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Design and Development of an Integrated Online Bus Ticketing System

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Abstract

Normally, bus tickets are purchased over respective counter of the bus terminal. With the rapid growth of electronic commerce (E-Commerce), it's emanate for this application to be designed and developed. The project addresses the design and development of an integrated online bus ticketing web and mobile application that will help both customers (passengers) and transport providers make ticket sales or purchases. The application will include ticket cancellation, ticket postponement and generation of a report on the end of the management. The Customers will have an option of printing out their ticket or not as they will be having it on a phone and downloaded as evidence of their ticket purchase. This project also addresses the problems such as illegal bus operations, long wait to purchase a bus

ticket, unsafe environment and many more. The project studies some issues on implementation and also recommendations on how Online Bus Ticketing System web application can take place effectively. This project also recommends a Decision Support System where it provides reliable choices to a customer to make decision. This project includes the development of a prototype an integrated Online Bus Ticketing System web application to support the research objective. This application will assist in future development that would support a fully integrated system that links staff of the bus company to customers, other mode of transport providers, and to government agencies. Dart (flutter) and firebase (database) are the programming tools used in development of this research project.

Keywords: Integrated, Online, Ticketing, Implementation, Dart and Bus Operator

1. Introduction

Transportation has long been hindered by a lack of efficient systems and facilities, making travel inconvenient. Public transportation has always been an essential mode of travel, evolving from months-long journeys with limited technology to modern systems that allow people to travel across the globe in hours. Online Bus Ticket Reservation Systems provide users with the ability to check ticket availability, purchase tickets, and make payments online, improving convenience and efficiency (Asaad *et al.*, 2012) ^[3]. Technological advancements, particularly the Internet of Things (IoT), have revolutionized how information is accessed and utilized. IoT-enabled devices, known as smart devices, can connect to the internet, allowing users to retrieve data from any location. This advancement has significantly reduced the time and effort required to obtain information, making web applications an essential tool for modern connectivity (Hasan, 2016) ^[10].

In today's digital era, consumers can book and validate transport tickets through mobile applications, further streamlining the ticketing process (Ceipidor *et al.*, 2013) ^[6]. The growing reliance on mobile devices over desktops and laptops has made smartphones an indispensable communication tool, offering convenience and accessibility anytime and anywhere (Meeker, 2015) ^[13]. In Ghana, for instance, mobile devices serve as the primary means of communication, as many individuals do not carry personal computers outside their workplaces (Jarad, 2014) ^[11]. Mobile phones and smartphones have thus become widely adopted for everyday tasks, including making travel reservations (Smith, 2016) ^[24].

The implementation of mobile-based booking systems has proven effective in developed and developing nations such as the United States, the UK, and India. In India, where tourism is a key economic driver, online booking systems have expanded the customer base for travel agencies, improving efficiency and revenue generation. Zambia, where paper-based ticketing is still prevalent, faces slow and time-consuming ticketing processes. Given that buses remain the primary mode of transportation, adopting modern technology for an integrated online ticketing system is essential to enhancing efficiency and reducing delays.

2. Problem Statement

The growing demand for an integrated online bus ticketing system has become essential in the transportation industry. The current fragmented and manual ticketing processes, limited availability of real-time information, and inconsistent user experience hinder passenger convenience and operational efficiency. To address these challenges, the objectives of an integrated system include offering a seamless booking process, providing real-time updates, ensuring secure automated ticketing, maintaining a consistent user experience, and integrating ancillary services to enhance passenger satisfaction. The implementation of data analytics and secure payment processing plays a critical role in improving system efficiency and security. Research by (Nwakanma *et al.* 2015) ^[16], (Vinayagamoorthy 2003) ^[25], and (Gwu 2021) ^[8] highlights the benefits of online ticketing systems in streamlining the bus reservation process, enhancing user experience, and fostering the growth of the bus transportation industry.

3. Objectives

3.1 General Objective

To design and implement an integrated Online Bus Ticketing System with an enhanced feature of payment via mobile gateways. The Specific objectives are: -

1. To design and develop a user interface for users to interact with the system.
2. To design and develop a database which will store users' data.
3. To develop individual modules.
4. To integrate developed units and test the system.

