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Development of an Advanced Public Transportation System for captive commuters on urban arterials in Ilorin, Nigeria

Oluwafemi O. Adeleke *, Yinusa Alaro Jimoh, Mutiu A. Akinpelu

Department of Civil Engineering, University of Ilorin, PMB 1515, Ilorin, Nigeria

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Advanced Public Transportation System
Automated Trip Scheduling
Digital Geographic Database

Abstract The study developed an Advanced Public Transportation System (APTS) software package that serves as an intelligent movement system for captive commuters. Although a typical APTS has an Automated Trip Scheduling System (ATSS), a Digital Geographic Database (DGD), and an Automated Vehicle Location Equipment (AVLE) as subsystems, the fact that vehicles in the study area are not equipped with AVLE made the authors to design for an APTS that has only the ATSS and DGD components. The ATSS subsystem has the specific objectives of reducing commuters waiting time at bus terminals, automating trip booking thus assuring a passenger of the availability of a bus and also keeps an inventory of passengers and trips made by commuters and the vehicles. The DGD allows maps of the service area to be displayed to the scheduler/operator and the commuters/clients on computer screen. The Ilorin metropolis a typical urban center in Nigeria, a developing economy, is used as the study area. Nigeria stands to benefit from ITS potentials if the developed package is put to use by urban transit operators.

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1. Introduction

The transportation challenges experienced in most Nigerian urban centers include traffic congestion, inadequate provision

of carriers for commuters in quantity and timeliness, poor traffic management, poor condition of roads, attitudinal behavior of drivers, among others. The situation calls for a very strong push by all stakeholders in the transportation sector to enhance the service performance of transportation facilities using Intelligent Transportation System (ITS). A study [1] enumerated the hindrances militating against Nigeria in benefiting from ITS potentials to include low level or total absence of either in-vehicle or facility based navigation systems, electronic sensors, traffic surveillance and control, information gathering and communication as well as traffic analytical computer hardware and software. Finance and skilled manpower are the other important factors identified. The authors were however

* Corresponding author. Tel.: +234 8060812278.

E-mail addresses: victorsgate@yahoo.com (O.O. Adeleke), dryajimoh@yahoo.com (Y.A. Jimoh).

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of the opinion that considering the level of technological and technical (manpower) capability and potentials of Nigeria, the country can begin to benefit from the innovative ITS especially in the aspects relating to the Pre-trip Travel Information, Route Guidance and Travelers Information subsystems and hence advocated for government and private sector driven policies toward this objective. This paper reports a software package developed for Advanced Public Transportation System.

Advanced Public Transportation System consists of three related technologies: A Digital Geographic Database (DGD), An Automated Trip Scheduling System (ATSS), and Automated Vehicle Location Equipment (AVLE) [2,3]. However, because the commercial vehicles and indeed almost all the vehicles in the study area are not installed with AVLE, this aspect of APTS is not included in the developed software package.

The aim of the study was therefore to develop an APTS software with a DGD and ATSS capabilities/functionalities. The DGD allows maps of the service area to be displayed to the scheduler/operator and the commuters/clients on the computer screen. The ATSS subsystem has the specific objectives of reducing commuters waiting time at bus terminals by automating trip booking thus assuring a passenger of the availability of a bus. The ATSS subsystem also keeps an inventory of passengers and trips made by commuters and the vehicles (carriers).

2. Literature review/state-of-art

This section discusses/describes the implementation status (state-of-art) of advances in technologies as implemented in the public transportation industry. Many public transportation agencies in the developed countries like US, Japan, Korea Britain, Canada, and a few in the developing countries such as India, Indonesia, Brazil among others, have been applying technological advancements to improve their services [4–9]. An application which has been successfully tested and deployed in APTS is AVL tracking system in public transport buses [10,11]. There are currently four major types of navigation technology employed by Automatic Vehicle Location systems which include GPS Satellite Location, Signpost and Odometer, Radio Navigation and Location, and Dead-Reckoning systems. Many AVL systems, however, use a combination of these technologies to compensate for the inherent shortcomings of using any one individual technology [10].

