services (Galawu, 2024).

Global:

3. RedBus, this is an Indian online bus ticket system that has integrated its operations with over 5000 bus companies. Regardless, of it being an Indian product it operates in six countries namely India, Indonesia, Malaysia, Singapore, Colombia, and Peru (RedBus, 2024). RedBus has vital features like searching, filtering, drop-off point pinning, pick-up point pinning, seat selection, secure payments, and GPS route selection (Brodowicz, 2024).
4. Busbud, this is a bus booking mobile application that was created by LP Maurice who is the CEO and Co-Founder. Busbud is not just for buses, trains as well are used too. The passenger can compare prices, times, and amenities until they find a suitable trip and bus to be on. It operates in 63 countries and 10,000 cities, they are trying to expand into Zambia as well. (busbud, 2024).

In conclusion, these existing applications all consist of GPS route tracking, drop-off point pinning, pick-up point pinning, seat selection, and payment functionality. These components are vital for both the bus company and the passenger. For the passenger, it aims to assure them by displaying full details about their trip for them to feel more safe and secure. For the bus companies, it aims to help them keep track of how many passengers chose a specific route or amenities, that type of data can help them with their data analytics on what passengers prefer.

3.2: Existing Tools

1. **Payment Tools:** Will assist with the passenger's financial transactions.
2. **Passenger and Bus Database tool:** This will be used to store user data, bus information, and ticket reservations.
3. **User interface and mobile app development (Frontend) tool:** This tool will assist with the user interface (visual appearance like buttons, texts, menus, and more) and will handle integrations with other tools such as the payment gateway, APIs, and the database. It will also help with Navigation and State management.
4. **Control and Backend Development Framework tool:** For example, Google Cloud (serverless framework) or Firebase real-time database (That aids with authentication and real-time updates). Will consist of Data management, Security, and Business logic. These components will help store, retrieve, and update user data, bus information, and ticket reservations. It will implement the business rules, logic, and main objectives while validating the user input, processing payments, and calculating ticket prices. It

will also implement security measures to protect user data and prevent unauthorized access.

3.2.1: How They Work

1. **Frontend Development (Mobile App):**

- The chosen framework is used to create the user interface for the app, allowing users to search for buses, book tickets, view their booking history, and receive notifications.

2. **Backend Development:**

- The backend handles server-side logic, such as processing ticket bookings, communicating with the database, and integrating with payment gateways and mapping APIs.

3. **Database Storage:**

- User data, bus information, ticket reservations, and other relevant data are stored in the chosen database.

3.2.2: Advantages of Current Tools

- **24/7 Booking Availability:** The user book tickets at any hour of the day.
- **Improved User Experience:** user-friendly interfaces that are easy to navigate eliminating the unnecessary costs of physical visits and long waiting times during queues.
- **Scalability:** with cloud-based platforms and scalable databases they handle increasing user traffic and data storage needs.

3.2.3: Weaknesses of Current Tools

While existing frameworks and tools offer a range of features, they often present challenges in terms of complexity, performance, cost, and security.

- **Complexity:** Some backend or frontend frameworks can be complex to learn and use, especially for developers with limited experience. ZedTurbo, on the other hand, is designed with a user-friendly interface and intuitive workflows, reducing the learning curve for developers.

- **Performance:** Depending on the app's complexity and usage, performance issues might arise, especially when dealing with large amounts of data from the database might delay processing.
- **Cost:** Cloud-based services and premium features can incur costs, which need to be considered within the project's budget. ZedTurbo offers a cost-effective solution with flexible pricing plans and open-source components.
- **Security:** Ensuring robust security measures is crucial, especially when handling user data like payment information. ZedTurbo prioritizes security by implementing robust measures such as secure authentication.

3.3: Whom is this system being addressed to?

The ZedTurbo system is addressed to:

- **Passengers:** Individuals who need to book bus tickets for travel within Zambia.
- **Bus Companies:** Companies that want to offer online ticket booking services to their customers.
- **Administrators:** Individuals responsible for managing the ZedTurbo system, including updates, maintenance, and data analysis.

3.4: Domain Research

This section, presents a review of existing research related to the proposed system, focusing on key functionalities, findings, and challenges of technologies such as online booking, online payments, GPS, and user rating systems. The discussion aims to provide developers with insights into the relevance and implications of these technologies within a transportation context.

First, Online Booking and Payment have been widely studied due to their potential to improve convenience and efficiency in transportation services.

Alejandro Tirachini (2013), demonstrated that introducing bus fare payment technologies, such as contactless card and magnetic strips significantly reduced transaction times and eliminated long queues. However, despite these benefits certain challenges still persisted. For instance, senior citizens showed reluctance to adopt these technologies, as they preferred traditional cash-based transactions, highlighting the importance of accommodating diverse user preferences.

Similarly, Sharmin Akter et al. (2019), developed a cloud-based bus ticket reservation system that integrated mobile banking and global wallets such as Google Wallet. Their findings revealed that this system saved time and costs for passengers while offering real-time seat selection. Nevertheless, the system faced challenges with inaccurate real-time tracking predictions, which could have undermined user trust and satisfaction.

Furthermore, Dr. Chaya Bagrecha and Sadiq Alam (2016), emphasized the environmental and operational benefits of online ticketing, including time savings, ease of use, and reduced operational costs. Yet, challenges such as unreliable internet connectivity during the time of booking, risks involved in monetary transactions, and risks of internet hackers remained significant concerns.

Also, Oloyede (2014), explored the advantages of an online bus ticket reservation system in Nigeria, demonstrating its effectiveness in eliminating fare evasion and fraud associated with cash handling.

Tigist Adam (2019) added that digital ticketing systems enhanced operational efficiency and provided a competitive advantage for bus companies.

In addition to online booking, search and filtering functionalities play a critical role in user-centric systems.

Riya Widayanti et al. (2023), highlighted the importance of integration content-based and collaborative filtering methods to deliver personalized. However, these types of systems faced challenges such as the "cold start" problem, where the algorithm struggles to generate accurate recommendations for new users or items that have limited data. Another issue was "popularity bias," which prioritized well-known options over niche preferences, potentially reducing the personalization of recommendations.

Similarly, Adarsh Kumar et al. (2020) emphasized the need for simulation parameters tailored to real-time transportation systems. Their study proposed integrating IoT and optimization techniques to reduce errors and improve efficiency in smart transportation systems.

Babur De los Santos et al. (2017) further analysed the importance of sorting and filtering algorithms for providing relevant search results. Despite their utility, these algorithms sometimes failed to deliver desired results due to gaps in the system's database.

Similarly, GPS technology has also been extensively explored in transportation research for its ability to enhance navigation and real-time tracking.

Muhammad Umar Farooq et al. (2017), demonstrated how GPS and Global System for Mobile Communications (GSM) technologies could be used for developing a Real-Time Locating System (RTLS) to predict the arrival times accurately and eliminate the long waiting hours for passengers. However, despite these benefits, these still observed errors in the time predictions, due to weather or any other factors that may distort the signals for the GPS, GSM and RTLS. In a similar study by Ajay Shingare et al. (2015), they implemented a GPS technology to track bus movements and current time. Regardless of this being effective, the system was restricted to Android devices limiting accessibility for IOS devices. On the other hand, G Mintsis, and I.N Tziavos (2004) emphasized that GPS systems offered greater accuracy compared to other navigation methods, as they were unaffected by weather conditions and could analyze traffic patterns.

GPS also played a crucial role in ensuring passenger safety by enabling location-based security measures, as noted by (J. Mounika, 2021).

However, challenges such as signal problems, missing data, and technical errors were reported by Li Shen and Peter R. Stopher (2014). These issues were particularly relevant in Zambia, where digital infrastructure is still evolving (Phillip, 2024).

Lastly, user rating and feedback systems have proven to be critical for enhancing passenger satisfaction.

Zhen-Song Chen et al. (2021), investigated the correlation between passenger satisfaction and loyalty, showing that satisfaction influenced passengers' likelihood of reusing a service. This study emphasized the importance of understanding customer needs through rating and feedback mechanisms. However, the focus on majority feedback often left minority concerns unaddressed.

Similarly, Isabel Kaluza et al. (2023), explored customer behaviour in online appointment systems and found that the availability of time slots influenced user decisions. Similar to the work of Zhen-Song Chen et al. (2021), this study also highlighted the limitations of relying primarily on majority feedback.

In conclusion, the proposed ZedTurbo system will integrate some features from the findings above such as the online booking for users to be able to purchase bus tickets easily through their mobile phone. Another feature will be the ratings and help feature, this feature is

vital for the developers and the bus companies to know and understand their customer's needs, likes and dislikes in order to satisfy them. Extra features will be integrated as well to ensure that ZedTurbo is a good and relevant system that is user centric.

3.5: Technical Research

This section will focus on what type of tools and technologies that will be needed and used in building this system. The technologies must be able to coordinate to achieve the main goal of the bus ticket reservation application.

3.5.1: Hardware Requirements

- A processor of 32 or 64-bit
- Storage of at least 5GB free
- A computer equipped with an operating system of Windows 10 and above

3.5.2: Software Tools

1. Integrated Development Environment (IDE) and Frameworks

Examples of IDEs: Android Studio (for Android app development), IntelliJ IDEA, Visual Studio, NetBeans, Eclipse

Purpose: It streamlines the coding process, improves productivity, and enhances the overall developer experience. And provides a good environment for testing, coding, and debugging. Aids with writing and saving programs (Nathan Roth, 2023).

Examples of Frameworks: Flutterflow, Angular, Django, Flutter (for cross-platform app development), and PyTorch.

Purpose: They provide pre-built structures and a set of components for building applications. They promote code reusability and aid developers in creating rich and robust functionalities of software. (Geeksforgeeks, 2024).

2. Database Management systems

Examples: MySQL, Firebase, Oracle, Microsoft SQL Server, MongoDB,

Purpose: Aid with data storage, manipulation, management, creation, retrieval, concurrency control, backup and recovery (Shanika Wickramasinghe, 2021).

3.6: Development Methodology

Software development methodology is an approach or framework in software development for systems that outlines the tools, techniques, and processes to create a high-quality software

product. It is used by a team to plan, structure, and manage the software development process (Nikitin, 2024). It guides the team through the entire process, from inception to deployment. Here are some of the most common ones:

3.6.1: Waterfall Methodology

The waterfall model is the simplest development model that flows like a waterfall. (Team, 2022), all the steps involved are conducted one after another (analysis, design, implementation, testing, deploying). Ensuring that every step is performed perfectly and must be completed then the next step can begin and so on. This model is suitable for small projects, where the team has experience from previous similar projects (GHARAJEH, 2019). It is not good for long ongoing projects that require frequent changes or adjustments.

How it works: A linear, sequential approach where each phase (requirements gathering, analysis, design, implementation, testing, deployment) is completed before moving to the next.

