Passengers Crowd Management System in Kigali

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A safe and effective transportation system is a key factor for national development. To achieve sustainable development goals, technology needs to be used in transportation sector. The authors noticed that the country economy is affected by some factors such as the time wasted by passengers on long queue waiting for the bus to come. Also, the mass gathering contribute in a rapid spread of COVID-19 among passengers. In this study, an effective system for booking bus ticket and tracking bus location was developed. The system uses web-based application that allows the user to check the bus availability, its location and pay ticket on line. The system was developed using ESP8266 a WiFi based microcontroller to provide communication between bus officials and clients, GPS for tracking bus location, LCD for displaying the availability of passengers on a particular bus station, bus official application for receiving the client request and client application for service request and make a follow up. The study was achieved by presenting system circuit diagram and process flow chart. Also, implementation of a physical prototype linked with developed web applications was done. The system enables passenger to easily track the bus location in its real time position, to save time for manual reservation of bus ticket. The passenger crowd management system (PCMS) is secured and can be used by administrator (companies) of buses due to its efficiency in monitoring both buses and passengers.

KEYWORDS: Transportation, Web-based application, Bus tracking, Ticket reservation, Crowd

Introduction

Transportation is currently on a fast development in Rwanda and other countries and is the key important in the sustainable development of the country. With goals set by the government of Rwanda in its 2050 vision, the use of technology in this sector is very important. Due to its crucial contribution in the economic development, with critical moment of COVID-19 pandemic in the world an excellent technology is needed to avoid crowd which is the most way causing the spread of the corona virus and save time taken by passengers to manually book their bus tickets. This system helps the passenger to easily book an online bus ticket by simply applying it via the installed application in his/her smart mobile phone and make an online payment of the ticket.

From the data provided by many researchers about bus management showed that transportation system is the main key development of a country (Guide, 2016). Therefore, it is very indispensible to develop a system that managed the crowd of passengers thereby provide reference in management and monitoring both buses and passengers.

In this paper, a web-based application was used to develop the PCMS. The PCMS consists of an ESP8266 a WiFi based microcontroller to provide communication between bus officials and clients, GPS for tracking bus location, LCD for displaying the availability of passengers on a particular bus station, bus official application for receiving the client request and client application for service request and make a follow up and focused on the implementation of an effective web-based system for online booking a bus ticket and tracking bus location from an installed GPS in the bus linked with smart mobile phone from nearest bus station.

Section II outlines the online bus ticket booking system. Section III describes the bus tracking system. Section IV explains and presents the system architecture. Section V describes the software design. Section VI shows the results and discussion.

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The conclusion is devoted in Section VII.

Online Bus Ticket Booking System

The bus ticket booking, this is a process where a passenger book and pay for his/her own ticket via a web portal. The manual reservation of ticket presented difficulties, the client has to pay cash, book the ticket via a busy phone call and ask for schedule (Alaya, 2014). The manual system required the client to go to the bus agencies to buy the tickets and had to take a long queue including lot of time spent in waiting to be served whereas the online bus ticket booking system enabled him/her to only apply it from home, office, everywhere respectively. In (Nwakanma et al., 2015) a system that enabled the customer to easily buy, pay ticket and inquire online any information was developed, the system allowed also the staff agencies to check the availability of the bus ticket to sell and print it for the client. Various researches on RFID based automated bus ticket system were also carried out (Shah et al., 2020).

Bus Tracking System

Nowadays, global position system (GPS) is mostly used as a tracking system that provides position location tracking in finding the nearby bus. The GPS also gives longitude, latitude and altitude position, it consists of the network of various satellites (Karthikeyan & Jawahar, 2018). In the location tracking, the Web servers can also be used to interpret the data received from the GPS (Jain et al., 2019). As reviewed in (Jain et al., 2019) for location tracking, Google maps is also used, it can provide satellite image, maps, route planning for traveling by foot, car, bicycle and any public transportation and a GPS application that can accurately track the school buses was developed. In (Jain et al., 2019) discussed about the technique that provides accuracy of the location which is the Kalman filter algorithm and reduces 66% of the location estimation error. In (Singla, 2015) they developed a system that enables clients to track bus information by means of LEDs at bus stops, Android application or web application and SMS, if the Android application is used as the bus tracking system the GPS is inbuilt system in the smartphone. In (Shah et al., 2020) they suggested passenger tracking system based on GPS and GSM, the system tracks the passengers by means of ticket number thereby displays location on Google map. Bus tracking system based on notification was developed in (Lambade et al., 2020), displayed precisely the speed, time and location of bus. (Sridevi et al., 2017) implemented a system that can track the bus and collects the information of the bus as the distance to each bus station along its route. (Mustapha et al., 2010) developed a system that accurately monitor the movement of campus bus and provide its real time position using RFID and GIS.