AVL helps in automatically determining the geographic location of a vehicle along with its speed [4]. The real-time positional information of vehicles is delivered via telephone, touch screen kiosk, internet through website, PDA/Mobile (SMS), and LED display screen at bus stations [10,4]. The transmitted information may include both the prediction about arrival/departure time and information about nature and cause of disruption, if any [4,12,13]. Analysis of the AVL system data would give such information as idle times of vehicles, speed violation, non-completion of trips, cancellation of trips, skipping of bus stops, etc. [4]. Benefits of AVL include improved fleet management through better time management and optimum utilization of available fleet and crew [4,14].

State-of-the-art advances in GIS application as a component of APTS have occurred in several areas, with many

regional and enterprise-wide GIS systems implemented by transit agencies. GIS systems are used as tools for creating, managing, analyzing, and displaying spatial data. Web-based maps and GIS applications are faster to develop and faster to use; their features and appearances have also improved. A growing number of agencies are incorporating multiple views of the spatial data, such as showing the street network in line form, in remotely sensed images, or with the two combined. Bus locations can also be displayed on GIS maps. In addition, LIDAR (Light Detection and Ranging) data, which provides spatial data with x - y - z coordinates, is starting to be used in a few transit applications. TriMet software for example is reported to have produced some of the most progressive GIS applications in the US [10,11].

APTS as deployed in developed countries also include Automatic Passengers Counters (APCs). In APC treadle mats, horizontal or vertical infrared beams, or machine vision applications record the time, location and number of boarding and alighting passengers (and thus passenger load) at each stop [10,11]. APC counts are used for service planning. Electronic (or automatic) fare collection is done through efficient cashless passenger fare payment system, incorporating magnetic stripe fare cards or smartcards, fare validation devices, turnstiles, and ticket vending machines. Fare collection can be on-board or off-board the bus [8,15].

3. Study area

Ilorin, the capital city of Kwara State in Nigeria, is a typical growing city in a developing economy. The township transportation network constituted the study area. The city's public transportation system is largely dominated by 14-seater capacity buses that ply designated routes (from a terminal to another). Each bus queues up at the terminal and only departs the terminal when it is filled to capacity i.e., their departures are not scheduled. Also, the "request or flag stop" bus stop system operates in the city as there are no scheduled stops along operated bus routes. The bus will only stop to allow boarding or alighting if requested.

4. Materials and methods

4.1. Data collection

4.1.1. Road network

The map of the road network of Ilorin metropolis was digitized and the major bus terminals labeled appropriately.

4.1.2. Origin–destination survey

Considering the nature of public transport system in the study area where the "request or flag stop" bus stop system operates, there is the need to identify and determine the number and locations of the terminals and consequently define the number of routes to be served by the system. An origin–destination survey questionnaire was administered on a sampled commercial commuting bus drivers and commuting passengers within the metropolis. The outcome of the survey was used to develop a database of the origins and destinations of commercial commuting bus drivers and commuters and to define the terminals used in the study. The terminals used in the design of the

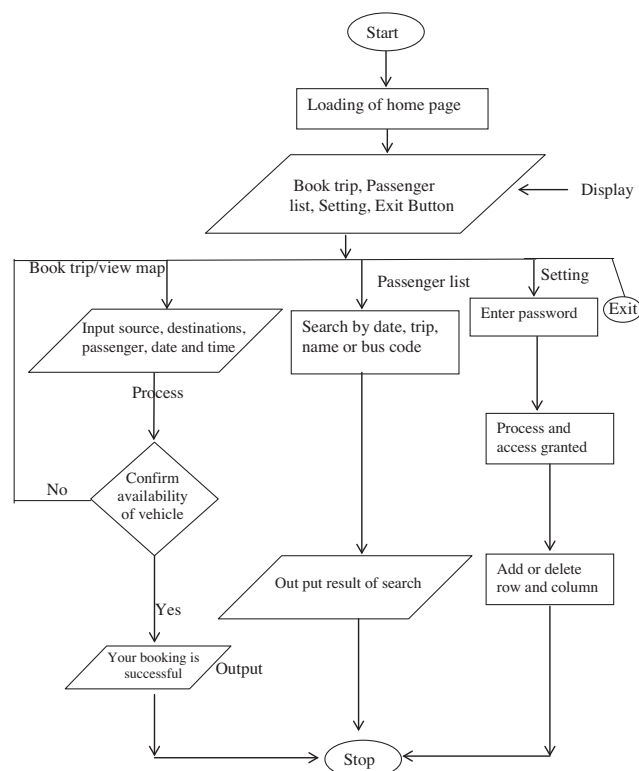


Figure 1 Program flow chart.

software are the most prominent and patronized terminals. The terminals were used in defining the routes.