Benefits:

- Simple and easy to understand
- Well-suited for projects with clear, fixed requirements
- Provides a structured approach

Disadvantage: It doesn't allow developers to be flexible in terms of making changes, scope adjustments, or updates it is static. It is difficult to identify risks or challenges in the earlier stages and once complete it will be difficult to fix those problems. (Paredes, 2024).

3.6.2: Agile Methodology

Agile methodology is a software development method that is achieved by breaking down the entire project into smaller components/segments called sprints. (Laoyan, 2024), which will be iteratively processed one by one manner. Involves each stage going through each stage of the entire systems development life cycle (SDLC) such as planning, design, development, testing, deployment, and review. Agile framework is an umbrella term for different variations under this methodology including kanban, scrum, and extreme programming.

How it works: An iterative approach that emphasizes flexibility, collaboration, and continuous improvement. It involves breaking down projects into smaller, manageable iterations called sprints.

Benefits:

- Adaptable to changing requirements
- Encourages customer collaboration
- Delivers working software frequently
- Improves product quality through continuous testing

Disadvantage: May take a long time to complete the entire project, because each sprint must be complete to move to the next and the project will lack proper documentation (Minnesota, 2022)

3.6.3: Scrum Methodology

Scrum is a methodology under the agile framework, that involves an iterative approach. It involves ceremonies that are more like meetings that must occur, such as sprint planning, daily scrum, sprint review, and backlog refinement (Somerstein, 2024). The project is divided into subsections called “sprints” These sprints have a duration of 1 week or 2 weeks to be complete. Once on sprint is complete there will be a sprint review. For daily reviews when a daily scrum occurs (Cho, 2010).

How it works: A specific implementation of Agile, scrum uses time-boxed iterations (sprints) to deliver incremental features. It involves roles like product owner, scrum master, and development team.

Benefits:

- Focuses on delivering value quickly
- Promotes teamwork and self-organization
- Encourages continuous improvement

Disadvantage: Scrum requires a high level of commitment from each team member for the project to be a success. Scrum may lead to scope creep because of a lack of strict deadlines (Chandana, 2024).

3.6.4: Kanban Methodology

Kanban methodology is under the agile framework as well. Its core process is to help teams visualize their work, limit work in progress, and improve workflow efficiency. By using a kanban board to visually represent the different stages of a process such as “To Do”, “In

Progress” and “Done”. Each task is broken down and is represented by a card that moves through the board as it progresses. Kanban involves regularly reviewing the Kanban board to identify bottlenecks and areas for improvement.

How it works: A visual method that focuses on visualizing work, limiting work in progress, and continuously improving flow. It uses a Kanban board to track tasks and their progress.

Benefits:

- Improves workflow visibility
- Reduces waste and bottlenecks
- Improved quality of software
- Improved communication and coordination
- Encourages continuous delivery

Disadvantages: It does not provide a clear structure and it is difficult to adapt to a multidisciplinary team (The Zenhub, 2021).

3.6.5: Other practices

Numerous methodologies can be used and implemented by developers when building a system and these include:

1. Spiral Model:

Spiral combines iterative development with risk management (geeksforgeeks, 2024). Each iteration involves planning, design, implementation, and evaluation phases. Risk analysis is conducted at each stage to identify and mitigate potential issues. It is often used for complex and large projects.

2. V-Shaped Model:

The V-shaped model is similar to the waterfall model the only difference is that for each stage of the SDLC, there is testing that must occur, and then the cycle proceeds. A sequential model that emphasizes verification and validation at each stage (Javatpoint, 2021). Testing activities are planned in parallel with development activities. Well-suited for projects with well-defined requirements and low risk.

3. Incremental Development:

Break down the project into smaller, incremental builds. Each increment delivers a functional part of the system. Allows for early delivery of value and flexibility to adapt to changing requirements (Graham, 1989).

3.7: Choosing the methodology

In building a bus ticketing system it is ideal to use a flexible methodology like the agile framework (Sagai Mangai, 2022). In this situation, we will be using scrum simply because:

- Scrum's iterative approach allows rapid development and deployment of features. Ensuring that the system can adapt to changing needs and customer feedback at a greater speed.
- When developing systems requirements change rapidly, hence, scrum's flexibility allows the team members to make those changes without any significant delays or disruptions. For example, if the passengers want a new feature on the app, developers will be able to add it and test it early without problems.
- Scrum's iterative approach reduces risks by breaking down the project into small sprints that will enable better manageability and faster mitigation.

With the use of scrum methodology, the development team will work in short sprints, focusing on delivering specific features like user registration, ticket search, and payment processing. By the end of each sprint, a working version of the app would be available for testing and feedback. This methodology will aid the team to respond to passenger feedback quickly, improve the customer's experience, add new features, fix bugs, and ensure customer needs are satisfied.

Chapter Summary

This chapter involves a lot of information to do with already existing systems and how these systems may be of value to society as well. It highlights subsections such as literature review, existing bus ticket applications, technical research, and development methodology. In the literature review, we focus on getting information about similar bus ticketing systems from different authors/scholars, books, theoretical works, dissertations, and journals. When it comes to the existing applications, we focus on comparing the already launched systems (such as Yango and InDrive) to the system we plan on building. Technical research outlines the technologies needed to develop such a system, for example, hardware components and software components. As for development methodology, we focus on the methodologies used to create a system. These include agile method, spiral, waterfall, and prototyping; they all

follow the components/steps involved in the systems development life cycle (SDLC). Towards the end of this chapter, we outline which methodology is ideal for a bus ticketing system and the justification of why it has been selected. In this case, we chose the scrum methodology because it is ideal for an ongoing project that requires each feature to be complete to some level. Therefore, scrum will help deliver a good quality complete system.

Chapter 4: Research Methods

Research methods are split into two types namely secondary research methods and primary research methods. Secondary research is collecting research that has been conducted by someone else already often used to review existing knowledge (Imed Bouchrika, 2024). Primary research is a type of research conducted by an individual to group and collect new knowledge on a research project, it involves observation, questionnaires, interviews, and focus groups.

4.1: Secondary research methods

Secondary research is a type of research that involves the researcher collecting data discovered by someone else, in short, it involves data that already exists (George, 2023). This type of research is also called desk research. Data can be obtained from reports, online sources, books, case studies, literature reviews, journals, and websites. Collecting relevant and similar data about the project you plan on building. Secondary research is the foundation of primary research that is conducted after, it supports it. It is divided into two sectors namely internal and external research.

4.1.1: Internal Research

Internal research is the process of gathering data and information from within a business or organization, by acquiring their permission to have access. Internal research can be used to: identify new customers, evaluate new markets, upgrade products or designs, assess the impact of new products or services, and determine if new products will meet customer needs (Taylor, 2023).

It can involve a variety of activities, such as:

- Employee surveys
- Analysis of sales data
- Customer feedback

In this scenario, **internal research will not be used**. The developer will have to focus on external research, for this type of secondary data collection.

4.1.2: External Research

External research involves gathering information from sources outside of the organization or project team (Thorsteinsdóttir, 2000). This can include academic papers, industry reports, government statistics, news articles, and other publicly available data. By conducting external research, we can gain a deeper understanding of the industry, market trends, and best practices. This information can be invaluable in informing our decision-making process and ensuring that our project is aligned with industry standards and future trends.

4.2: Primary research methods

A primary research method is a method type that lets the researcher collect their own information by conducting acts such as questionnaires or interviews. The information they will acquire will be in relation to their project, hence, they must question relevant individuals who have knowledge that can help in this project.

This type of research method involves activities namely:

- Interviews: The researcher will interview relevant individuals about their intended project. These individuals can be key stakeholders of a bus company, simply for the researcher to gain qualitative insights.
- Surveys and Questionnaires: These will involve well-structured questions that can either be open-ended or closed-ended. Will involve a sample of individuals, which will help gather quantitative data from passengers and users that may use this proposed system.
- Observation: The researcher will have to observe the current bus ticketing process to identify any gaps and opportunities, that they may take advantage of when building this mobile application.

4.2.1: Interview

An interview is a conversation that involves two or more individuals coming together to share certain information about a specific topic of interest; there will be the researcher and the respondent (Academy, 2023). It can be structured, semi-structured, or unstructured; it all depends on the environment and individual you are interviewing, it should be a friendly but professional conversation.

The main purpose of an interview is to aid the researcher collect in-depth and detailed information from the individual or group of people being interviewed. It helps the researcher understand and explore the respondent's experiences, thoughts, opinions, and feelings in their own words (Eleanor Knott et al, 2022). It helps provide a better understanding of the topic being discussed.

Interviews have numerous benefits for example:

- Interviews do not restrict the respondent when it comes to the way they must answer the questions they are given. Therefore, open-ended questions are the most advised, they help encourage participants to share their thoughts freely, revealing more insights.
- Interviews allow researchers to delve deep into participants' experiences, beliefs, and opinions about something.
- Interviews promote tailored questioning, in a way that a researcher can adapt and ask questions based on participants' responses, leading to more insightful and better-quality responses. In a way that every response will be in line with the discussion.
- Interviews foster a personal connection between the researcher and participant, building trust and rapport.
- Interviews prioritize the participant's voice, empowering them to share their experiences in their own words.
- Interviews can provide additional insights that may not be captured by other methods.

An interview is a formal way of data collection, regardless of it being a difficult process because it involves people like stakeholders who may not be obligated or interested to share sensitive information with the researcher, which is a disadvantage and limitation. Other limitations are likely to occur during interviews and these are as follows:

- Interviewers may unintentionally introduce bias through their questioning style, body language, or interpretation of responses.
- Participants may have difficulty accurately recalling past events, leading to inaccurate or incomplete information. One reason can be that interviews must occur during a short period of time which will have an impact on the participant's train of thought, resulting in inaccurate or jumbled feedback.
- Arranging and coordinating interviews can be time-consuming, especially for large-scale studies.

- Interviews often involve a small number of participants, limiting the generalizability of findings to a wider population.

Interviews, questionnaires, and observations are all valuable research methods, each with strengths and weaknesses. They all rely on each other in one way or another. Interviews are very effective when it comes to acquiring detailed and in-depth information. Questionnaires often have closed-ended questions that restrict the respondents from fully expressing themselves. Observations are not always accurate because the researcher monitors intentionally or unintentionally and does not ask anyone about anything. Interviews, questionnaires, and observations complement each other regardless of their distinctive limitations and benefits. Combining interviews and questionnaires can help triangulate findings, increasing the validity and reliability of the research. Additionally, questionnaires can provide quantitative data on large samples, while interviews can provide qualitative insights into the underlying reasons for those quantitative findings. As for observations they can be used to validate or challenge information obtained through interviews, ensuring that the data is accurate and reliable.

In conclusion, conducting an interview for this project can help provide better information about how ZedTurbo can make the ticketing process more effective. By looking into what the people/users need and how ZedTurbo can satisfy them to some extent. This will help in creating a user-friendly application that the users will enjoy using and the bus companies will manage to use it accordingly too.

4.2.1.0: Who was interviewed?

