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(AASTU)

COLLEGE OF ELECTRICAL AND MECHANICAL ENGINEERING
DEPARTMENT OF SOFTWARE ENGINEERING

Advanced Programming Project Documentation

Project Title: Public Transportation Management for Addis city

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Abstract

Public transportation plays a vital role in the functionality and sustainability of urban centers like Addis Ababa. However, even though the number of people in Ethiopia is increasing by the day, there is no digitized way of optimizing transportation systems to solve the problem of efficiency. The problem remains the same in that the available transportation buses aren't available in the right place at the right ti

me. This project aims to address this challenge by proposing a framework for enhancing public transportation, since most of the people in Addis Ababa are users of public transportation. To briefly mention some of the problems that can be solved, they are overcrowding, delays, and inefficient resource allocation (in our case, bus allocation.)

The main objective of this project is to develop an application that efficiently allocates buses by interpreting real time data from the city, hence solving the problems mentioned above.

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Chapter I : Introduction

Addis Ababa is known for its crowd. It is the most populated city in Ethiopia, and it makes sense, since it is the capital city of Ethiopia. In fact, we can say Addis Ababa is overpopulated. This project is undertaken to solve the problem every adult/person who uses transportation faces in his/her everyday life; that is, the lack of buses to accommodate this population. The problem might not even be the lack of buses; instead, it is the inefficient allocation of these buses that create this problem of delay and overcrowding.

We are motivated to take on this challenge to try to solve this problem because this issue is everywhere, daily, and everyone is affected by it. Solving this problem will not only bring personal satisfaction, but also improves the quality of life for Addis Ababa citizens, making Addis Ababa a civilized and ordered city instead of having queues for public transportation everywhere in the city.

The main objective of this project is to develop an application that solves the problem of delay and overcrowding. And specifically, it is also aimed at efficiently distributing the available resources in order to mitigate the current problems that are here because of inefficient resource allocation. The problem is going to be solved by developing an application that figures out the optimal solutions based on the available data, and this application will use famous algorithms like Dijkstra's algorithm to find the shortest distance from one point to another. This application is to be developed by using Java programming language.

The scope of this project is limited to Addis Ababa, and it will specifically be tailored to fit the city's geographical shape, location, traffic patterns, population density and other relevant things to consider when doing this project.

Chapter II: Background and Literature Review

Rapid Urban Growth and Infrastructure Strain

Addis Ababa, founded in 1887, has undergone a remarkable transformation, evolving from a modest city into a bustling metropolis. With a population exceeding 5.4 million and an annual growth rate of 4.46%, it ranks among the top ten cities in Sub-Saharan Africa. Serving as Ethiopia's capital, Addis Ababa acts as a financial and commercial hub, attracting businesses and industries. Moreover, it plays a pivotal role as a transport center, hosting international organizations such as the UNECA and the AU.



However, this rapid urbanization has placed significant strain on the city's infrastructure, particularly its public transportation system. The burgeoning population has outpaced the system's capacity to adapt, resulting in a pressing demand for efficient and accessible mobility options.

A Mix of Public Transport Options

Despite facing challenges, Addis Ababa offers a diverse range of public transportation choices to cater to various needs and budgets:

- **Anbessa Buses:** Operated by the city government, these buses provide a structured network with designated stops.
- **Mini bus:** Recognized for their iconic blue and white mini buses, mini bus offer flexibility and affordability, albeit being prone to overcrowding.
- **Midi Buses:** With higher capacity, these buses offer a more comfortable alternative on certain routes.
- **Saloon Taxis:** Privately owned vehicles that offer personalized service at a higher cost.
- **Walking:** Many residents rely on walking for short trips, making it a significant mode of travel.