System Architecture

1. Block diagram

The system uses ESP8266 NodemCu which is a WiFi based microcontroller unit. All components (GPS, LCD, buzzer and LED) are connected to ESP8266. In otherwords ESP8266 holds programming data in its memory which helps to receive data from input devices as (GPS client booked ID) and gives Output to the Output devices. ESP8266 communicates with client App and company App via server, because when a client books a ticket, the ESP8266 receives a notification from company App. This notification message helps the driver to know the exact station at which clients stand. LED is ON while GPS got satellite and buzzer beeps to notify the driver that there is client whom booked a ticket on bus station ahead. Client App links clients whom made online bus booking to server and the bus for tracking the bus's location. Company App provides travelling schedule to the client App and receives the booking station from client app and then communicates to ESP8266. Server links client, company and vehicle. Client App is installed in Android mobile. Figure 1. shows the block diagram of PCMS.

2. Flow chart

Steps given in Figure 2. below explains about system working procedures.

- **Step1**: Bus station declaration. We declare the bus station in programming according to the travelling line via programming
- **Step2**: Configure global positioning system to get satellite
- **Step3**: Configure ESP8266 NodemCu to server via bus Wi-Fi for communicating with web-based application
- **Step4**: While the GPS gets satellite, the LED turns ON immediately. Otherwise LED is turned OFF
- **Step5**: GPS prints the location (latitude and longitude) of
where the bus/vehicle is located.

**Step 6:** Monitor the location on Display

**Step 7:** If ESP8266 NodemCu gets booked id of passengers and when vehicle is going to reach nearby the station, the display in vehicle prints text to alert the driver that must take the client on the station ahead and the buzzer beeps.

**Step 8:** GPS gets the distance and location of the booked station.

**Step 9:** ESP8266 sends message before one hour to the client before vehicle is departed from the taxi park to show him/her the bus is going to depart from taxi park.

**Step 10:** If there is not booked id received by the ESP8266,
the buzzer is OFF and display will only monitor the latitude and longitude of where the bus is located.

Steps given in Figure 3. below describes the algorithm for web-based application

Step1: To input vehicle travelling schedule in database. The vehicles list is entered in database by using their plate number and the line in which vehicle is supposed to travel

Step2: Database gets the vehicle travelling schedule

Step3: Sends vehicle travelling schedule to server

Step4: Server sends travelling schedule to client application

Step5: Client chooses the bus he/she want to travel.

Step6: Fill book ticket options and sends to company application via server.

Step7: Client gets the remaining places available in vehicle.

Step8: Client gets link to pay travelling fees.

Step9: while the client pays travelling fees he/she will receive unique address.

Step10: Check time in booked options.

Step11: Company application sends vehicle tracking links to the clients for every 5 minutes.

Step12: if server is failed to get the vehicle travelling schedule, the message to alert you will appear.

Software Design

The web-based application is developed in Herpertext markup language (HTML), PHP, CSS and MySQL for data managements to facilitate both client and the bus owners for
booking activities for both users of the system, for clients sides, it helps them to book the available bus in the system, which generates in turn the payment ID that is used in payment process via the integration of telecommunication company, the bus owners now accept the payment by generating the automatic message for payment approval. The following Figure 4 shows the homepage of the system that used by the users to book their tickets. This system is linked to hardware components ESP8266, GPS, LCD, LED and buzzer for assuring all proposed functions are included.

The Figure 5. below shows the page whereby the customers after logging in, they are able to book the tickets at any particular route, the price and destination are already stored in database to facilitate the system to operate accurately.

The bus booking system owners are responsible to enter the availability of the the bus with the specific routes, once these

### Figure 4. Homepage of the system

![Homepage of the system](image)

### Figure 5. Customer booking page

![Customer booking page](image)
route are added, it displays on customers side for their choice depends on their destination. Figure 6 describes the bus availability page.

Figure 7 represents the summary report of everyday activities is daily recorded and is generated from the system and helps the users to keep tracking on events logs, once the passengers are booked she/he waits to receive the link through short message service containing the latitude and longitude, the user of the system use these location to track the bus from source to the station where the passengers wait for the bus.

Results and Discussion

In this way, the proposed system allows the bus owners to make their services available online and being accessed by their clients without waiting the bus on long queue, it is linked
to hardware devices to help the user to monitor the bus from bus parking to different stations until the destination, the use of GPS and ESP8266 helps to send link to clients who has made the booking and enables them to acquire realtime information about the bus they are booked. The implemented prototype work perfectly and has proven that it decreases the crowd during the bus waiting process.

Conclusion

In this research paper, the PCMS was developed and it enables the client/passenger to book the bus ticket and track the available bus at its real time position and pay his/her own bus ticket via cashless method. The Web-application was used for both client and administrator/bus agencies and developed in PHP, HTML, CSS, and MySQL for storing the data needed by both clients and Vehicle owners. The results showed that the system is faster and secured in operation. Furthermore, it is limited to the fact that it needs to be triggered at certain interval of time which is settled in scripting language to give the update to their clients, this implies some charges of the system to the bus owners and it requires the client to be connected on internet for location further studies can be made to address those challenges of communication.

References