ZedTurbo is intended to be a bus ticket reservation application, therefore during this interview process a few bus companies that were visited stated that they cannot disclose such information. Hence, for this research only the survey/questionnaire responses will be used for analysis and a feasibility study for the end product to exist and still be a vital component to the Zambian society.

4.2.2: Questionnaire

A questionnaire is a research method that involves a series of questions concerning a specific project or topic. It is used to collect useful information from relevant respondents, and could either be written or oral questions (Lietz, 2010).

The questionnaire that will take place in this situation will be split into two forms namely, closed-ended and open-ended questions. This is because certain questions need full insight and explanations to grasp the actual matter, whereas other questions just need respondents to give single-word responses that will still carry great weight in the data collection process.

Closed-Ended questionnaire questions

The questions will be structured as follows:

1. What is your occupation?

- a) Local student
- b) Foreign student
- c) Worker
- d) Parent/ Guardian
- e) Other

Question Objective: To understand the type of passenger who uses this mode of transportation.

2. Have you ever used public transportation, buses to be precise? (Moving from district to district or province to province etc.)

- a) Yes
- b) No

Question Objective: To assess if this respondent has used this type of transportation mode before.

3. Do you currently use public transportation in Zambia?

- a) Yes
- b) All the time
- c) Never
- d) Rarely
- e) No

Question Objective: To evaluate whether or not the person still uses this mode of transportation.

4. How often do you travel by bus within Zambia?

- a) Daily
- b) Weekly

- c) Monthly
- d) Yearly
- e) Rarely
- f) Never

Question Objective: To analyze how often the passenger uses this mode of transportation.

5. Have you ever used a mobile application to purchase bus tickets in Zambia?

- a) Yes
- b) No

Question Objective: To see the user's familiarity with bus ticketing mobile applications.

6. If yes, which applications have you used? (Open-ended answer)

Question Objective: To know the names of bus ticketing applications they have used.

7. How was your experience with bus services in Zambia?

- a) Good
- b) Bad
- c) Neutral
- d) Very Bad

Question Objective: To analyze the passenger's experience.

8. Is physically purchasing a bus ticket hard and complicated?

- a) Yes
- b) No

Question Objective: To investigate the process of purchasing a bus ticket.

9. Does purchasing your tickets physically take much of your time?

- a) Yes
- b) Not Really
- c) Maybe
- d) No
- e) Very Much

Question Objective: Understand whether or not it takes much of the passenger's time to purchase a ticket physically.

10. When purchasing the tickets from conductors, are the prices for the trips accurate or do they exaggerate?

- a) Yes
- b) No

Question Objective: To know whether conductors lie or exaggerate about the bus fare prices.

11. What features would you like to see in a mobile bus ticketing application to improve your travel experience?

- a) Displayed Bus details
- b) Notification reminder for trip
- c) Page for Purchasing Bus Ticket
- d) Ratings and Help page
- e) User-friendly interface

Question Objective: Gain insights into desired features like filtering, and seat selection.

Open-Ended questionnaire questions

12. What are the biggest challenges you face when booking bus tickets online?

Question Objective: Asked to help identify common challenges associated with existing online booking systems, such as website usability, security concerns, and payment difficulties.

13. How long does it typically take you to purchase a bus ticket?

Question Objective: To analyze the duration at which it takes for the passenger to purchase a ticket.

14. How important is it to you to be able to compare prices and bus companies before booking a ticket?

Question Objective: To understand the importance of comparing prices before purchasing their ticket.

15. Would you be comfortable using a mobile application to pay for your bus ticket?

Question Objective: To analyze whether the passenger will trust the mobile application for any transaction.

16. How important is it to you to have a user-friendly and intuitive mobile application?

Question Objective: Assess the importance of a seamless user experience and identify any specific preferences or requirements.

17. Explain your experience when you wanted to purchase a bus ticket from one of these bus companies.

Question Objective: To know the step-by-step procedure of how the bus ticketing process goes.

4.2.3: Focus Groups

A focus group is a qualitative research method that brings together a small group of people to participate and answer questions about a topic, product, or service before it is launched or to provide feedback on it (Victoria Wibeck et al, 2007). The group is typically chosen based on specific demographics or shared characteristics relevant to the research topic. The researcher guides the discussion and encourages open-ended conversation for deeper insights.

While focus groups offer many benefits, it's important to recognize their limitations. The small sample size and potential for moderator bias can impact the generalizability of findings (Smithson, 2010). To mitigate these limitations, researchers often combine focus groups with other research methods, such as surveys or interviews.

4.2.4: Observation

Observation is the act of noticing, perceiving, monitoring, and examining an environment, object, event, behaviour, or person. Observation is mainly used to gather information or record data; which could be direct or indirect when it comes to intentions (Malgorzata Ciesielska, 2017).

With such a project observation is vital and very helpful. Not every passenger will be keen enough to participate in a questionnaire, and as the researcher certain actions must be engaged to gain more depth on the topic. These activities include observing, which involves being around an environment where you will sit in silence and pick certain traits, actions, and characteristics of an environment without forcing anyone to give you information.

However, for ZedTurbo there must be a combination of qualitative and quantitative observations. The following must be considered:

1. Passenger behaviour

What to observe:

- how passengers currently interact with bus ticketing processes at bus stations or on the buses themselves. Pay attention to behaviours like queueing, ticket purchasing, and boarding.

Why:

- This helps identify pain points passengers face, such as long wait times, confusion about ticket prices, difficulty in finding available buses, or challenges in managing cash transactions.

Information gained:

- Understanding these behaviours allows the design for ZedTurbo to directly address these issues, making the process faster, more organized, and convenient for passengers

2. Ticketing processes and cash handling

What to observe:

- Monitor how tickets are issued and how cash transactions are handled by bus operators and ticket sellers. This includes observing the time taken for transactions and any inefficiencies or risks (e.g., cash loss or theft).

Why:

- Observing ticketing and cash handling practices highlights operational inefficiencies and security risks

Information gained:

- This observation provides a basis for features like mobile payments and digital ticket records, reducing dependency on cash and enhancing security for both operators and passengers.

Chapter Summary

Research methods is a chapter that explains research on other people's work and data collection. It is comprised of the different types of research methods, for example the secondary and primary research. This chapter expands these research methods and explains what falls under each one of them; whilst stating its purpose in this type of project. Secondary research involves the internal research and the external research, for this project we shall strictly focus on the external research that involves collecting data from already existing past reports, case studies, journals and articles. These will have to be relevant studies to help add value to this project. In the primary research we have the interviews, questionnaires, focus groups and observation. For this form of research, the researcher will be collecting data from relevant users that have slight knowledge of this area of study. This section elaborates the type of questions that will be asked and the reason as to why those questions are being asked (the objective).

Chapter 5: Data Analysis and Design

5.1: Data analysis

The collected data must be summarized and logically interpreted to transform into sensible information and determine the relationship, reasoning, and correlation between the data and the project (Eldridge, 2024). This process is called **data analysis**.

For the questionnaire, the *population of participants was 100* and the settled *sample size was 50 participants*. About **65 questionnaires were distributed** to Zambian citizens and a few individuals from different countries living in Zambia.

The questionnaire was created online using **Google Forms**; the link is given below:

[“https://docs.google.com/forms/d/e/1FAIpQLSe5_Kfh6WwvQmpVYu4ULTA7JKmugbDCxdHG9m7d8YN-BD_C_A/viewform?usp=sf_link”](https://docs.google.com/forms/d/e/1FAIpQLSe5_Kfh6WwvQmpVYu4ULTA7JKmugbDCxdHG9m7d8YN-BD_C_A/viewform?usp=sf_link)

From the 65 distributed questionnaires, **53 individuals participated**. As displayed below:

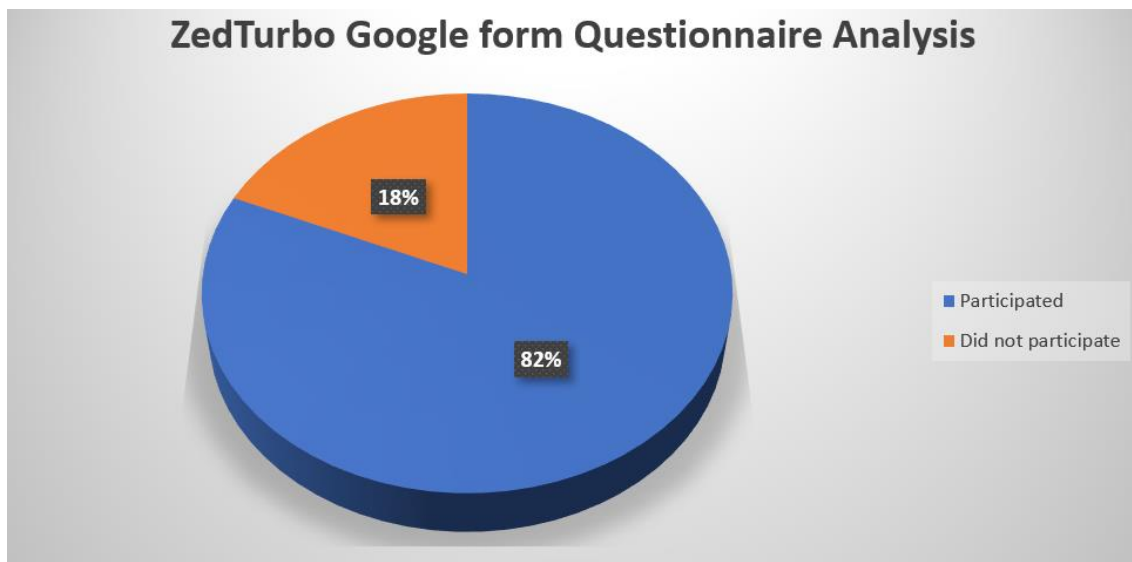


Figure 2: Questionnaire response Analysis

Analysis from questionnaire

An analysis of the responses from the respondents who participated in the questionnaire is outlined below.

Q. What is your occupation?

- a) Local student
- b) Foreign student
- c) Worker

- d) Parent/ Guardian
- e) Other

Question Objective:

- To understand the type of passenger who uses this mode of transportation.

The data analysis shows that the “Zambian society” is filled with different individuals in different occupations such as students (local and foreign), parents, lawyer, economists, and other working-class individuals displayed in the graph below. However, the majority who participated are Local students.

What is your Occupation?

53 responses

 [Copy chart](#)

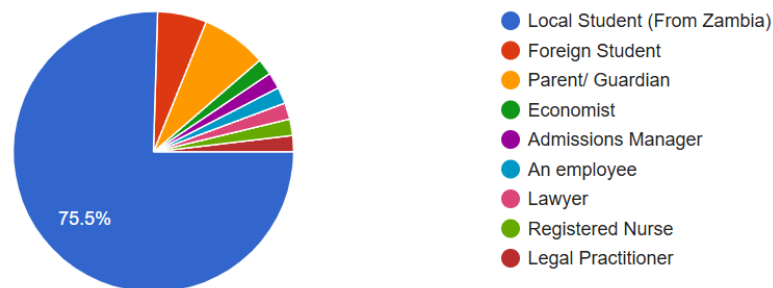


Figure 3: Respondents occupation Analysis

Q. Do you currently use public transportation in Zambia?

- a) Yes
- b) All the time
- c) Never
- d) Rarely
- e) No

The objective of this question:

- To evaluate whether or not the person still uses this mode of transportation.