4. Literature Review

Studies highlight benefits such as reduced queuing times, improved payment security, and increased route optimization. Researchers emphasize the importance of user-friendly interfaces (Hasan, 2016) ^[10], real-time information (Abdullahi & Gummi, 2014) ^[1], and data analytics for informed decision-making (Rahman *et al.*, 2020) ^[20]. The literature study examines similar studies on current online bus ticketing systems, helping to understand how they operate. The main purpose of this review is to assess the processes related to designing and developing an Online Bus Ticketing System.

The application of the Internet in the business world has become a major trend in practice and has generated a hot stream of research in recent literature. The Internet, as a collection of interconnected computer networks, provides free exchange of information. As such, it has become a powerful channel for business marketing and communication (Palmer & Eriksen, 1999) ^[18], and for new business opportunities—often called "e-business" or "e-commerce" today (Schneider & Perry, 2001) ^[22].

A review will be conducted on transport agencies that have adopted online booking and reservation systems to assess their impact on businesses. The implementation of automated fare collection systems, or electronic ticketing, is already a reality in the Brazilian public transport market. About five years ago, experiences regarding this subject covered no more than 13 cities, with only five fully operating their electronic ticketing systems, while others had partially implemented them, had ongoing projects, or had interrupted operations (NTU, 1998) ^[15].

According to (Pedone 2001) ^[19], the widespread use of the Internet has led to the development of various electronic services, commonly known as e-services. One example is electronic tickets (e-tickets), which serve as proof of authorization for transportation, entry to destinations, or access to internet services. Customers can obtain e-tickets through web purchases, vendors, or transfers from other users. Non-transferable e-tickets, such as airline e-tickets, require validation to prevent duplication and ensure security. (Kaur and Singh 2007) ^[12] conducted research on the development of an online bus ticketing system, concluding that e-ticketing enhances the efficiency of report generation:

1. **Daily Sales Report** – The system administrator can generate reports by entering details such as departure date and bus number. This report provides a summary of daily sales for bus operators.
2. **Monthly Sales Report** – Administrators can generate reports showing total monthly sales for all buses under a particular operator.
3. **Cancellation Report** – The system generates cancellation reports to track and compare canceled reservations.

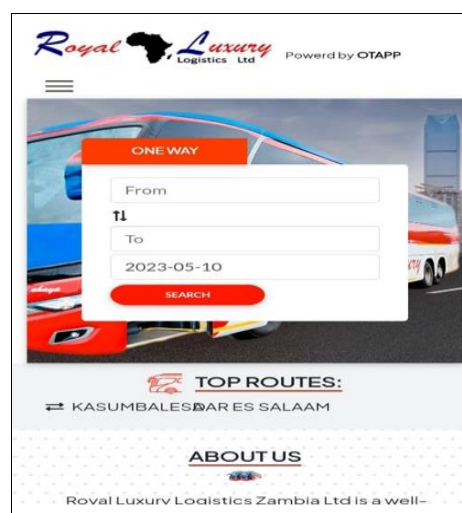
E-bus ticketing applications enable customers to select bus types, seating preferences, and pickup/drop-off locations, and provide multiple payment options (Oloyede *et al.*, 2014) ^[17].

According to (Mezghani 2008) ^[14], a consultant with the European Metropolitan Transport Authority (EMTA), the organization has established a working group to address electronic ticketing. This group is responsible for compiling knowledge, sharing experiences, and conducting research on electronic ticketing in public transport. EMTA has developed frameworks covering public transport pricing, ticketing systems, and electronic ticketing.

5. Works Related

5.1 Existing Systems

According (Banda. V 2021) ^[5] UBZ bus operators have the own web based application for running online bookings and reservation services. This system only works with UBZ bus, meaning the customer using this system has no choice of choosing any other bus like Likili, Power tools, Post Bus etc.

