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Implementation of a web application for managing public transport in the city of bunia (Democratic Republic of Congo)

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Abstract

Public transport is a fundamental driver of development in emerging cities, promoting population mobility and supporting economic activity. In Bunia, a city in the Ituri province of the Democratic Republic of Congo, public transport management remains largely manual, characterised by poor organisation, a lack of planning, and difficulties related to data archiving.

This situation is particularly evident within the Translux association, a major player in local urban transport. This article proposes the design and implementation of a web application to optimise the management of public transport operations.

The methodology adopted is based on needs analysis, UML modelling, development using PHP, and data management via MySQL. The results obtained show a significant improvement in the management of routes, reservations, vehicles, drivers, and fares, while reducing data entry errors and enhancing decision-making transparency.

Keywords: public transport, web application, information system, route management, digitalisation.

Introduction

Public transport plays an essential role in urban development, facilitating population mobility and contributing to economic activity. However, the effective management of this sector represents a major challenge, particularly due to population growth, increased traffic and logistical constraints. In

response to these challenges, the integration of a transport management information system appears to be an innovative solution for optimising operations, reducing delays and improving the user experience (World Bank, 2021).

Furthermore, the experience of certain African cities that have adopted similar solutions demonstrates significant gains in terms of efficiency and user satisfaction (African Development Bank, 2022).

This study therefore aims to identify and propose an IT system suitable for managing the Translux association's public transport system, highlighting the technologies and tools likely to improve coordination, profitability and user satisfaction.

Around the world, public transport plays a fundamental role in moving people, reducing congestion and lowering carbon footprints. Many major cities, including New York, London and Tokyo, have invested in intelligent management systems based on web and mobile applications, facilitating journey planning, pricing and passenger flow management.

Europe has been a pioneer in the adoption of public transport management technologies. Cities such as Paris, Berlin and Amsterdam have digital platforms that allow citizens to check timetables, book tickets online and access real-time traffic information. The integration of public transport with soft mobility solutions (bicycles, scooters) is also a priority.

In Africa, rapid urbanisation poses many transport challenges. Several initiatives have been launched to modernise the sector, notably in Nairobi with the Ma3Route app, which provides passengers with real-time traffic information. However, in many African cities, public transport remains poorly organised, making urban mobility difficult.

In the Democratic Republic of Congo, public transport is largely informal, dominated by taxis, motorcycle taxis and private buses. In Kinshasa, some attempts at modernisation have been made. However, in cities such as Bunia, public transport management remains archaic, characterised by weak regulation and a lack of digital solutions to improve traffic flow.

The city of Bunia is experiencing rapid population growth, leading to a significant increase in demand for public transport. However, the lack of a structured management system creates several difficulties, including the absence of fixed timetables and clearly defined stops, difficulty in accessing information for passengers, variable and sometimes arbitrary pricing, and poor coordination between different modes of transport. This raises the following question: what IT solution can be used to optimise public transport management in the city of Bunia?

To carry out this work, we used the *Unified Process* (UP) method, which is a software design and development process. This method offers a disciplined approach that allows tasks and responsibilities to be clearly assigned within a development organisation. The study is structured around five points: the first deals with the research hypothesis, in which we provide an answer to the question raised; the second focuses on a review of the theoretical literature and a summary of related work; the third presents the method, techniques and modelling of the new system; the fourth presents the results obtained; and the last point is devoted to discussing the results based on similar work.

1 Literature review

1.1 Synthesis of work

We do not claim to be the first to address a subject related to transport management systems, as many researchers have preceded us. That is why it is important and necessary to consult the work of those who have already presented their ideas in the scientific field, in order to benefit from them, avoid certain mistakes and not overlook useful advances. To this end, previous work provides a valuable safeguard for our study. In particular, we have:

- Digitalisation of public transport in African cities

According to Okuna (2012), the integration of digital technologies into African transport management is a key factor in improving urban mobility. particular, the author highlights the importance of digital devices that can disseminate real-time information on traffic, routes and traffic conditions. Using the example of the Ma3Route application developed in Nairobi, he demonstrates that participatory collection of road data helps to reduce congestion and optimises decision-making for users.