From the data collected, it shows that about 69.8% and 15.1% of individuals use public transportation (Buses) which is a total of **84.9%**.

Do you currently use public transportation in Zambia? (Buses)

53 responses

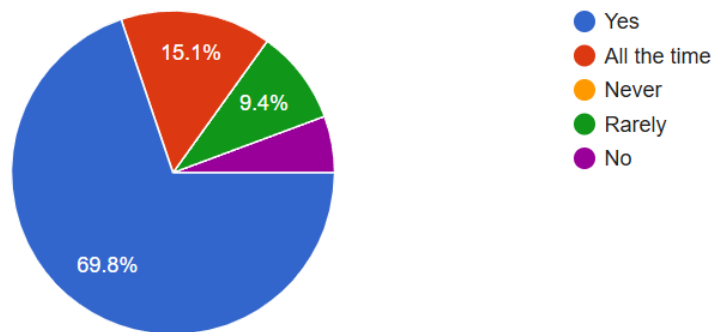


Figure 4: Respondents that use public transportation

The conclusion from this data is that many people use public transportation as their means of mobility.

Q. Have you ever used a mobile application to purchase bus tickets in Zambia?

c) Yes

d) No

Question Objective:

- To see the user's familiarity with bus ticketing mobile applications.

From this analysis, it shows that **92.5%** of individuals are **unaware** of any bus ticketing mobile application in Zambia.

Have you ever used a mobile application to purchase bus tickets in Zambia?

53 responses

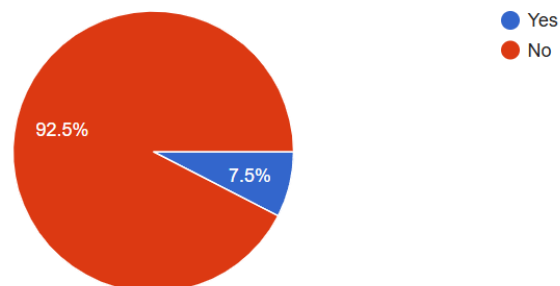


Figure 5: Respondents that know any mobile application for booking tickets

The conclusion to this question is that very few people know about such applications (bus ticketing apps) in Zambia.

Q. Does purchasing your tickets physically take much of your time?

- a) Yes
- b) Not Really
- c) Maybe
- d) No
- e) Very Much

Question Objective:

- Understand whether or not it takes much of the passenger's time to purchase a ticket physically.

Does purchasing your tickets physically take much of your time?

53 responses

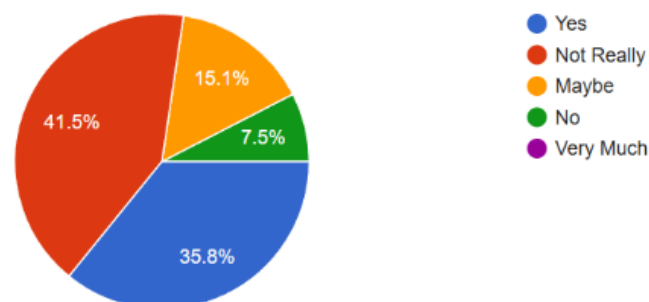


Figure 6: Whether purchasing tickets takes much time

The conclusion for this question is that purchasing a bus ticket from the respondent's point of view can take a lot of time and can sometimes be a favourable duration that may not take up much of your time.

Q. When purchasing the tickets from conductors, are the prices for the trips accurate or do they exaggerate?

- a) Yes
- b) No

Question Objective:

- To know whether conductors lie or exaggerate about the bus fare prices.

When purchasing the tickets from conductors, are the prices for the trips accurate or do they exaggerate?

53 responses

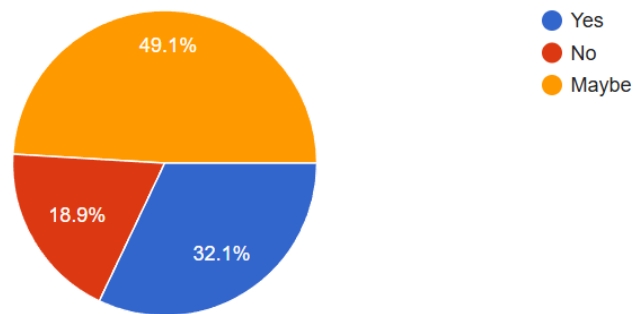


Figure 7: Respondents views on whether conductors are deceptive over the prices of the tickets

The conclusion here is that for some passenger's the conductors lie about the prices (32.1%) to them, whereas in other cases they tell the truth about the prices and other passengers have no idea whether it is the truth or a lie (49.1%).

Q. What features would you like to see in a mobile bus ticketing application to improve your travel experience?

- Displayed Bus details
- Notification reminder for trip
- Page for Purchasing Bus Ticket
- Ratings and Help page
- User-friendly interface

Question Objective:

- Gain insights into desired features like filtering, and seat selection.

What features would you like to see in a mobile bus ticketing application to improve your travel experience?

[Copy chart](#)

53 responses

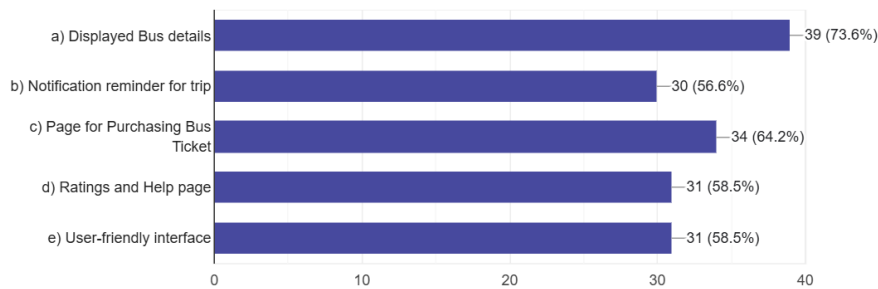


Figure 8: Features respondents want

The conclusion here is that all the features listed will be vital for the users.

Q. Would you be comfortable using a mobile application to pay for your bus ticket?

Question Objective:

- To analyze whether the passenger will trust the mobile application for any transaction.

Would you be comfortable using a mobile application to pay for your bus ticket?

[Copy chart](#)

53 responses

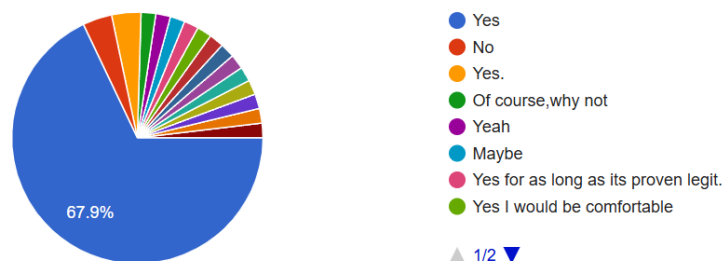


Figure 9: Whether the passenger will be comfortable to make transactions through the app

In relation to the above graph, it is safe to say that many users will be comfortable with making payments on a mobile application to pay for their bus ticket.

Q. How important is it to you to have a user-friendly and intuitive mobile application? (On a scale of 1 to 10)

Question Objective:

- Assess the importance of a seamless user experience and identify any specific preferences or requirements.

How important is it to you to have a user-friendly and intuitive mobile application?

 Copy chart

53 responses

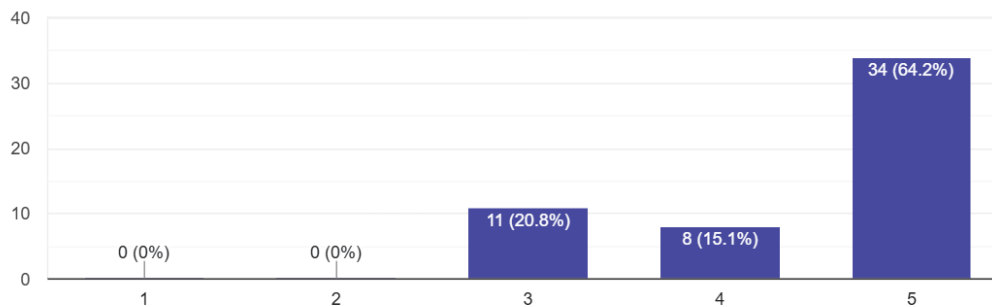


Figure 10: The need for a user-friendly mobile application

The conclusion from the above analysis is that many people would prefer an application that is user-friendly and not difficult to navigate.

Q. Explain your experience when you wanted to purchase a bus ticket from one of these bus companies.

Question Objective:

- To know the step-by-step procedure of how the bus ticketing process goes.

RESPONDENTS EXPERIENCE FROM PHYSICAL PURCHASING OF BUS TICKETS

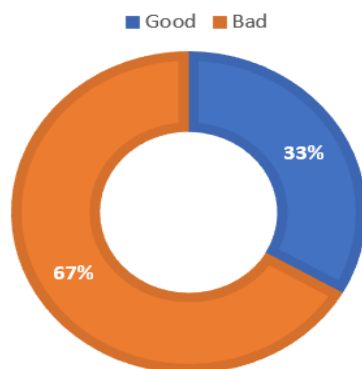


Figure 11: Respondent's experience during the physical purchasing of bus tickets

From the responses above from the respondent's experience when they went to purchase a bus ticket from these bus companies, the conclusion from the many responses is that a few said that their experience was "okay" and accurate, whereas the majority are either complaining about the long queues, poor customer care and one even experienced theft in the process, they lost

their phone. Therefore, there is a need for a solution to eliminate this manual and physical situation when purchasing a bus ticket.

5.1.1: Research Conclusion

Based on the research that was conducted and the analysis; the researcher has concluded that this application can be a vital component in the market and help a number of individuals living in the Zambian society.

This application will be generic and will comprise of bus companies that the user can pick from and purchase their bus ticket from the comfort of their home. This application will help reduce operational costs for the bus companies and will help save a lot of time for the passengers because they won't be standing in long lines anymore to purchase a ticket.

5.2: System Design

System design is the process of creating a detailed plan for a system's components, architecture, data, and overall structure to meet the desired system requirements (GeeksforGeeks, 2024).

5.2.1: Use case Diagram

A use case diagram is a blueprint or visual representation that shows how users interact with a system (Reza Fauzan, et al., 2019). It consists of:

- An actor; the system's users and is often represented as a stick figure. In this case is the passenger/user.
- Use cases; are the actions or tasks that the system performs. These are represented as ovals.
- Relationships; these are the lines and arrows that display how the actor(s) interact with the system.