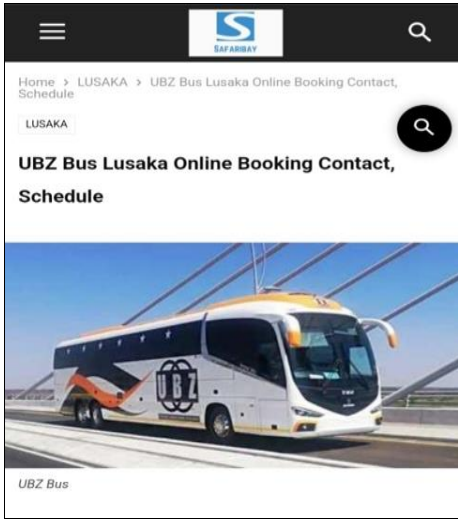


Source: ubzbusonlinebooking.com

Fig 1: UBZ bus Lusaka Online Booking System

This System limits customer in a way that once the customer misses a bus going to a given destination he or she has no other options if it's the only bus that goes to that underlined destination.

ROYAL LUXURY online bus booking System is also another system that only deals with Royal Luxury Buses. Having one integrated online bus ticket that has all these bus operators both those that have the System and those that are still using Manual system. These bus operators have built these systems independently. This means customers should have an account on each and every system which is cumbersome to other customer, but with an Integrated Online Bus Ticketing System a user is going to have only one account and be able to access any registered bus operator in the System (Banda, V., 2021) [5].



Source: royalluxuryonlinebooking.com

Fig 2: royal luxury online bus booking system

There some bus operator that are still using only manual ticketing system, quite a number of these bus operator has continued using manual ticketing System. According to (Banda. V 2021) [5] Customers must go to a specific location to get themselves booked for a ticket; thus bus ticketing in Zambia is still done manually. For each of these planned trips, management will also appoint a bus driver. The management provides standard tickets with the ticket serial number after the schedule is set. On the ticket for a specific journey, the destination and price are printed. The inception of DotCom Zambia Bus ticket and reservation system was initiated in September 2013 when members of staff of the DotCom Zambia Staff experienced the frustration of bus travel within Zambia first hand and felt there must be a better way to travel.

Table 1: Comparison between current Online Bus Ticketing System and an Integrated Online Bus Ticketing System

Current Online Bus Ticketing System	Integrated Online Bus Ticketing System
I. Customers create an account on every Bus operator's software.	Customers will only have to create one account and access any Bus Operators services.
II. Customers have to switching into different Bus Operator's software, looking for available Bus in their route.	Customers won't be switching to different software, because they will be using just one software to access any Bus operator services.
III. Not every Bus Operator has the same software.	The software will be open to every Bus operator.
IV. Limited market, only available to Customers that have an account on the specific software.	This software will create a wide market for Bus operator.
V. Bus Operators spend lots of money building their own software.	Bus Operators will spend less compared building a new software, because they will just be registering their Company in the System.

Source: Author,2024

Since the inception of DotCom Bus Ticket Zambia, the ticket and reservation system allows the general public to reserve, select their seats and pay for their bus travel via a number of methods: Online, Smart Phone, SMS, Public Computer Kiosk, Supermarket and any authorized third party location.

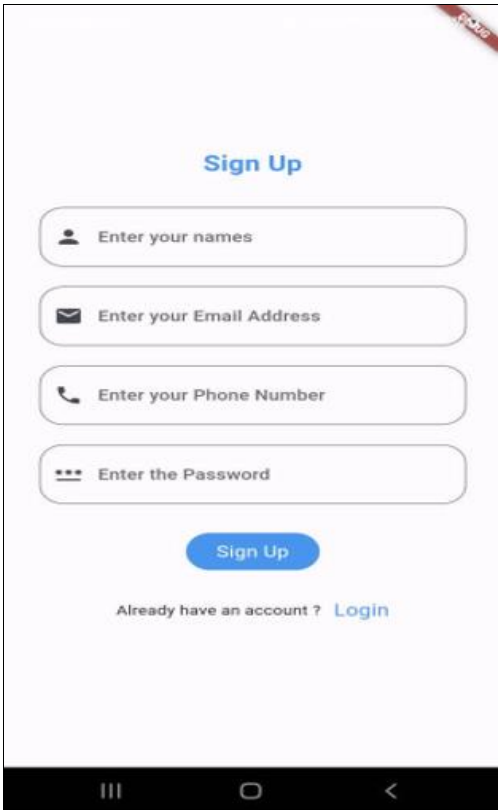
This is an all encompassed meta-search system meaning customers are not restricted to one Bus Company. Therefore, customers can still use their favorite bus companies.'