Although this approach is relevant, it focuses primarily on road information rather than on a comprehensive management architecture for journeys, drivers, bookings or vehicles.

- Structured management of stations and passenger flows: contributions from Kouadio (2021)

Kouadio (2021) highlights the challenges encountered at bus stations in Abidjan, where manual management of arrivals and departures leads to delays, financial losses and general disorganisation. The author proposes a computerised system

for scheduling, organising bookings and centralising operations. His contribution demonstrates that automation provides greater visibility and reduces operational errors.

However, his approach remains focused on metropolitan bus stations and does not take into account semi-urban realities, such as those observed in the city of Bunia.

- Modernisation and structuring of urban transport in the DRC: the METROKIN project

Luluka and Kayembe (2022) present a study on the evolution of urban transport in Kinshasa, notably through the METROKIN initiative aimed at creating dedicated corridors and integrating electronic ticketing into urban buses. Their analysis reveals that digitalisation is a key driver for reducing congestion, improving service quality and providing reliable data for strategic planning.

Although this project is innovative, it mainly concerns large cities with more developed infrastructure than that found in Bunia.

- Web-based information systems and operations management

Several studies emphasise the importance of information systems in operational management. According to Díaz and Pérez (2019), a web-based information system makes it possible to structure data, improve internal communication, automate repetitive tasks and produce reliable reports that facilitate decision-making. The authors point out that web technologies offer accessibility and flexibility suited to organisations with limited resources.

Similarly, Mboma (2020) emphasises that web platforms based on client-server architecture facilitate data reliability, user coordination and information security. He argues that digitalisation is a strategic lever for organisations faced with dispersed and decentralised management.

Analysis of previous work shows that:

- Okuna (2012) focuses on road information and traffic;
- Kouadio (2021) proposes a structure for stations, but in a dense urban context;
- Luluka and Kayembe (2022) work on heavy infrastructure adapted to large metropolitan areas;
- Díaz, Pérez (2019) and Mboma (2020) demonstrate the relevance of web-based information systems for organisational management.

This study stands out for:

✔ An integrated approach covering journey management, bookings, drivers, vehicles and pricing;

✔ A web solution fully adapted to the semi-urban context of Bunia;

✔ Comprehensive development including UML modelling, client-server architecture and MySQL database;

✔ A contribution to the digitalisation of public transport in the growing cities of the DRC.

This literature review thus clearly highlights the added value of our work in the scientific field.

1.2 Theoretical literature review

The conceptual framework of this study is based on the following main concepts:

- **Public transport**

Public transport refers to all services organised to enable the collective mobility of populations within an urban or interurban area. In the context of Bunia, it mainly includes minibuses, private buses and community transport vehicles managed by associations such as Translux. (https://fr.wikipedia.org/wiki/Transport_public)

- **Information system**

According to Laudon (2018), an information system is an organised set of human, material, software and procedural resources used to collect, process, store and disseminate information.

- **Web application**

A web application is a platform accessible via the Internet or an internal network, allowing multiple users to interact simultaneously with a centralised system. This type of application is particularly suitable for organisations with dispersed teams, thin clients and continuous accessibility requirements. (DRAJIMA T. 2019:19)

- **UML modelling**

UML (Unified Modelling Language) is a standard modelling language used to graphically represent the structure and functioning of a system. It allows requirements, user interactions and system architecture to be formalised prior to development.

- **Digitalisation**

Digitalisation refers to the use of digital technologies to transform and optimise processes. In this study, it concerns the

transformation of traditional public transport management to an automated and centralised management mode.

- **Client-server architecture**

This IT model is based on communication between a client (user interface) and a server (database, business logic). It enables clear organisation, easier maintenance and better performance.

2 Method, techniques, modelling

2.1 Method

As any lesson is only as good as its preparation, scientific work is also judged by the value of the methods and techniques used in its development. Therefore, to carry out this work, we will mainly use the UP method to modernise our application using the UML language.

2.2 Techniques used

Interview technique: This technique enabled us to talk to managers and drivers at the Translux association to better understand their public transport management needs and the challenges they face in organising and planning journeys.