Below is the system's Use case diagram:

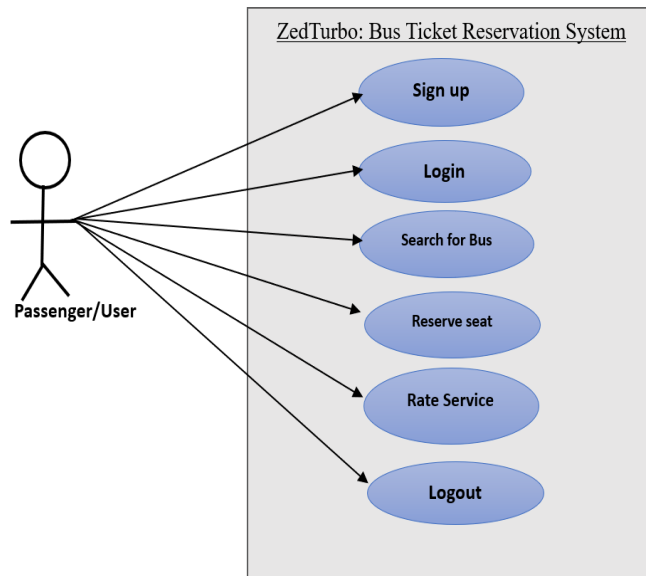


Figure 12: Use case Diagram

5.2.2: Flow chart Diagram

A flowchart diagram is a visual representation that displays the step-by-step procedures involved in a system, these steps are put in a sequential order (Ensmenger, 2016). It involves vital shapes that have meanings such as:

- Oval: used for the beginning (start) or the end (stop)
- Rectangle: used for processes.
- Arrows: define the flow and connections.
- Diamond: used for decisions (if, else).
- Parallelogram: used for inputs and outputs.

Below is the flow chart diagram that will be used for this system:

ZedTurbo Flowchart:

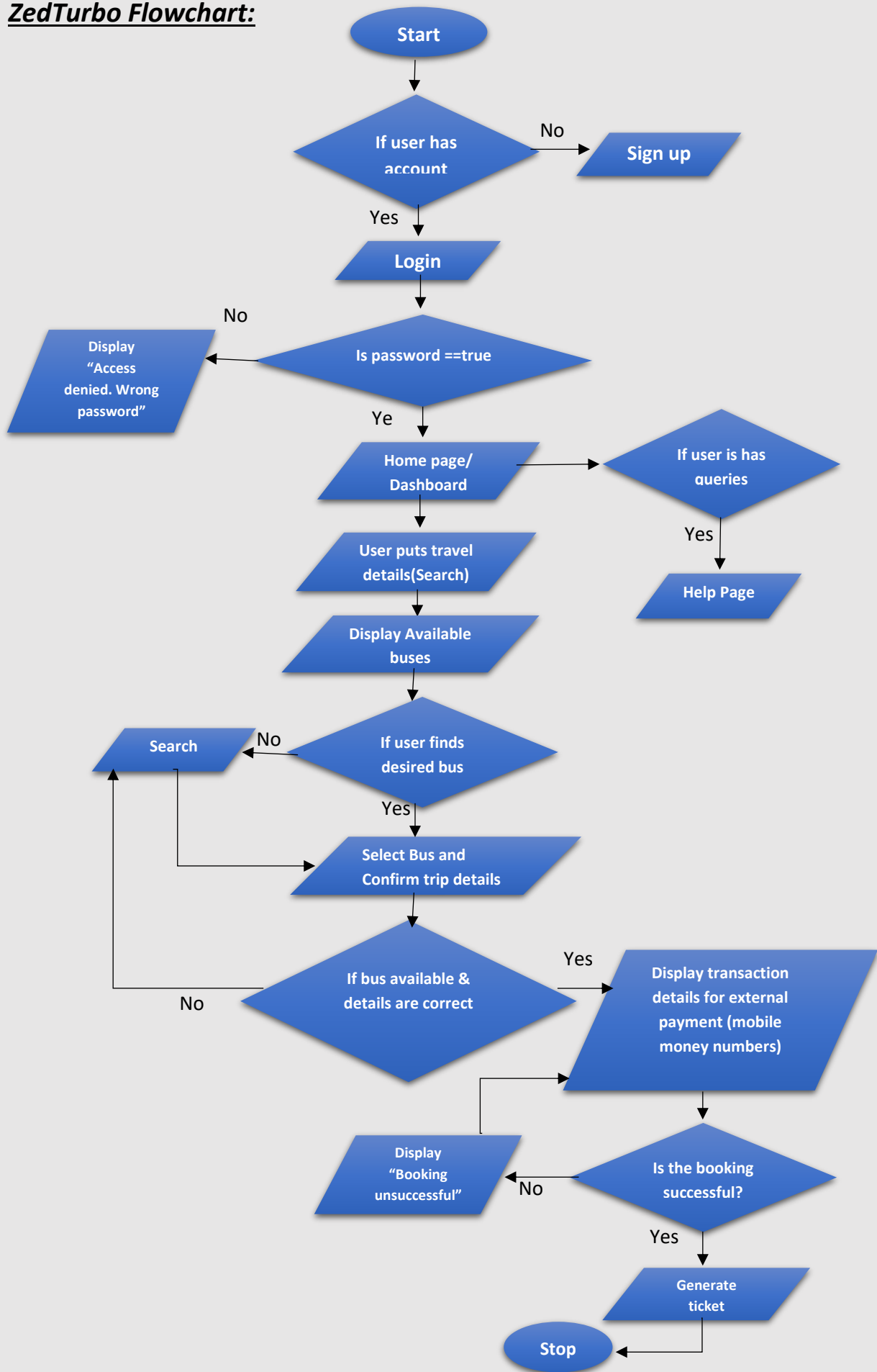


Figure 13: Flowchart

5.2.3: Entity Relationship Diagram

An ER diagram is a structural diagram commonly used in database design, which could be conceptual or physical; it displays the relationships between each entity in the system (Qing Li, 2009). An entity is an existing component with distinct characteristics, such as people, concepts, or objects.

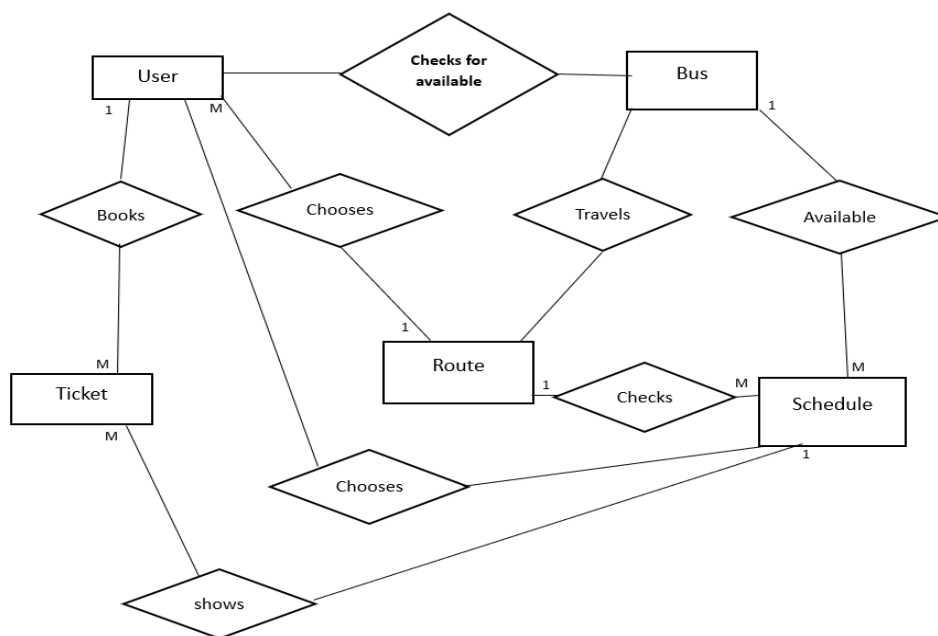


Figure 14: ERD

Chapter Summary

This chapter consists of an analysis of the data collected by the developer and the conclusions about the creation of a bus ticket reservation mobile application. There is the system design at the end of the chapter, displaying the diagrams that will be used during the creation of this mobile application, including an entity relationship diagram, flow chart, and a use case diagram.

Chapter 6: Implementation

This chapter explains how the system was built, step by step. It covers the key modules identified during the design phase, breaking down their logic and functionality. The system's structure is described in detail, along with diagrams, pseudocode, and other tools to help visualize how everything works.

6.1: User Authentication module

This module consists of the login and signup pages that have been put together on one page. This page is linked to the database (Firestore), which ensures secure access to the mobile application for new and existing users. Below is the code for this module and on the right-hand side is the user interface.

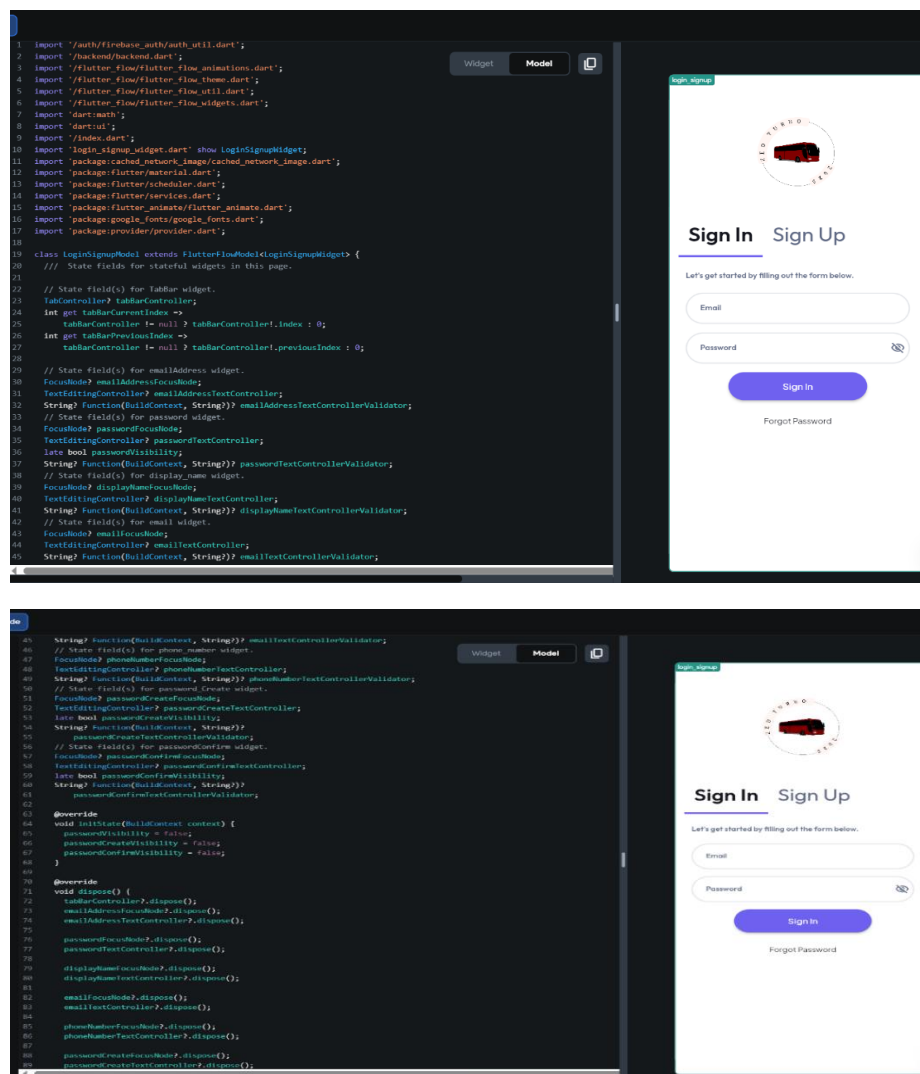


Figure 15: User Authentication Module Code

6.2: Homepage module (Dashboard)

This module displays the first page the users will see once they log in successfully into this application called “ZedTurbo”. The users will be able to view the available bus companies and trips offered. Below are a few lines of code for the page. On the right-hand side is what the user interface of the dashboard looks like in the mobile application.