While this diversity provides some flexibility, the current transportation system grapples with several limitations:

- Overcrowding: Existing infrastructure and vehicle capacity struggle to accommodate the growing number of commuters, resulting in congested buses and shuttles.
- Long Wait Times and Unreliable Schedules: Traffic congestion, stemming from inadequate planning practices, leads to delays and frustration among passengers.
- Limited Reach: Certain areas, particularly on the outskirts, lack proper access to public transportation, compelling residents to resort to private vehicles or endure long walks.

These limitations significantly impact residents' daily commutes, impeding their productivity and overall well-being.

Motivation for Further Research

Despite the presence of a public transportation system, Addis Ababa confronts substantial challenges in meeting the needs of its burgeoning population. Further research is imperative to devise and implement effective solutions that address the aforementioned limitations. This research aims to:

- Analyze data pertaining to ridership, traffic patterns, and infrastructure constraints.
- Identify specific areas for improvement within the existing system.
- Explore best practices adopted by other rapidly growing cities, tailoring them to the context of Addis Ababa.
- Develop a comprehensive plan to tackle issues related to capacity, efficiency, and accessibility.

By undertaking this research, we can contribute to the creation of a more efficient, accessible, and sustainable public transportation system for Addis Ababa. Such efforts will enhance residents' quality of life and facilitate smoother mobility of people and goods across the city.

Chapter III: Design and Implementation (Methodology)

Requirement Gathering Methods

The Methods we use for requirement gathering are:

1) Observation:

As students, we observe the current public transportation system in Addis City to understand its strengths, weaknesses, and areas for improvement.

- Method: We spend time at bus stops, terminals, and on public transportation routes, noting factors such as frequency of buses, passenger waiting times, vehicle conditions, and overall system efficiency.
- Purpose: Observations provide firsthand insights into the practical challenges faced by passengers and operators, guiding our understanding of requirements.

2) Discussion with Group Members:

We engage in group discussions with our project team members to brainstorm ideas, share observations, and analyze potential solutions.

- Method: Regular meetings are held where team members share their perspectives, discuss findings from observations, and collectively identify key requirements for the public transportation system.
- Purpose: Group discussions foster collaboration, allow for diverse viewpoints, and help refine requirements through collective input.

3) User Forms:

To gather specific feedback and preferences from users, we design forms with questions related to their experiences and expectations regarding public transportation.

- Method: Users are provided with digital forms containing structured questions about their commuting habits, preferences for routes, desired features, and pain points with the current system.
- Purpose: User forms enable us to collect structured data directly from stakeholders, helping to prioritize features and design solutions tailored to user needs and **since users**

can fill the form without exposing themselves this can be very important to express ideas freely.

4) Interviewing Others:

Apart from direct users, we conduct interviews with various stakeholders such as transportation authorities, drivers, and city planners.

- **Method:** Interviews are conducted through digital communication channels, where we ask targeted questions to gather insights and opinions on public transportation challenges and potential solutions.
- **Purpose:** Interviews provide valuable perspectives from different stakeholders, helping us understand broader issues and ensuring our solution aligns with the city's transportation goals.

The requirements which we gathered using different methods which are listed above are:

Functional Requirement

- **User Registration:** Allow users to register accounts to access the system.
- **Route Management:** Enable administrators to define and manage public transportation routes.
- **Schedule Management:** Provide functionality to create and manage bus schedules for each route.
- **Ticketing System:** Implement a ticketing system for passengers to purchase tickets online.
- **Fare Calculation:** Automatically calculate fares based on distance traveled and ticket type.
- **Passenger Information:** Display relevant information for passengers, such as Passenger id, schedules dates, and ticket prices.
- **Adding and Deleting bus on System based on their service time(age)**
- **Reporting System:** Generate reports on bus utilization, revenue, and passenger demographics for analysis.
- **Notifications:** Send notifications to users regarding route changes, delays, or cancellations.

Non-functional Requirements:

- **Performance:** Ensure the system can handle a large number of users and transactions efficiently.
- **Security:** Implement robust security measures to protect user data, such as encryption, authentication, and access control.