Documentary technique: This technique involved consulting specialist books, research articles and online resources on transport management systems, as well as UML methodologies and web application development technologies.

Observation technique: Field observation of Translux's daily operations provided information on existing processes and identified weaknesses that could be improved by the application.

2.3 Modelling

a. Use case diagram

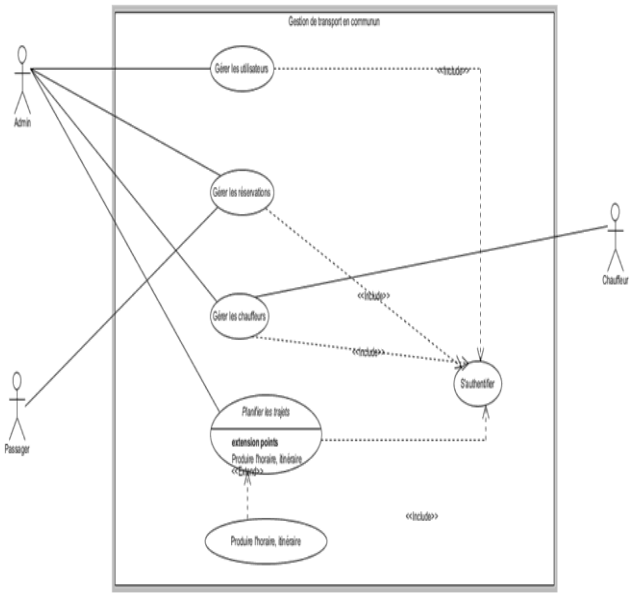

Figure 1 : Use case diagram

Source: Our design based on the Visual Paradigm tool

This figure shows the impact of each actor in our information system

b. Activity diagram

- **Activity: "Authenticate"**

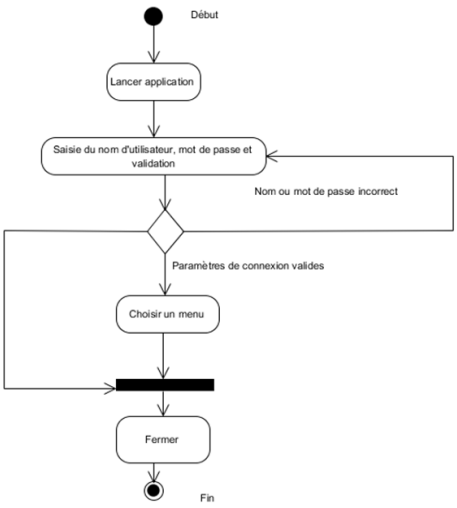

Figure 2 : "Authenticate" activity diagram

Source: Our design based on the Visual Paradigm tool

This activity diagram shows the chronology of operations for authentication

- **"Manage users" activity**

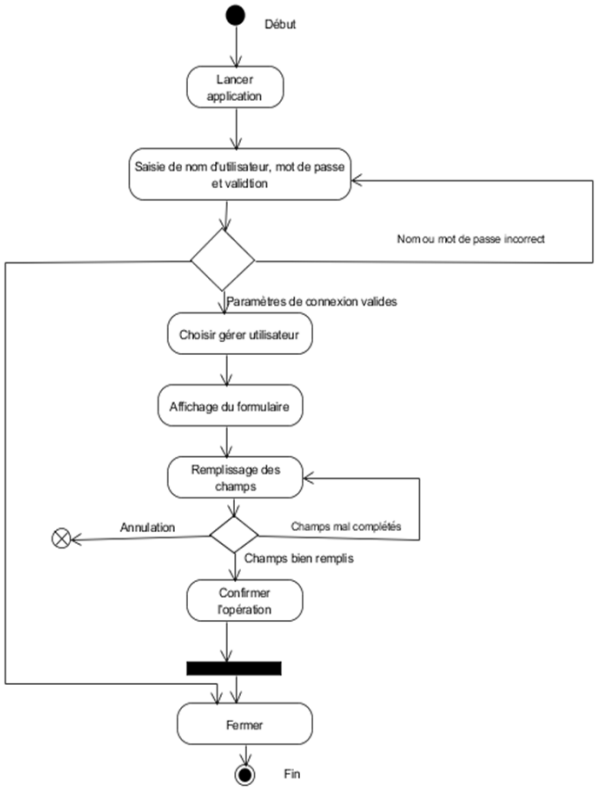