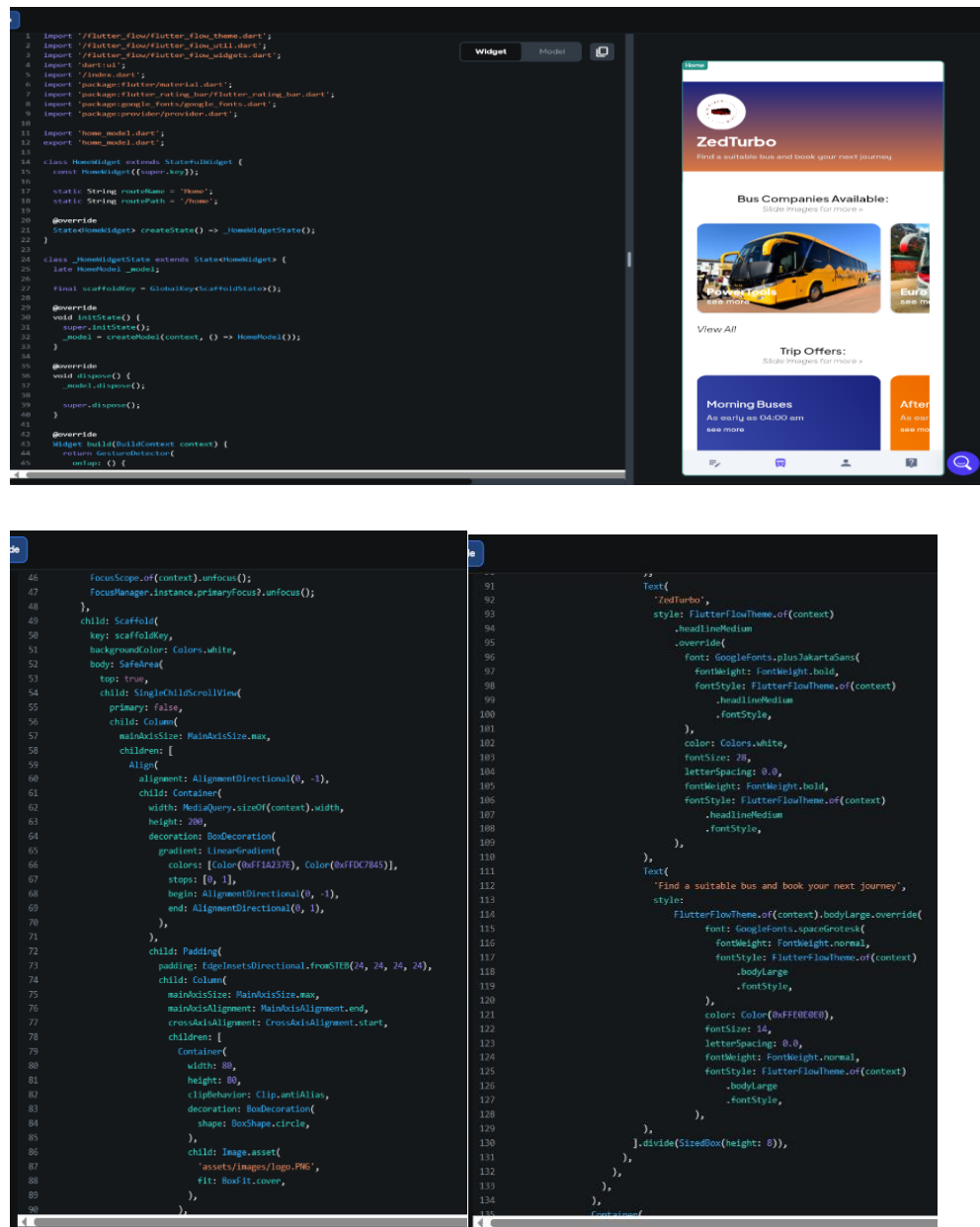


Figure 16: Homepage module code

6.3: Trips module

The trip module/page displays available bus trips for all the bus companies available on this mobile application. It shows the time, approximate arrival, departure time, and other necessary details the passenger deserves to know. Below is the user interface with records from the database and the code behind the functional page.