4.1.3. Vehicle departure time survey

Vehicle departure time survey was carried out for three consecutive days on two of the routes used in the study. The purpose was to determine the movement patterns of the commercial buses along the selected routes and to quantify the number of buses and departure schedules that will meet the demands of the commuting community.

Data on the departure times of the commuting buses from the terminals were collected for three days on two of the routes, namely Route 1 which is the link from Unilorin P.S Terminal to Challenge Bus Terminal and Route 2 which is the link from Post Office Terminal to Oja Oba Terminal. The survey focused on bus traffic alone. The 12-h day survey commenced at 7:00 am and ended at 7:00 pm.

4.2. Software development

The application software was written using the Visual Basic 6 programming language.

The object-oriented approach of the programming was used instead of the structural programming approach. The advantage of this approach is that it offered higher portability, faster code execution, and fewer code lines. Microsoft ADODC control was used for the database. This was chosen for its superior database handling capabilities and also the high integration with Structured Query Language (SQL). The data were produced in Microsoft Access before being transferred into the Microsoft ADODC. Fig 1 shows the program flow chart.

5. Results

5.1. Data

5.1.1. Terminals and travel routes

Fourteen terminals were identified in the study based on the origin–destination survey and are as listed below. The terminals were used to define the routes to be serviced by the developed software; a travel route being a link between two terminals. Consequent upon the identification of the terminals, sixty travel routes were identified.

The terminals are:

1. Offa Garage Bus Terminal.
2. Oja Oba Bus Terminal.
3. Asa Dam Bus Terminal.
4. Tipper Garage Bus Terminal.
5. Unilorin (P.S) Bus Terminal.
6. Geri Alimi Bus Terminal.
7. Unilorin (mini campus) Bus Terminal.
8. Airport Bus Terminal.
9. Gaa Akanbi Bus Terminal
10. Taiwo Oke Bus Terminal.
11. Pipeline Bus Terminal.
12. Post Office Bus Terminal.
13. Challenge Bus Terminal.
14. Unity Bus Terminal.
15. Basin Bus Terminal.
16. Tanke junction Bus Terminal.
17. Fate Bus Terminal.

5.1.2. Departure time survey

On Route 1 which is from Unilorin P.S Terminal to Challenge Bus Terminal, a total of 122, 116, and 122 trips were recorded on day 1, day 2, and day 3, respectively, while on Route 2 which is from Post Office Terminal to Oja Oba Terminal, 63,

Table 1 Departure times of buses on Route 1 (Unilorin P.S Terminal to Challenge Bus Terminal) for the first five trips of the 3 days of survey.

Trip number	Dept. time day 1	Dept. time day 2	Dept. time day 3
1	7.05 am	7.08 am	7.00 am
2	7.10 am	7.13 am	7.08 am
3	7.22 am	7.27 am	7.20 am
4	7.32 am	7.39 am	7.29 am
5	7.44 am	8.00 am	7.40 am

Table 2 Departure times of buses on Route 2 (Post Office Terminal to Oja Oba Terminal) for the first five trips of the 3 days of survey.

Trips number	Dept. time day 1	Dept. time day 2	Dept. time day 3
1	7.00 am	7.10 am	7.05 am
2	7.05 am	7.12 am	7.08 am
3	7.09 am	7.14 am	7.11 am
4	7.12 am	7.16 am	7.14 am
5	7.15 am	7.18 am	7.20 am

Table 3 Summary of number of buses and departure periods for Route 1 (Unilorin PS Terminal to Challenge Bus Terminal).

Departure times	Number of buses			
	Day1 (veh)	Day2 (veh)	Day3 (veh)	Average number of departures (veh/day)
7.00–9.00 am	10	10	12	11
9.00–11.00 am	15	12	14	14
11.00–1.00 pm	15	13	16	15
1.00–3.00 pm	24	22	24	23
3.00–5.00 pm	30	35	30	32
5.00–7.00 pm	25	26	29	27

Table 4 Summary of number of buses and departure periods for Route 2 (Post Office Terminal to Oja Oba Terminal).