Drawbacks

The current Systems exist as entities for each bus operators, which proves as time wasting for Customers and in terms of marketing for Bus Operators it is disadvantaging, reason been the market is limited by the number of users registered under the Company's System. (Author, 2024)

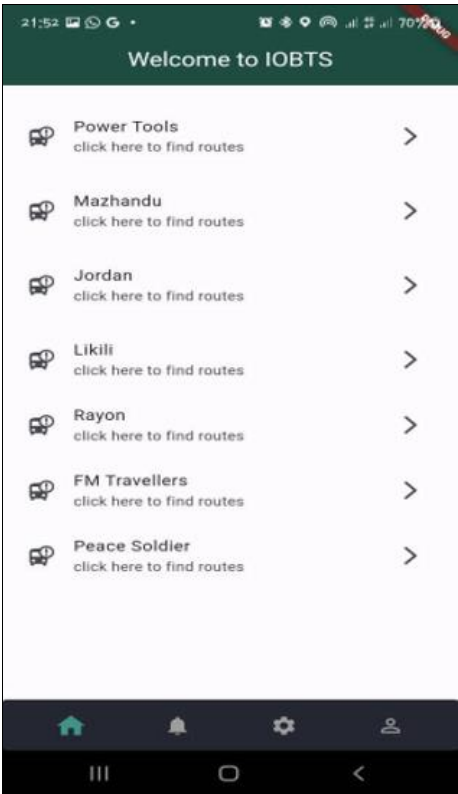
Proposed System

The system which we prefer to develop would not only help in generating e- tickets but also help bus operating Companies in terms of marketing strategy, decision making, auditing. Marketing to a large number of users unlike the existing system where Customers have to create an accounts on each different bus operator's systems. This System will integrate all existing bus operating systems to one system where both customers and bus operators can have one account each, which helps in system optimization and less use of resources.