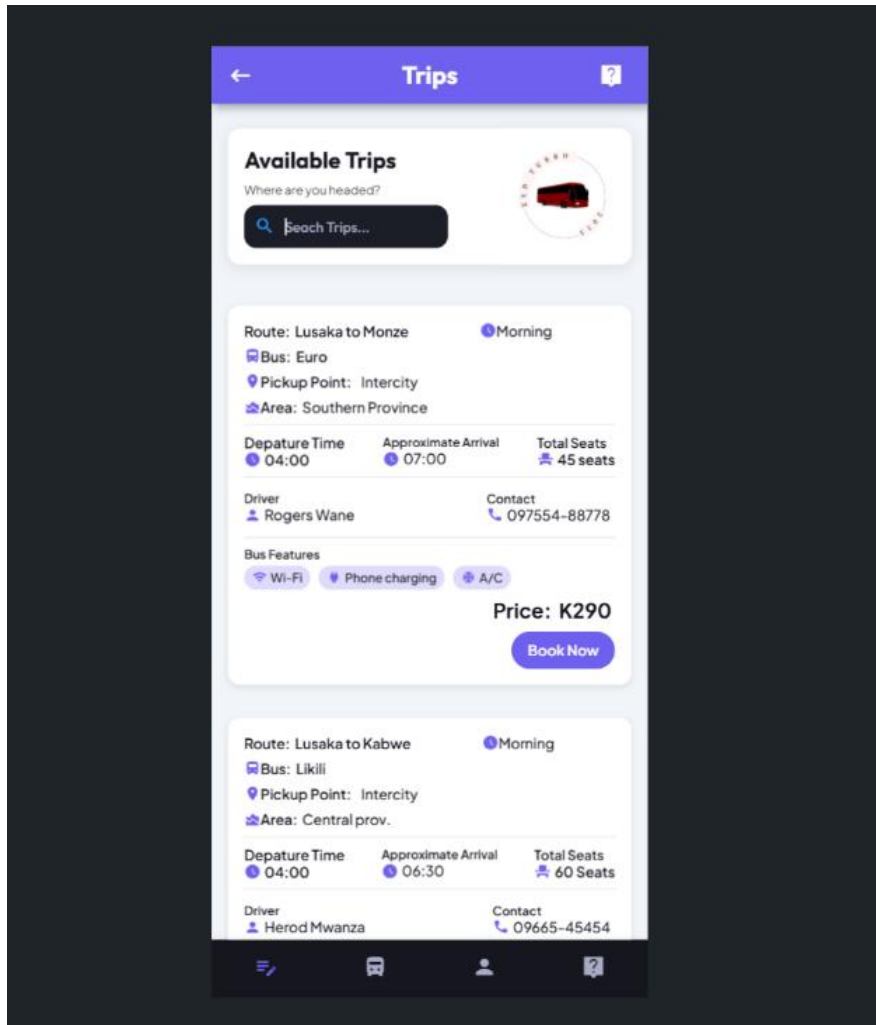


Figure 17: User interface for trips page

```

1 import '/backend/backend.dart';
2 import '/flutter_flow/flutter_flow_autocomplete_options_list.dart';
3 import '/flutter_flow/flutter_flow_icon_button.dart';
4 import '/flutter_flow/flutter_flow_theme.dart';
5 import '/flutter_flow/flutter_flow_util.dart';
6 import '/flutter_flow/flutter_flow_widgets.dart';
7 import 'dart:ui';
8 import '/index.dart';
9 import 'trips_widget.dart' show TripsWidget;
10 import 'package:easy_debounce/easy_debounce.dart';
11 import 'package:flutter/material.dart';
12 import 'package:flutter/scheduler.dart';
13 import 'package:google_fonts/google_fonts.dart';
14 import 'package:provider/provider.dart';
15 import 'package:text_search/text_search.dart';
16
17 class TripsModel extends FlutterFlowModel<TripsWidget> {
18   /// State fields for stateful widgets in this page.
19
20   // State field(s) for SearchText widget.
21   final searchTextKey = GlobalKey();
22   FocusNode? searchTextFocusNode;
23   TextEditingController? searchTextController;
24   String? searchTextSelectedOption;
25   String? function(BuildContext, String)? searchTextControllerValidator;
26   List<TripsRecord> simpleSearchResults = [];
27
28   @override
29   void initState(BuildContext context) {}
30
31   @override
32   void dispose() {
33     searchTextFocusNode?.dispose();
34   }
35 }
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Figure 18: Trips Module Code

6.4: Search function on the Trips module

The search function is part of this application. It helps users type in what they are looking for in the hope of finding it through the search bar.

Below is the search function source code for the Trips page:

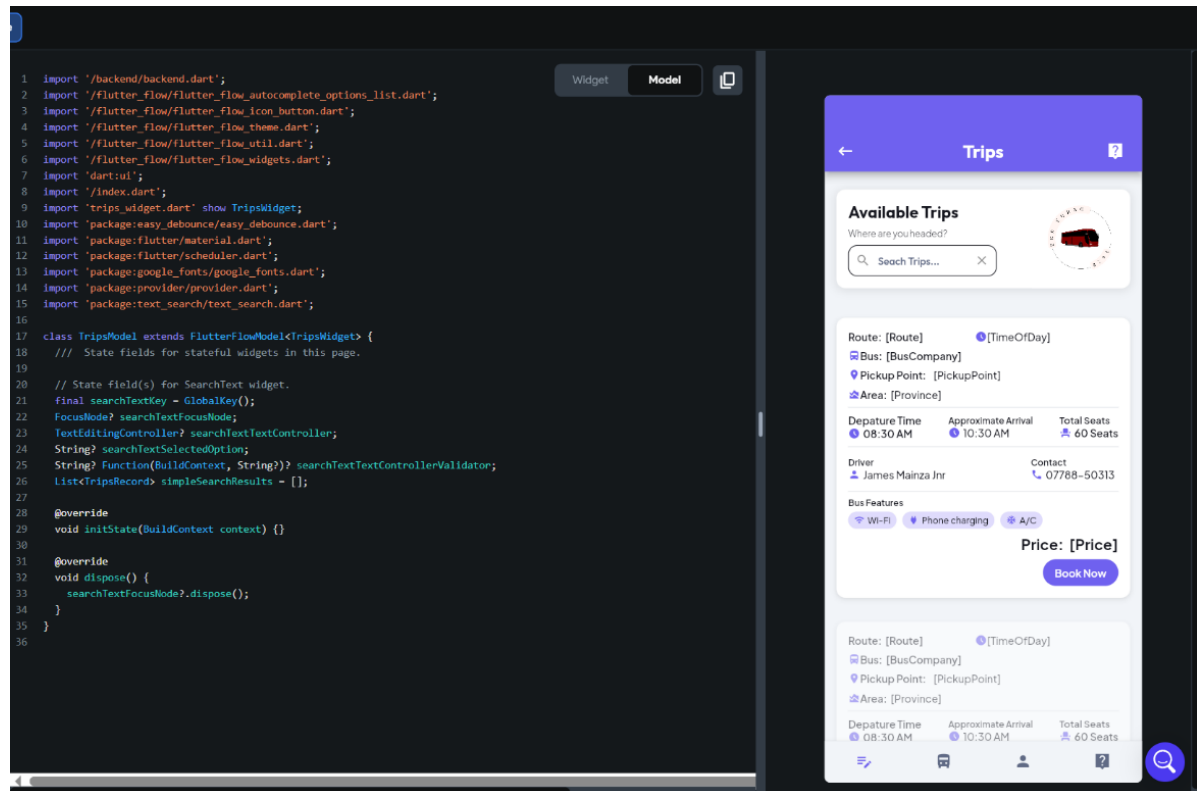
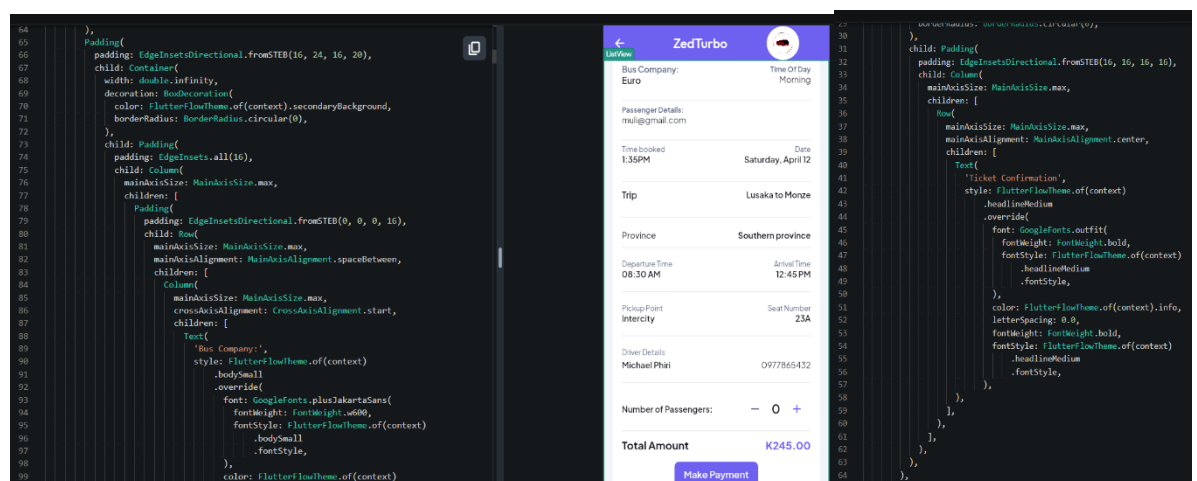


Figure 19: Code for Search function

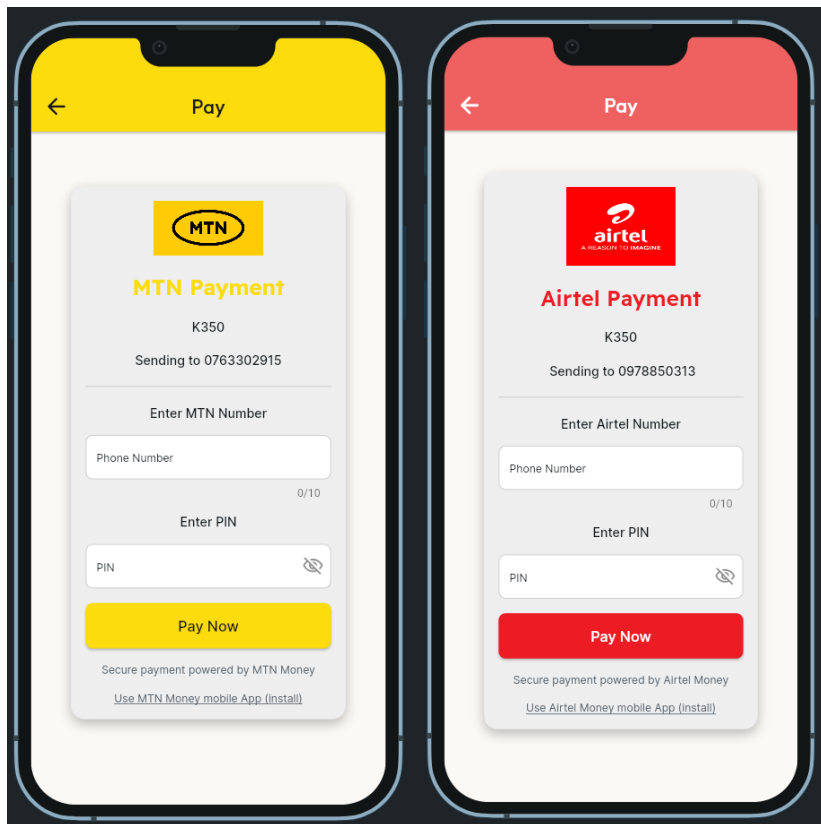
6.5: Ticket Confirmation Page

This page extracts the details the user has chosen for the trip. It is important for them to confirm before making any payments. Below is the source code and user interface:



6.6: Payment Module

These pages display how the user will make a payment. Below are the user interfaces involved:



```
17 import 'airtel_pay_model.dart';
18 export 'airtel_pay_model.dart';
19
20 class AirtelPayWidget extends StatefulWidget {
21   const AirtelPayWidget({super.key});
22
23   static String routeName = 'AirtelPay';
24   static String routePath = '/airtelPay';
25
26   @override
27   State<AirtelPayWidget> createState() => _AirtelPayWidgetState();
28 }
29
30 class _AirtelPayWidgetState extends State<AirtelPayWidget>
31   with TickerProviderStateMixin {
32   late AirtelPayModel _model;
33
34   final scaffoldKey = GlobalKey<ScaffoldState>();
35   final animationsMap = <String, AnimationInfo>{};
36
37   @override
38   void initState() {
39     super.initState();
40     _model = createModel(context, () => AirtelPayModel());
41     _model.textController1 ??= TextEditingController();
42     _model.textFieldFocusNode1 ??= FocusNode();
43     _model.textController2 ??= TextEditingController();
44     _model.textFieldFocusNode2 ??= FocusNode();
45
46     animationsMap.addAll({
47       'containerOnPageloadAnimation': AnimationInfo(
48         trigger: AnimationTrigger.onPageload,
49         effectBuilder: () => {
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Figure 21: Payment code

Chapter 7: Testing

This chapter explains how the ZedTurbo app was tested to ensure it works correctly and meets user needs. Testing helps identify bugs, improve performance, and validate that all features function as intended.

7.1: Types of Testing

i. Unit Testing

Unit testing involves testing individual components or modules of the application to ensure they work correctly in isolation. For ZedTurbo, several key features were tested to verify functionality before integrating them into the full system.

1. Search Functionality

The search feature was tested by entering different destination names (e.g., "Monze" and "Kitwe") to confirm that the system correctly retrieves and displays relevant bus trips.

Test cases

The test cases included:

- **Valid Search:** Entering "Kitwe" returned all available trips to Kitwe.
- **Partial Search:** Typing "Mon" displayed trips to Monze, Mongu, and other matching destinations.
- **No Results:** Searching for a non-existent route (e.g., "Unknown"), it will show that there is no such record in the database.

The diagrams below display the search test case in the testing environment in Flutterflow:

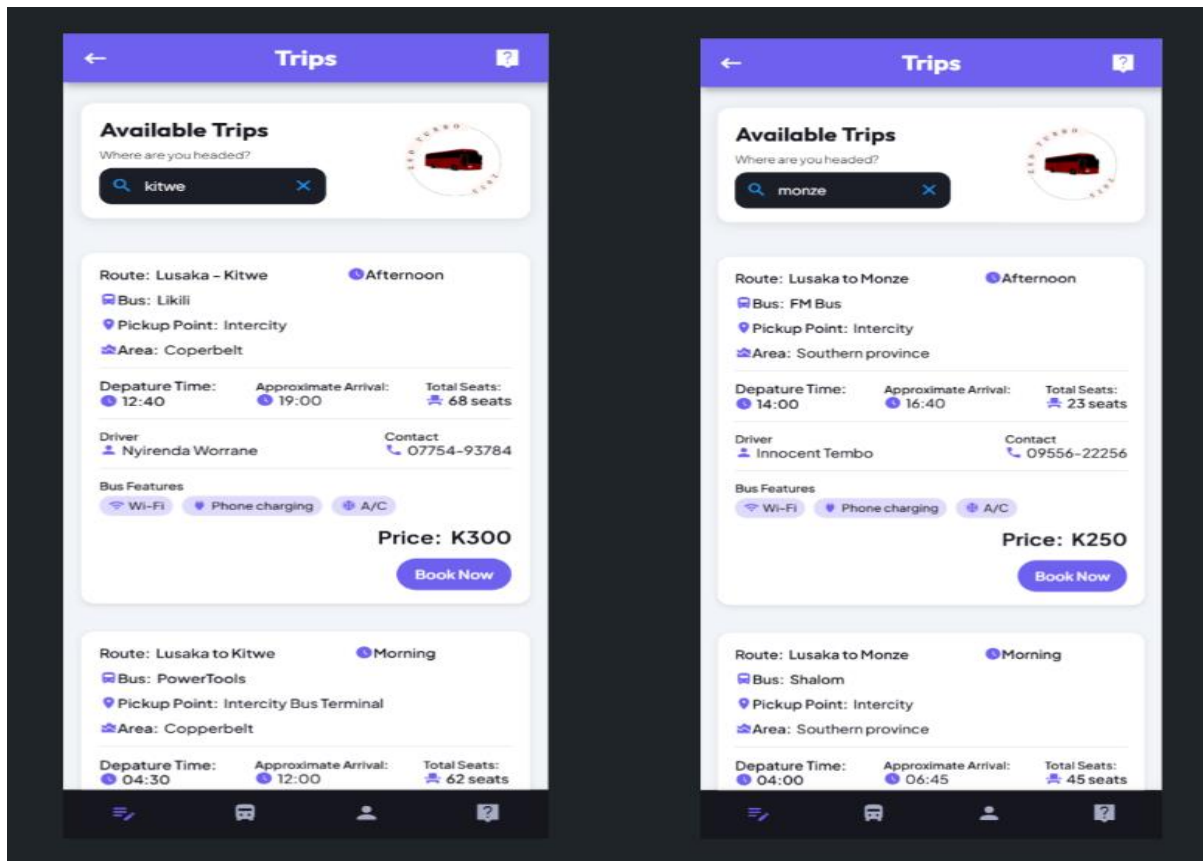


Figure 22: Search function in Trips Module

2. Filtering with Search

The filtering system was tested to confirm that users could refine search results by preferences such as bus company, price, departure time, province, and desired bus driver. Tests included:

- **Price Filter:** Displays trips within the user's desired budget and other prices that are not so far from that range.
- **Time Filter:** Selecting "Morning Departures" correctly displayed buses leaving before noon.
- **Bus operator Filter:** Choosing "Power Tools Buses" only lists trips from that company will appear.