Departure times	Number of buses			
	Day 1 (veh)	Day 2 (veh)	Day 3 (veh)	Average number of departures (veh/day)
7.00–9.00 am	18	20	19	19
9.00–11.00 am	7	6	12	8
11.00–1.00 pm	9	7	12	9
1.00–3.00 pm	9	10	9	9
3.00–5.00 pm	6	7	9	7
5.00–7.00 pm	14	21	16	17

Advance Transit System

DIGITAL MAP AND AUTOMATED VEHICLE SCHEDULING SYSTEM

THE MAP OF ILORIN METROPOLIS AND ENVIRONS

SELECT your Source Station
Unilorin P.S

SELECT your Trip Date
Monday, November 14, 2011

TRIP FARE
N 50.00
X 2
TOTAL = N 100.00

Trip Schedule from Unilorin P.S

Source - Destination	Time of Trip	Bus Code-No
Unilorin P.S to Challenge	7:30 AM	AK001
Unilorin P.S to Challenge	9:00 AM	AK002
Unilorin P.S to Challenge	10:30 PM	AK001
Unilorin P.S to Challenge	12:00 PM	AK002
Unilorin P.S to Challenge	1:00 PM	AK004
Unilorin P.S to Challenge	2:00 PM	AK002
Unilorin P.S to Challenge	3:00 PM	AK001
Unilorin P.S to Challenge	4:00 PM	AK004
Unilorin P.S to Post Office	8:30 AM	AK003
Unilorin P.S to Post Office	11:00 AM	AK003
Unilorin P.S to Post Office	12:30 PM	AK003
Unilorin P.S to Post Office	2:00 PM	AK003
Unilorin P.S to Post Office	3:30 PM	AK002
Unilorin P.S to Post Office	5:00 PM	AK003
Unilorin P.S to Tipper Garage	1:00 PM	AK005
Unilorin P.S to Tipper Garage	2:00 PM	AK005
Unilorin P.S to Tipper Garage	3:00 PM	AK005
Unilorin P.S to Tipper Garage	4:00 PM	AK005
Unilorin P.S to Tipper Garage	5:00 PM	AK005
Unilorin P.S to Unilorin Mini	8:00 AM	AK005
Unilorin P.S to Unilorin Mini	10:00 AM	AK005
Unilorin P.S to Unilorin Mini	12:00 PM	AK006
Unilorin P.S to Unilorin Mini	3:00 PM	AK006

KEYS
MAJOR ROADS
OTHER ROADS
RIVERS/STREAMS
BUS TERMINALS
NOTEABLE PLACES

Passenger(s) Information for Booking
14-Nov-2011 Unilorin P.S to Challenge 9:00 AM AK002 2

How many Passenger do you want to book for? 2

Passenger 1
Name: adeleke o. o.
Age: 50 Sex: M

Passenger 2
Name: adeleke j. a.
Age: 40 Sex: M

All passengers are please advise to be available in their specified Bus Terminals, 5 minutes before the take off time.

ENTER

PASSENGERS LIST

SETTINGS

HOME

Figure 2 Book trip and view map page.

70, and 64 trips were recorded on day 1, day 2, and day 3, respectively. Extract of the obtained data from the departure time survey are given in Tables 1 and 2 for the first five trips on each of the 3 days of the survey for Route 1 and Route 2, respectively.

The collected data from the 3-day departure time survey were analyzed and summarized as given in Tables 3 and 4. Table 3 shows the number of buses that depart Unilorin P.S Terminal to Challenge Bus Terminal (Route 1) within the specified period of the day, while Table 4 shows the number of buses that depart Post Office Terminal for Oja Oba Terminal (Route 2) within the specified period of the day.

From Table 3, since an average of eleven buses (filled to capacity) depart between 7.00 am and 9.00 am, it is deduced that eleven buses will be needed along Route 1 to meet the travel demand of commuters along the route, and the buses will need to be supplied between the period of 7.00 am and 9.00 am at 10 min interval. Similarly, fourteen buses will need to be supplied between the period of 9.00 am and 11.00 am at 9 min interval, 15 buses between the period of 11.00 am and 1.00 pm at 8 min interval, 23 buses between 1.00 pm and 3.00 pm at 5 min interval, 32 buses between 3.00 pm and 5.00 pm at 4 min interval, and 27 buses between the period of 5.00 pm and 7.00 pm at 4 min interval.