Figure 3 : "Manage users" activity diagram

Source: Our design based on the Visual Paradigm tool

This activity diagram shows us the chronology of operations for managing users

c. Sequence diagram

- **"Authenticate" sequence**

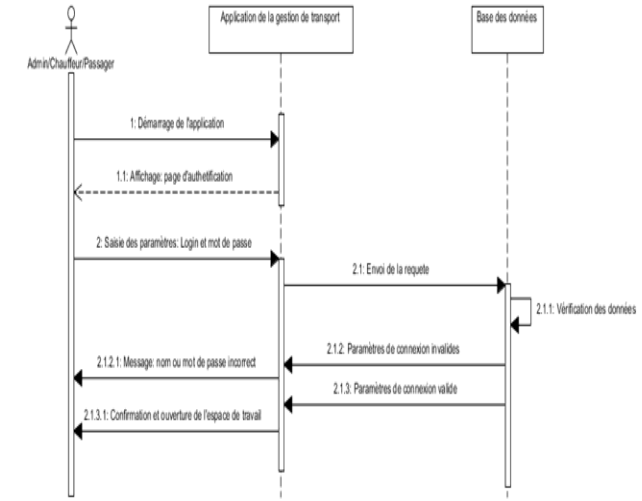

Figure 4 : "Authenticate" sequence diagram

Source: Our design based on the Visual Paradigm tool

- **"Manage users" sequence**

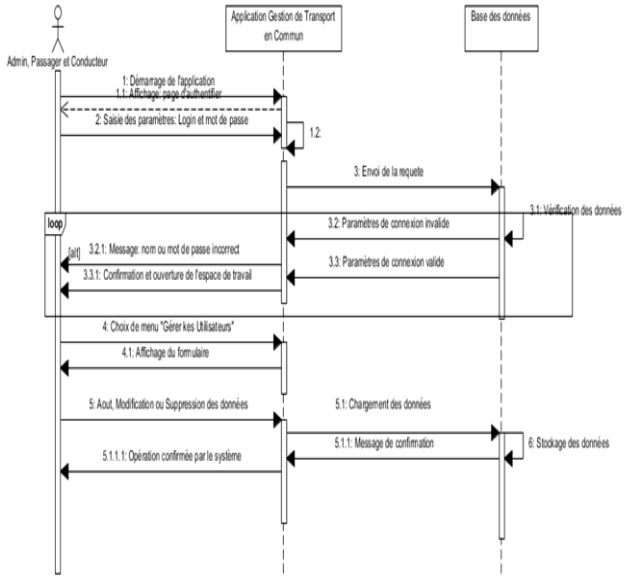

Figure 5 : "Manage users" sequence diagram

Source: Our design based on the Visual Paradigm tool

d. Class diagram

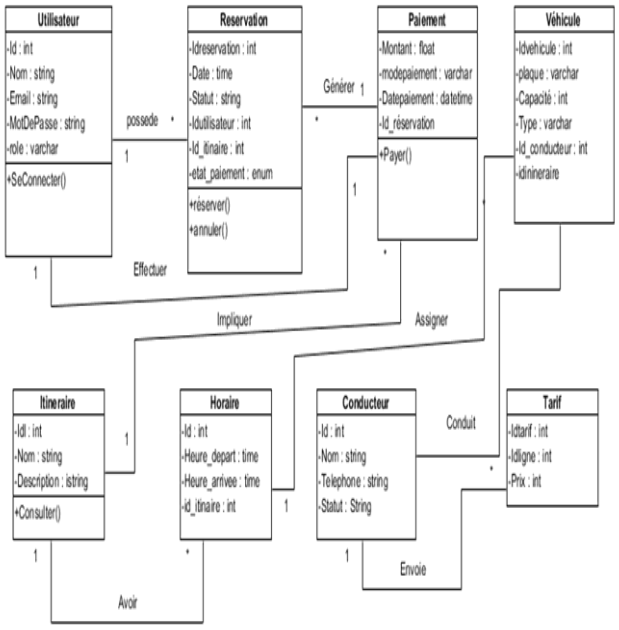

Figure 6 : Class diagram

Source: Our design using the Visual Paradigm tool

In this class diagram, we show the links between our entities

2.4 Relational table diagram

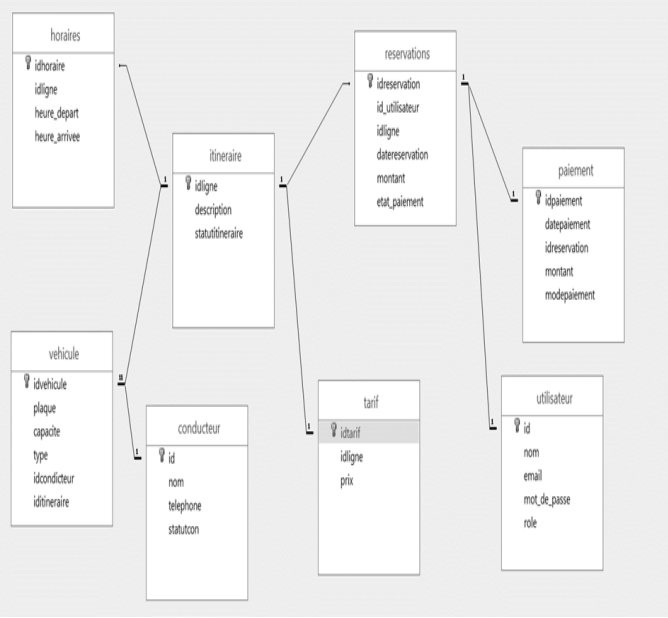

Figure 7 : Physical Data Model

Source: Our design based on Access

This figure represents our physical data model, i.e. how our tables will be structured in our system.