Summary

Duration	Unit Testing
- Testing occurred in <i>2 weeks</i>	- Each module was tested one by one and worked accordingly

ii. Integration Testing

Integration testing was conducted to ensure that different modules of the ZedTurbo application work together correctly. This testing phase focused on verifying data flow and interactions between connected components, including the search functionality, authentication system, booking process, and payment page.

Duration	Integration Testing
- Testing occurred in 2 weeks	- All modules were combined. They were tested together and worked accordingly

i. User Acceptance Testing (UAT)

User Acceptance Testing involves giving the application to actual end-users for them to try and interact with the system. To verify usability and identify potential issues and misunderstandings regarding certain features in the application.

Duration	UAT Testing
- Testing occurred in 3 weeks	- Users were given the system to use. They had no complaints. Feedback from them helped change certain parts.

ii. Functional Testing

The core functionalities were tested and evaluated to ensure that they align with the specifications.

Duration	Functional Testing
- Testing occurred in <i>3 weeks</i>	- Each module was tested and compared with the expected outcomes.

iii. Performance Testing

Systems performance when given to users.

Summary

Duration	Performance Testing
- Testing occurred in <i>2 weeks</i>	- The entire application's delays were not more than 1 minutes. Therefore, the response time was within the expected range.

7.2: Others

- **Reported errors:** Text fields and certain features on the screen were not positioned properly; hence, on the phone screen, they were looking squished. The payment module had many issues when generating the API from MTN.
- **Test Duration and Participants:** The entire testing process was an ongoing activity; once each unit/page was created, it went through testing, hence the duration is “12 weeks”. As for the testing participants, they are listed below:
 - My project supervisor (Mr Alex Ng’uni).
 - A former UNILUS I.T Graduate (Mambwe Soza).
 - UNILUS lecture (Mr Perry Longwani).
 - Fellow students and a few family members posing as passengers.

Chapter 8: Critical Evaluation

This chapter presents a comprehensive critical evaluation of the ZedTurbo bus ticket reservation application, assessing its performance, usability, and impact on Zambia's public transportation sector. The evaluation systematically examines both the strengths and limitations of the platform, providing valuable insights into its effectiveness in addressing the needs of passengers, bus operators, and other transportation stakeholders. Through this analysis, we gauge the system's success in transforming traditional ticketing processes while identifying areas for future improvement and scalability within Zambia's evolving digital landscape.

8.1: Benefits of the Developed ZedTurbo Bus Ticket Reservation System

User-Friendly Interface and Accessibility:

- The ZedTurbo mobile application was designed with a focus on intuitive navigation and accessibility.
- The evaluation examined how users can effortlessly perform key functions such as searching for bus routes, comparing ticket prices, and booking.
- The interface ensures that even first-time users can operate the system without extensive guidance, making it accessible to a wide demographic range in Zambia.

8.2: Challenges Faced During Development and Study

i) User Adoption Concerns

- The study revealed resistance among some demographics, particularly older passengers and those in rural areas, who prefer traditional cash-based ticketing. Addressing this requires comprehensive user education about digital payment security and app functionality.

ii) Industry Collaboration Barriers

- Some established bus operators were hesitant to share real-time data, requiring negotiations to demonstrate mutual benefits. This affected the initial breadth of operators available on the platform.

iii) Resource Constraints

- As a student project, development was limited by budget for advanced features like GPS tracking, real-time, payment gateways, or AI-powered recommendations.

Chapter Summary

Despite these challenges, ZedTurbo proves to be a **viable solution** for Zambia's transportation inefficiencies, offering **speed, transparency, and convenience** over traditional methods. Future improvements should focus on **expanding operator partnerships, enhancing rural accessibility, and securing funding for advanced features**. This evaluation underscores ZedTurbo's potential to **revolutionize bus travel in Zambia** while paving the way for further innovation in digital mobility solutions.

Chapter 9: Conclusion

The conclusion of this documentation marks the completion of the **ZedTurbo Bus Ticket Reservation Application**, a project designed to transform Zambia's traditional bus ticketing system. Upon evaluating the system's effectiveness in tackling the challenges identified, it is evident that ZedTurbo delivers significant improvements. The application successfully simplifies ticket booking, enhances transparency in pricing, and provides a secure digital platform, effectively addressing the inefficiencies faced by passengers and bus operators.

9.1: Limitations and Challenges

While ZedTurbo represents a significant improvement over traditional bus ticketing systems, it is important to acknowledge its limitations and potential challenges.

i) Challenges

- **User Trust:** Some passengers were hesitant about digital payments due to cybersecurity concerns.
- **Convincing older individuals to adopt:** Some passengers, particularly older generations or those unfamiliar with digital tools, may resist transitioning from physical ticketing to a mobile app.

ii) Limitations

- The application lacks the implementation of real-time and GPS tracking.
- For the payment gateway, Airtel, MTN Money, and "543 konse konse" company that handles transactions gave a verbal quotation consisting of the price ranges of integrating their gateway technology, which ranged from K6,000 to K11,000, depending on the type of system. Additionally, a lengthy process is involved in collecting the payment gateway API; hence, because of the duration of this project, it could not be implemented.

9.2: Possible Enhancements

To enhance ZedTurbo's functionality and adoption, the following improvements are suggested:

1. **Offline Mode:** Introduce limited functionality for users with poor internet access.
2. **A payment gateway** for the payments to be successful.
3. **Expanded Partnerships:** Collaborate with more bus operators to increase route coverage.

4. **Multi-Language Support:** Incorporate local languages (e.g., Bemba, Nyanja) to improve accessibility.


9.3: Summary of findings

The development of **ZedTurbo**, a bus ticket reservation mobile application, aimed to address the inefficiencies in Zambia's traditional bus ticketing system. Through extensive research, it was evident that manual ticketing processes lead to long queues, dishonest pricing, and inconvenience for passengers. The existing digital solutions in Zambia, such as the **UBZ mobile app**, are limited in scope, catering only to a specific bus operator, "UBZ".

Key findings from the research include:

- **Market Gap:** There is a demand for a centralized, user-friendly platform that aggregates multiple bus operators, allowing passengers to book tickets conveniently.
- **Passengers' struggles:** Passengers face challenges such as time wastage, lack of transparency in pricing, and difficulties in comparing bus services.
- **User Acceptance:** Survey responses indicated that **92.5% of respondents were unaware of existing bus ticketing apps**, highlighting an opportunity for ZedTurbo to fill this gap. Additionally, **84.9% of participants regularly use public buses**, reinforcing the need for a digital solution.

Supervisory Meeting Forms



**UNIVERSITY
OF
LUSAKA**

SUPERVISORY MEETING FORM

STUDENT NAME: MULIMA NCHIMUNYA MAINZA STUDENT ID: BIT21210446

SUPERVISOR NAME: Mr. Alex Nguni

DATE OF MEETING	ISSUES DISCUSSED AND ACTION AGREED	SUPERVISOR SIGNATURE	STUDENT SIGNATURE
25/09/24	Focused on chapter One of the Report. - Numbering to be revised - To start working on system.	<i>[Signature]</i>	<i>[Signature]</i>
16/10/24	Focused on chapter two. The problem statement must be clear enough.	<i>[Signature]</i>	<i>[Signature]</i>
30/10/24	Reviewed chapters 2 and 3.	<i>[Signature]</i>	<i>[Signature]</i>
6/11/24	- Add citations and expand information - Review the questions	<i>[Signature]</i>	<i>[Signature]</i>
7/11/24	Reviewed chapter 5 and advised to make corrections!	<i>[Signature]</i>	<i>[Signature]</i>
14/11/24	Student made corrections and showed good progress to this level.	<i>[Signature]</i>	<i>[Signature]</i>

Supervisor Comments: Student made good progress. She was consistent with attending meetings.

[Signature]
14/11/24

Figure 23: First Supervisory form

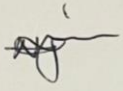
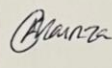
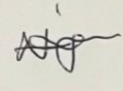
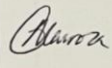
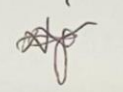
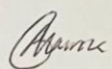
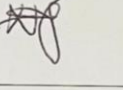
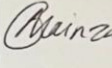
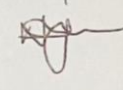
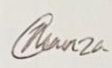
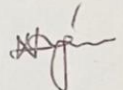
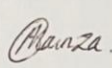


UNIVERSITY OF LUSAKA

SUPERVISORY MEETING FORM

STUDENT NAME: MULIMA MAINZA .N. STUDENT ID: BIT 21210446

SUPERVISOR NAME: R.R. ALEX NG'UNI

DATE OF MEETING	ISSUES DISCUSSED AND ACTION AGREED	SUPERVISOR SIGNATURE	STUDENT SIGNATURE
24 th March, 2025	Met for the first time to arrange days of meetings. Asked to work on chapter 6 & 7		
15 th April, 2025	Report Writing: Chapter 6 & 7. Was sent for review. Must review corrections pointed out.		
30 th April, 2025	System Demo was made. Chapters 8 & 9 were sent in for review. Student advised to make corrections		
6 th May, 2025	System demonstrated and suggestions were made for improvement		
14 th May, 2025	Demonstration of System. Suggestion made to have more test data		
16 th May, 2025	A complete research document was provided. Corrections were suggested after review.		

Supervisor Comments: The student was
consistent with meetings and a very
cooperative person!

Figure 24: Second Supervisory Form

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