From Table 4, an average of nineteen buses at 6 min interval can be economically supplied between 7.00 am and 9.00 am, eight buses at 15 min interval between 9.00 am and

11.00 am, nine buses between 11.00 am and 1.00 pm at 13 min interval, another nine buses between 1.00 pm and 3.00 pm at 13 min interval; seven buses between 3.00 pm and 5.00 pm at 17 min interval, and 17 buses between 5.00 pm and 7.00 pm at 7 min interval. The approach described above is used to determine and generate the data on the required number of buses and their departure schedule that will be adequate to meet the demand of the commuting community along the remaining routes.

5.2. Software development

5.2.1. Program objectives

The program achieved the following objectives:

It displays the map of Ilorin metropolis (service area) to the trip makers/scheduler who books trip online. In the software package, the trip maker defines the route on which the travel is intended by selecting the origin and the destination. The program:

- Automates trip assignment process within few seconds by assigning the booked trips to available bus on that route at the specified time.
- Provides a reliable means of confirming the availability of vehicles or carrier on a particular route at any given period by matching the demand for bus with availability of bus in the pool at the time.

Advance Transit System

DIGITAL MAP AND AUTOMATED VEHICLE SCHEDULING SYSTEM

THE MAP OF ILORIN METROPOLIS AND ENVIRONS

TRIP FARE

Select your Source Station: Unilorin P.S

Select your Trip Date: Monday, November 14, 2011

TRIP FARE: N 50.00 X 2

TOTAL = N 100.00

Trip Schedule from Unilorin P.S

Source - Destination	Time of Trip	Bus Code-No
Unilorin P.S to Challenge	7:30 AM	AK001
Unilorin P.S to Challenge	9:00 AM	AK002
Unilorin P.S to Challenge	10:30 PM	AK001
Unilorin P.S to Challenge	12:00 PM	AK002
Unilorin P.S to Challenge	1:00 PM	AK004
Unilorin P.S to Challenge	2:00 PM	AK002
Unilorin P.S to Challenge	3:00 PM	AK001
Unilorin P.S to Challenge	4:00 PM	AK004
Unilorin P.S to Post Office	8:30 AM	AK003
Unilorin P.S to Post Office	11:00 AM	AK003
Unilorin P.S to Post Office	12:30 PM	AK003
Unilorin P.S to Post Office	2:00 PM	AK003
Unilorin P.S to Post Office	3:30 PM	AK002
Unilorin P.S to Post Office	5:00 PM	AK003
Unilorin P.S to Tipper Garage	1:00 PM	AK005
Unilorin P.S to Tipper Garage	2:00 PM	AK005
Unilorin P.S to Tipper Garage	3:00 PM	AK005
Unilorin P.S to Tipper Garage	4:00 PM	AK005
Unilorin P.S to Tipper Garage	5:00 PM	AK005
Unilorin P.S to Unilorin Mira	8:00 AM	AK005
Unilorin P.S to Unilorin Mira	10:00 AM	AK005
Unilorin P.S to Unilorin Mira	12:00 PM	AK006
Unilorin P.S to Unilorin Mira	3:00 PM	AK006

BOOKING SUCCESSFUL
You have Successfully Booked:

--- adeleke o. o.
--- adeleke j. a.

Tripp Name : Unilorin P.S to Challenge
Date of Trip : 14-Nov-2011
Time of Trip : 9:00 AM
Bus Code No : AK002
TOTAL TRIP FARE = N 100.00

PASSENGER INFORMATION for Booking

14-Nov-2011 Unilorin P.S to Challenge 9:00 AM AK002 2

How many Passenger do you want to book for? 2

Passenger 1: Name: adeleke o. o. Age: 50 Sex: M

Passenger 2: Name: adeleke j. a. Age: 40 Sex: F

All passengers are please advise to be available in their specified Bus Terminals, 5 minutes before the take off time.

PASSENGERS LIST

SETTINGS

HOME

Figure 3 Window showing a successful booking.

- iii. Keeps a comprehensive historic record for the bookings, which the Operators can analyze for future trip schedule planning.

5.2.2. Application of developed package

5.2.2.1. *The home page.* The date and the time of the computer system must be in correct settings before the operations can work. The “home page” has four command buttons namely:

- Book trip/view map.
- Setting.
- Passenger list and
- Exit button.

These buttons would allow both the scheduler/operator and the trip marker/client navigate to any part of the software depending on the required operation.