3 Results

3.1 Home

Figure 8 : System home page

Source: Testing the web application on the local machine, Chrome browser

This image shows the home page for our transport management web application

3.2 User registration page

Figure 9 : User registration form

Source: Testing the web application on a local machine, Chrome browser

On this page, we show the interface for registering new users in the system

3.3 User dashboard

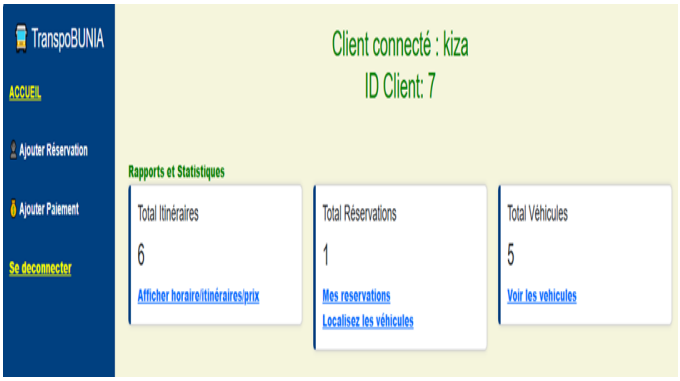

Figure 10 : User dashboard

Source: Testing the web application on a local machine, Chrome browser

On this page, we show the user dashboard in the system

3.4 Admin session interface

Figure 11 : System admin session interface

Source: Testing the web application on a local machine, Chrome browser

On this page, we show the admin session interface in the system

3.5 Vehicle addition page

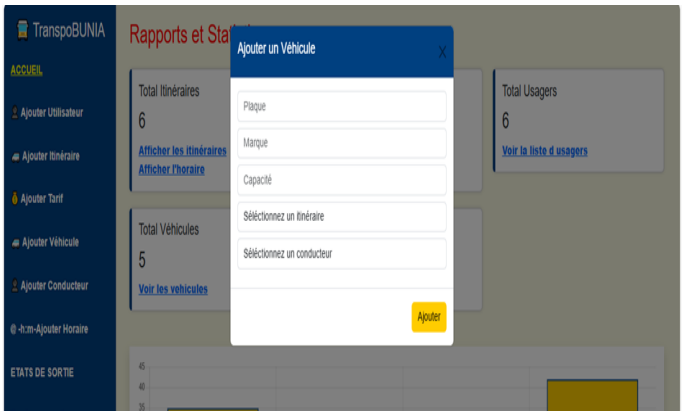

Figure12 : Vehicle addition form

Source: Testing the web application on a local machine, Chrome browser

On this page, we show the form for adding a vehicle by admin in the system

4 Discussion of results

The web application we have created provides a real solution to these problems. With its client/server system, it makes Translux's public transport management simpler, faster and more centralised.

Thanks to this platform, passengers can:

- Consult timetables and routes for available journeys;
- Book a vehicle remotely via an online form;
- Receive a booking confirmation and an automatically generated receipt.

Administrators, meanwhile, benefit from a secure dashboard that allows them to:

- Manage user accounts (drivers and passengers);
- Plan journeys and assign vehicles;
- Track bookings in real time;
- Produce output reports such as pricing sheets, timetables, or booking reports.

In short, this new computerised system enhances transparency, efficiency and coordination between the various stakeholders in public transport. It significantly reduces the margin for error and facilitates decision-making. This progress is not intended to abruptly replace the old system, but to gradually correct its shortcomings.

In light of previous work in the field of digital transport management, our project is part of a modernisation process adapted to the local context of the city of Bunia.

- (Okuna, 2012) Has implemented a mobile and web application that allows users to report and view real-time traffic conditions through crowdsourcing. This system has helped to improve mobility and road safety in Nairobi, but it remains focused primarily on traffic and road incidents.
- (Kaouadio, 2021) Proposed a platform for managing passenger flows in bus stations in order to reduce organisational chaos and financial losses. This work emphasises the need to digitise booking and planning processes, but is essentially limited to managing flows in stations.
- (Luluka, 2022) Highlighted the importance of modernising urban transport through a dedicated transport system (DTS), supported by digital regulation and electronic ticketing tools. Although relevant for a large metropolis, this project is more focused on the implementation of heavy infrastructure than on the day-to-day management of transport services.