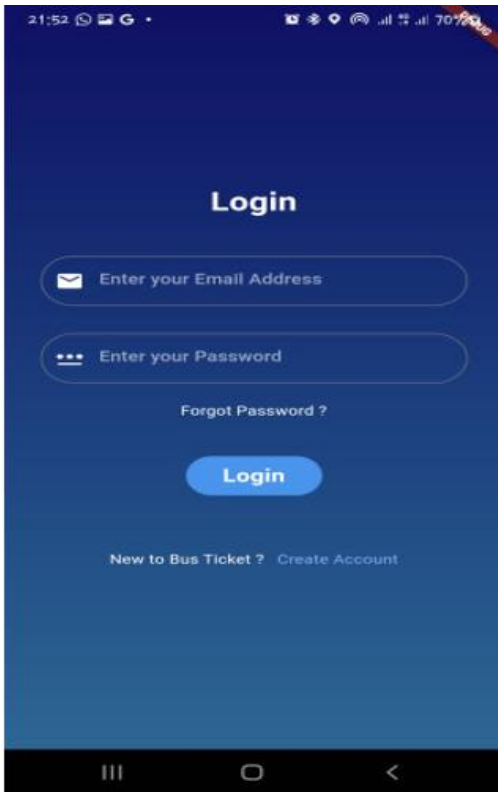
Source: Author, 2024

Fig 3: Show integrated systems



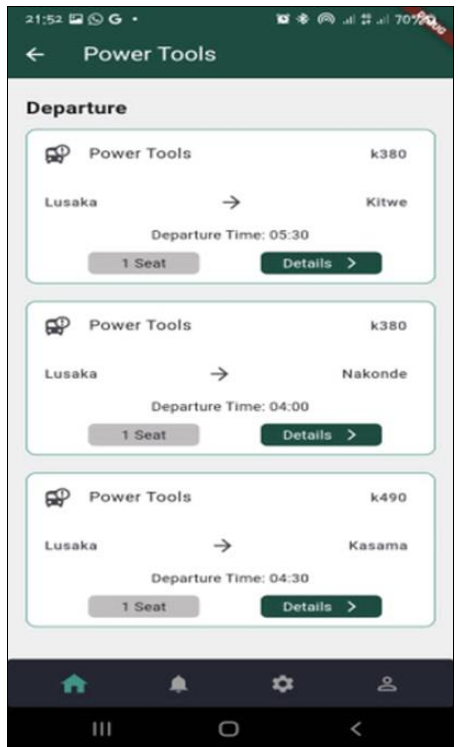
Source: Author, 2024

Fig 5: Shows an interface were a user has access to available Buses



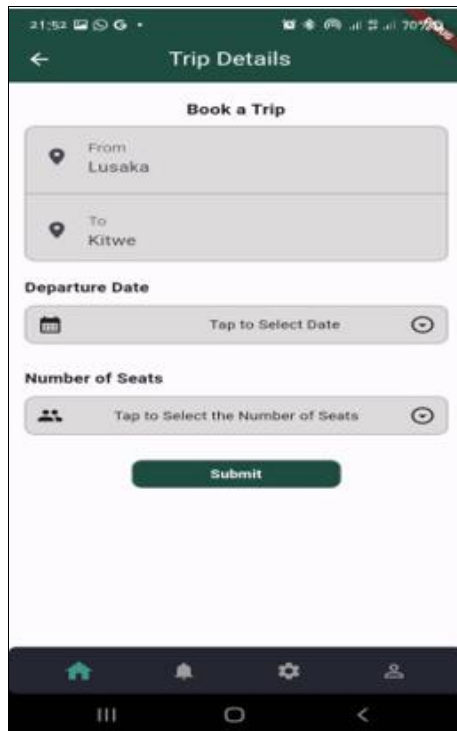
Source: Author, 2024

Fig 4: Shows an interface were a user can login into a system



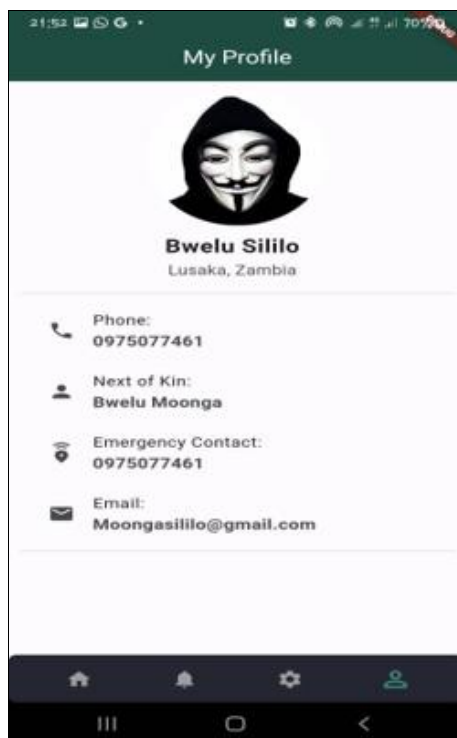
Source: Author, 2024

Fig 6: Shows an interface were a user selected one of the bus operators



Source: Author, 2024

Fig 7: Shows an interface with trip details before booking



Source: Author, 2024

Fig 8: Shows a user's profile

6. Methodology

This section discusses the methodologies used to develop an Integrated Online Bus Ticketing System. It describes the research design, data collection methods, sampling techniques, target population, and sample frame. Research methodology refers to the systematic process of collecting data for a research project, which can be conducted for either theoretical or practical purposes. For example, management research can be strategically conceptualized alongside operational planning methods and change

management. The information used in this study was gathered through oral interviews, as articulated by (Nwakanma *et al.* 2015) ^[16].

6.1 Exploratory Research Design

The primary aim of exploratory research is to identify and analyze challenges, gaining a comprehensive understanding of the subject. In contrast, conclusive research seeks to test specific hypotheses and establish relationships between variables. The current study focused on examining the characteristics of consumers, bus operators, and the market, making it a descriptive study within the conclusive research framework (Banda. V 2021) ^[5].