5.2.2.2. *Book trip/view map page.* The preview of the page is given in Fig. 2. It is designed in a very simple way, so that scheduler can interact with the system without the assistance of a tutor. The top right-hand corner of the screen displays the map of the Ilorin metropolis and environs. A key is provided on the map to guide both client and operator. Textbox is also located at the top right-hand corner of the map to display the bus terminals or the notable places highlighted by the cursor.

The client can click on any of the bus terminals, which must be his origin to display a list of trip schedules available from that terminal to every other terminal within the metropolis at a given period. The trip schedules are displayed at the bottom left-hand quarter of the screen from which the client can select his choice of trip.

Alternatively, the client can select his origin from the drop down menu with the caption “select your source station” located at the top left corner of the screen to accomplish the same task explained above. Below this menu, there is another menu with caption “select your trip date” where the client can choose the trip date. However, the time and date selected must be reasonable i.e., it must not be for a past time and you cannot book for more than two weeks ahead.

Directly below the map is another frame containing a drop down menu where you can select the numbers of passengers you intend to book. This displays a number of dialog boxes where you can fill in the names, age and sex of passengers depending on the number selected; however, the maximum number of passengers you can book at a time is four. At the end of the whole process, “Enter” button is clicked to confirm if your booking is successful. Fig. 3 shows the window displaying a successful booking. From this page or the “Home page,” you can go to another page called “Passenger list.”

5.2.2.3. *Passenger list.* The Passenger list database window shown in Fig. 4 and the “Setting Page” (which is the Database

Date	Name	Age	Sex	Trip	Time of Trip	Bus no
21-Feb-07	Femi Falana	43	F	Geri-Alimi to Airport	02:30 PM	AK037
21-Feb-07	Sola Akinpelu	53	M	Geri-Alimi to Airport	02:30 PM	AK037
21-Feb-07	wale	46	F	Pipe Line to Post Office	04:30 PM	AK031
22-Feb-07	Sola Adeoye	21	F	Challenge to Unilorin Mini	07:30 AM	AK015
22-Feb-07	Akinyemi Sunday	21	M	Unilorin Mini to Post Office	01:00 PM	AK015
22-Feb-07	John Uche	23	M	Asa Dam to Taiwo Oke	01:00 PM	AK040
22-Feb-07	Tope Alabi	45	F	Unilorin Mini to Airport	02:00 PM	AK039
22-Feb-07	Sunday Ojo	30	M	Unilorin Mini to Airport	02:00 PM	AK039
22-Feb-07	Ayo Bayerre	15	M	Geri-Alimi to Airport	02:30 PM	AK037
22-Feb-07	Akande Moses	23	F	Oja Oba to Post Office	03:00 PM	AK018
22-Feb-07	Wale Ayeni	45	M	Oja Oba to Post Office	03:00 PM	AK018
22-Feb-07	Remi Aluko	34	F	Pipe Line to Post Office	04:30 PM	AK031
22-Feb-07	Dare Adewole	23	M	Fate to Tanke Junction	05:00 PM	AK021
23-Feb-07	Adewale Taiba	15	F	Unilorin P S to Post Office	11:00 AM	AK003
23-Feb-07	Adewale Kayode	4	M	Unilorin P S to Post Office	11:00 AM	AK003
23-Feb-07	Segun Folaranmi	12	M	Gaa-Akanbi to Pipe line	12:00 PM	AK034
23-Feb-07	Idowu Adeniji	13	F	Gaa-Akanbi to Pipe line	12:00 PM	AK034
23-Feb-07	tola	9	F	Unilorin P S to Post Office	12:30 PM	AK003
23-Feb-07	wale	10	M	Unilorin P S to Post Office	12:30 PM	AK003
24-Feb-07	Segun Obasanjo	63	M	Unilorin Mini to Airport	02:00 PM	AK039
24-Feb-07	Dayo Ajayi	34	M	Geri-Alimi to Airport	02:30 PM	AK037

Figure 4 Passenger list database window.