- **Scalability:** Design the system to scale horizontally and vertically to accommodate future growth in user base and data volume.
- **Usability:** Ensure the user interface is intuitive, responsive, and accessible for users of all levels of technical proficiency.
- **Compatibility:** Ensure compatibility with a wide range of devices and web browsers.
- **Data Integrity:** Guarantee the integrity and consistency of data stored in the MySQL database.

Mathematical analysis/derivations

Mathematical analyses and derivations for various aspects of PTS, including the number of cars, revenue generated by each car, number of passengers, number of drivers, and distance traveled by each car, can be shown as follows:

Number of Cars (C):

This can be determined based on factors demand, capacity, and frequency of service required. This can be done by simply counting the number of cars which can give service on each day and sum of each day till day 30/28 gives the number of cars in a month and sum of 12 months gives numbers of cars in a year.

Revenue Made by Each Car per Day :

Revenue made by each car per day can be calculated by multiplying the number of passengers and price of each ticket .Revenue Made by Each Car per Month:This can be calculated by summing up the revenue made by each car per day over the course of a month.

Number of Passengers per Day :

The number of passengers per day can be obtained from the number of tickets sold.

Number of Passengers per Month -This can be calculated by summing up the number of passengers carried by all cars per day over the course of a month.

Number of Drivers:

The number of drivers required can be determined based on the number of cars in operation, shift schedules, and legal requirements for maximum driving hours. Each car may require one or more drivers depending on factors such as operating hours and breaks.

Implementation

For implementation purposes we use language java(using javafx) and mysql for databases.

Procedures:

First of all, we assigned specific tasks to each group member, such as user registration for one member etc. After individual development, we integrate all components and test them for functionality and integration. Any issues identified were discussed collaboratively and resolved. Finally, we will prepare the system for deployment, gathering feedback from users and stakeholders to guide future improvements.

Chapter IV: Results and Discussions

- **Route Optimization:** it has led to reduction in travel time for passengers. Considering factors such as
 - ◆ Traffic congestion
 - ◆ Road condition
 - ◆ Passenger demand
- The system provides passengers with up-to-date information about bus schedules, routes, and any changes or disruptions.
- Reduction congestion: We optimize routes by avoiding route overlapping and managing high passenger flows is essential for an efficient transportation system.

We have full data about each Transport destination and stop stations but we take some of the samples for demonstration purposes and in order to manage them easily.

No	Departure/Stop	Stop/Departure	Price
1	Tulu Dimtu	Koye	5
2	Tulu Dimtu	Akaki	5
3	Koye	Goro	7
4	Akaki	Meksiko	10
5	Akaki	Koye	7
6	Goro	Megenagna	10
7	Meksiko	Megenagna	10

8	Megenagna	Lambert	5
9	Megenagna	Ayat	15
10	Lambert	Ayat	10
11	Megenagna	4-Kilo	7
12	Piyasa	Saris-Abo	10
13	Piyasa	6-kilo	10
14	6-Kilo	MeskelAdebabay	5
15	6-Kilo	Merkato	15
16	6-Kilo	Gemo	20
17	Gemo	Addisu_Gebeya	20
18	Gemo	MeskelAdebaaby	20
19	Addisu_Gebya	Merkato	10
20	Merkato	Piyasa	15

Conclusion

Our project intends to transform the manual transportation system into a digitized platform through the creation of a user-friendly app developed using Java programming language. By simplifying the booking process to just entering departure and destination points, we aim to save time and space while enhancing convenience for users. Since it is digital, it reduces potential threats like fraud and theft, thereby ensuring the integrity of both the system and user bank transactions. In addition to these benefits, our digital solution eliminates the need for a paper-based ticketing system, thereby contributing to environmental sustainability by reducing paper waste. Finally, optimized routes and schedules based on demand have reduced travel time.

Reference

- Public transport system of Addis Ababa city
- public service transport service (<https://www.psetse.gov.et/>)