Compared to these solutions, our application offers a web platform adapted to the semi-urban context of Bunia, with features tailored to local realities: online booking, route planning, driver management, standardised pricing and automatic receipt generation.

In view of the results obtained, it is clear that our initial hypothesis has been verified: the implementation of a web application effectively optimises the management of public transport in the city of Bunia. It improves not only the quality of service provided to users, but also the organisational efficiency of the Translux association.

Conclusion

Having reached the end of our research on the topic "Implementation of a web application for public transport management in the city of Bunia: the case of the Translux association", we first noted the absence of a structured public transport management system in the city. This situation led to several problems: a lack of reliable information for passengers, no fixed timetables, arbitrary pricing, poor coordination of routes and a limited ability to produce reports or plan journeys effectively.

These shortcomings motivated our research question: what IT system can be put in place to optimise public transport management in the city of Bunia within the Translux association?

To answer this question, we formulated the hypothesis that the implementation of a web-based management application would improve the efficiency, transparency and coordination of public transport in Bunia.

Our main objective was to design a web application adapted to the local context, capable of automating transport management tasks: route planning, passenger reservations, driver and vehicle management, timetable display and pricing. More specifically, this application had to offer a user-friendly interface, guarantee data security via an authentication system, and produce useful documents such as booking receipts, timetables, and pricing reports.

To do this, we used the UML method for system analysis and modelling, as well as observation, interviews and document consultation techniques to collect data. We then designed and implemented an application based on a client-server architecture, developed with HTML, CSS, PHP and SQL technologies, and tested in a WAMP environment.

Ultimately, our work enabled us to achieve the objectives set and validate our initial hypothesis. The application developed meets the needs of the Translux association, while paving the way for better organisation of public transport in the city of Bunia.

However, we remain aware that this work, like any human endeavour, is not without its limitations, particularly with regard to mobile extension, real-time incident management and online payment integration. These aspects constitute areas for future improvement, which may be explored by other researchers or developers wishing to delve deeper into this issue.

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