Advance Transit System

SETTINGS PAGE

Source	Destination	Price(N)	T1	B1	T2	B2	T3	B3	T4	B4	T5	B5	T6	B6	T7
Taiwo Oke	Post Office	20	07:30 AM	AK020	10:30 AM	AK019	12:30 PM	AK020	02:30 PM	AK019	04:00 PM	AK020			
Taiwo Oke	Offa Garage	40	08:30 AM	AK029	10:30 AM	AK034	12:30 PM	AK029	02:30 PM	AK034	04:30 PM	AK029			
Taiwo Oke	Oja Oba	20	07:00 AM	AK033	08:30 AM	AK033	11:00 AM	AK033	01:30 PM	AK033	03:30 PM	AK033	05:00 PM	AK033	
Taiwo Oke	Unilorin Miri	20	07:00 AM	AK006	09:00 AM	AK006	11:00 AM	AK006	05:00 PM	AK006					
Gaa-Akanbi	Challenge	30	07:00 AM	AK016	09:00 AM	AK016	12:00 PM	AK016	02:00 PM	AK016	04:00 PM	AK016			
Gaa-Akanbi	Tipper Garage	30	07:00 AM	AK012	09:00 AM	AK004	11:00 AM	AK012	02:00 PM	AK010	04:00 PM	AK010			
Gaa-Akanbi	Pipe line	30	07:30 AM	AK034	12:00 PM	AK034	05:00 PM	AK034							
Gaa-Akanbi	Taiwo Oke	30	08:30 AM	AK034	09:30 AM	AK035	11:00 AM	AK035	01:00 PM	AK035	03:00 PM	AK035	05:00 PM	AK035	
Airport	Post Office	50	08:15 AM	AK019	10:15 AM	AK020	12:15 PM	AK019	02:15 PM	AK020	04:15 PM	AK019			
Airport	Asa Dam	40	09:00 AM	AK036	01:00 PM	AK036	05:00 PM	AK036							
Airport	Oja Oba	40	07:00 AM	AK036	11:00 AM	AK036	03:00 PM	AK036							
Geri-Alimi	Post Office	40	07:00 AM	AK037	10:00 AM	AK037	01:00 PM	AK037	04:00 PM	AK037					
Geri-Alimi	Airport	20	08:30 AM	AK037	02:30 PM	AK037									
Geri-Alimi	Asa Dam	20	07:30 AM	AK038	12:00 PM	AK038	04:00 PM	AK038							
Unilorin Miri	Unilorin P.S	60	07:00 AM	AK005	09:00 AM	AK005	11:00 AM	AK005	01:00 PM	AK006	04:00 PM	AK006			
Unilorin Miri	Airport	40	08:00 AM	AK039	11:30 AM	AK039	02:00 PM	AK039	04:00 PM	AK039					
Unilorin Miri	Post Office	30	08:15 AM	AK015	09:45 AM	AK015	11:15 AM	AK015	01:00 PM	AK015	03:00 PM	AK015	05:00 PM	AK015	
Oja Oba	Post Office	20	08:00 AM	AK017	09:00 AM	AK018	10:00 AM	AK017	12:00 PM	AK017	02:00 PM	AK017	03:00 PM	AK018	04:00 PM
Oja Oba	Airport	40	08:00 AM	AK036	12:00 PM	AK036	04:00 PM	AK036							
Oja Oba	Offa Garage	40	08:00 AM	AK028	10:00 AM	AK028	12:00 PM	AK028	02:00 PM	AK028	04:00 PM	AK028			
Oja Oba	Taiwo Oke	20	07:45 AM	AK033	10:00 AM	AK033	12:15 PM	AK033	02:00 PM	AK033	04:15 PM	AK033			
Asa Dam	Airport	40	10:00 AM	AK036	02:15 PM	AK036									
Asa Dam	Post Office	30	08:30 AM	AK022	11:00 AM	AK022	01:00 PM	AK022	03:30 PM	AK022					
Asa Dam	Taiwo Oke	20	07:00 AM	AK040	10:00 AM	AK040	01:00 PM	AK040	04:00 PM	AK040					
Asa Dam	Offa Garage	30	07:45 AM	AK029	11:30 AM	AK040	02:30 PM	AK040							
Taiwo Oke	Asa Dam	30	08:30 AM	AK040	10:45 AM	AK040	01:45 PM	AK040	05:00 PM	AK040					
Urutty	Fate	40	09:00 AM	AK027	12:00 PM	AK027	02:30 AM	AK027	04:30 PM	AK027					
Oja Oba	Fate	40	08:30 AM	AK041	11:30 AM	AK041	03:30 PM	AK041							
Fate	Tanke Junction	30	08:30 AM	AK021	11:30 AM	AK021	02:30 PM	AK021	05:00 PM	AK021					
Fate	Urutty	40	07:30 AM	AK027	10:00 AM	AK027	01:30 PM	AK027	03:30 PM	AK027					
Fate	Oja Oba	40	07:00 AM	AK041	10:00 AM	AK041	01:00 PM	AK041	05:00 PM	AK041					

ADD NEW DELETE ROW Enter Password:

BOOK TRIP PASSENGERS LIST HOME

Figure 5 Database window.

window) shown in Fig. 5 are designed for the proper administration of the system by the operator. The Passenger list is a table where records of operations of the system can be accessed.