6.1.1 Sample Size

The respondents in this study included commuters, bus operators, students, and general internet users. Their insights were gathered to assess the effectiveness of existing ticketing systems used by most travel companies and to determine potential improvements.

6.1.2 Data Collection

Data collection techniques were chosen based on cost-effectiveness, efficiency, and reliability. This approach allowed for the collection of large sample data at a low cost while ensuring accurate and well-thought-out responses from participants. Some respondents preferred questionnaires over interviews, providing them with ample time to respond thoughtfully.

6.1.3 Ethical Considerations

As (Wang 2010) ^[26] noted, research often raises ethical concerns. Researchers must ensure that participants are treated fairly and that their data is used responsibly. While controlling ethical violations can be challenging, this study prioritized ethical considerations, including confidentiality, anonymity, and privacy. The questionnaire did not include sensitive topics or questions that could cause emotional distress. Additionally, all participants' identities remained protected to uphold ethical research standards.

6.1.4 Analysis

Non-functional requirements focus on system constraints, such as maximum user capacity, security, reliability, and scalability. A comprehensive analysis was conducted to understand how existing systems operate, informing the development of the proposed system. While documentation generated at this stage was not intended for end-users, it was utilized by analysts, researchers, and designers to create detailed system specifications. Consequently, bus operators, customers, administrators, and the general public were not required to review the documentation analysis for accuracy (Green *et al.*, 2021) ^[7].

6.1.5 Design

Design specifications provide explicit details about system requirements and how the components integrate. Design specifications have historically been used in public infrastructure projects and continue to be employed in system development. This approach ensures that the system meets customer needs by incorporating environmental considerations, dimensions, ergonomic elements, cost and maintenance, aesthetic factors, safety, quality, and documentation (Asaad *et al.*, 2013) ^[4].

7. Results and Discussion

The implementation phase of this system was less creative but more resource-intensive than system design. It was the longest and most expensive phase of the development process and included three key steps:

1. **System Construction** – The system was built and tested to ensure it met design specifications. Given the high cost of debugging, testing was prioritized over programming.
2. **Performance Measurement** – Key Performance Indicators (KPIs) such as conversion rates, booking success rates, and user satisfaction were tracked to assess system effectiveness.
3. **User Segmentation & Predictive Analysis** – Users were segmented based on booking frequency and route preferences, enabling targeted marketing and system optimization. Predictive analysis was employed to forecast demand, optimize ticket pricing, and allocate resources efficiently.

Additionally, user feedback and reviews were analyzed to enhance customer satisfaction. Security and fraud detection mechanisms were implemented to ensure transaction integrity. Establishing a feedback loop for continuous improvement ensures that the system evolves to meet user needs, fostering a user-centric online bus ticketing experience.

Possible Applications

The Integrated Online Bus Ticketing System offers several advantages:

1. **Passenger Convenience** – Users can book tickets from home or on the go, reducing the need for physical ticket counters and increasing ridership.
2. **Operational Efficiency** – Bus operators can manage schedules, passenger data, and financial transactions more effectively.
3. **Data-Driven Decision-Making** – Passenger data analytics can improve route planning and marketing strategies.

However, challenges include high initial investment costs, staff training requirements, and internet connectivity issues that may disrupt service.

According to (Anderson & Davis 2020) ^[2], online ticketing systems empower passengers to browse schedules, select seats, and make secure payments conveniently. This increased convenience encourages public transport usage, reducing private vehicle dependence and traffic congestion.

8. Conclusion

The Integrated Online Bus Ticketing System represents a transformative innovation that enhances both passenger experience and operational efficiency. By prioritizing user convenience, accessibility, and real-time communication, the system fosters trust and reliability among passengers. Additionally, data-driven insights help bus operators optimize fleet management and reduce costs.

Beyond efficiency, this system contributes to urban mobility and environmental sustainability by reducing traffic congestion and encouraging public transport adoption. Ultimately, an Integrated Online Bus Ticketing System is not just a technological advancement, it is a catalyst for change in the transportation industry.

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