The number of trips a particular vehicle has made with dates and time can be determined from the database. In addition, the list of passengers and every other information about them can be obtained from the record. The information include the name of passenger, age, sex, trip made, trip date, trip time as well as the bus registration number. These can be achieved by browsing the "Search by" dialog box located below the table. An illustration is given in Fig. 4.

5.2.2.4. The settings. The database on which the operations of the whole system rely is called the "Settings." It is simply the brain box of the whole design. It is on this page the system accesses any information displayed to the client. A printed copy of part of the database is given in Fig. 5. The flexibility of this page cannot be over emphasized. It has unlimited number of rows and columns, so that additional information can be provided by the operators depending on the situation at hand. The flexibility property makes it easy for the operators to update the system.

The information supplied in the database includes the trip origin, trip destination, trip tariff, departure time (T) and bus registration number (B). Lastly, the database has a password, so that it is not accessible to unauthorized persons.

6. Discussion

The introduction of Advanced Public Transportation System (APTS) technology has demonstrated the efficiency of the operation of a surface transportation system in the following areas:

1. Full automation of vehicle scheduling and trip reservation functions that utilize technologies such as Automated Trip Scheduling System (ATSS) in combination with Digital Geographical Data base (DGD). This can help transit agencies to increase the percent of shared rides, achieve efficient utilization of vehicle and driver resources and reduce the operating costs by reducing vehicle dead heading. This is possible only when the bus ride demand is adequately documented so that optimum number of buses would be allowed to ply a route.
2. The commuters too would make self available at the bus terminals only and strictly on schedule after his booking has been confirmed successful. The unnecessary waiting time at the bus stops would be eliminated and both commuters and the drivers would enjoy better management of their times.
3. The ATSS technology automates many aspects of trip reservation which enhances the service quality to transit users (commuters). For example, customers are able to book rides with the transit agency more easily and reliably, well

ahead of the actual time of the trip. The critical information of whether vehicles are available and the operating bus departure headways are helpful ITS framework for an urban trip making network. Furthermore, workload of schedulers or operator could be significantly reduced as ATSS is capable of providing all desired information such as trip schedules, transportation fare, and availability of carriers at their finger tips while booking ride requests. Desired information on the screen in a timely manner as well as the headways at particular times of the day are also available.

4. Advanced Transit System keeps a comprehensive historic record of bookings, vehicle trips, etc. which the operators can analyze for proper administration of the system and future trip schedule planning and estimation of revenue for the operation of commuting vehicles in a fleet.

The following are however the limitations of the developed ATSS software;

1. The software cannot handle more than thirty trip schedules for a given route in a day.
2. The DGD highlights only the origin when a given route is selected.
3. The software only reflects journeys from one terminal to another.

7. Conclusion and recommendations

The benefits derivable from the implementation of developed Advanced Public Transportation System software (APTS) include the follows:

1. It reduces commuters waiting time at bus terminals, automates trip booking thus assuring a passenger of the availability of a bus and keeps an inventory of passengers and trips made by commuters and the vehicles (carriers).
2. The DGD allows maps of the service area to be displayed to the scheduler/operator and the commuters/clients on computer screen.
3. APTS can be more efficiently operated with the availability of Automated Vehicle Location Equipment (AVLE). In case of a trip cancellation as a result of traffic incident such as vehicle breakdown, it would be easy to alter the ATSS-built trip plans for the vehicle in-real-time with AVLE as AVLE provides real-time information about the vehicle location and status. Efforts should be made by Governments of developing nations to establish industries, which will develop necessary technology to produce AVL equipment to enhance transportation services.
4. Governments of developing nations should encourage and provide incentives for demonstration of projects with the APTS technology in various localities and under differing conditions so as to advance the use of such systems in the country.

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