Application of Automated Vehicle Location System in a Public Transit System in Ilorin, Nigeria: Issues and Challenges

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Abstract

Intracity public transit services in urban centres of developing economies including Nigeria remain largely inefficient as evidenced in the noticeable large number of commuters waiting at bus stops for vehicles which arrival times or even operations are not predictable. This exactly describes the situation of public transit services along the University of Ilorin students' movement corridor in Ilorin metropolis, Nigeria. This study was therefore carried out to enhance the performance of the public transportation system along the studied corridor through the application of Automatic Vehicle Location System (AVLS). The objectives were to: improve on the monitoring of vehicles and drivers; create an avenue for tracking of vehicles by riders and stimulate the development and deployment of AVLS technology. Automatic Vehicle Location Equipment was installed in two vehicles in the fleet of the University used for public transit and their movements monitored through SMS messages and the internet. The study showed that the vehicles varied their route from the scheduled designated route which is the studied student movement corridor a number of times during operational hours and on some days did not operate on the corridor. Issues and challenges that came to the fore during the study, which are responsible for the dearth in the application of AVLS in public vehicles operating on the movement corridor and by extension other urban centres in Nigeria include: lack of administrative will by heads and managers of public transport services to apply the technology; lack of funds; lack of requisite expertise and poor internet and GSM communication services. These issues should be addressed through enlightenment and investment in AVLS technology.

Keywords
Automatic Vehicle Location System, Willingness, Enlightenment, Investment, Expertise

1. Introduction

The ineffectiveness of public transport services among other factors which include continuous growth in urban population, private vehicle ownership, and ineffective traffic management system is identified as the cause of traffic congestion in urban centres with dire consequences on social and economic activities (World Bank, 2011). It is established that improving a country's transportation system does not solely hinge on building new roads or repairing aging infrastructures, but that the future of effective transportation system lies in Intelligent Transportation System (ITS).Ball (2011) defined ITS as the integration of information and communications technology with transport infrastructure. An important sub-system of ITS is the Automated Vehicle Location System (AVLS) which makes use of Automated Vehicle Location Equipment (AVLE) for vehicle tracking. AVLE are electronic devices for automatically determining and transmitting the geographic location of a vehicle. AVLEs are registered with tracker service providers and accessed using tracking application devices which include Geographic Positioning System (GPS), computers and mobile phones. Thus for public transportation, a suitable AVLS for both managerial and commuter's use, goes a long way in making the transport system very effective through improved positional information on vehicles which result to improved trip planning by commuters and improved productivity by transit agencies (Ezell, 2010).

Although it is reported that the ITS/AVLE technology is known to be beneficial to efficient transit system and has been developed, tested and documented in cities around the world, it has however not been sufficiently deployed in public transit in Nigeria as reported by Adeleke et. al. (2013). In Ilorin metropolis, Nigeria, for example, there is no known intracity public transit operating in the metropolis that has engaged the AVLS to improve its performance. Transit operations in the metropolis and along the studied movement corridor remain inefficient as generally observed in cities in Nigeria as evidenced in long waiting times by commuters at bus stops and the unpredictability of arrival times of vehicles among others which result in

losses of productive hours and health hazards of stress and frustration. The study therefore installed AVLE into two public transit vehicles in the University of Ilorin fleet on the Tanke Tipper Garage – University Bus Park student movement corridor with the aim of utilizing the AVLS tool in assessing and enhancing the transit performance of the vehicles. The objectives of the study were to: i. enhance the management of the transit vehicles and improve productivity through effective monitoring and assessment of the vehicles operations, ii. provide real-time vehicle location information for both managers and commuters and iii. stimulate the development and deployment of AVLS in intracity public transit. The paper reports on the issues and challenges that emanated from the study.

1.1 **Study Area**

The study area is the movement corridor from Tanke Terminus to the University of Ilorin bus park at the Permanent site of the University of Ilorin, Ilorin, Nigeria. Transit operators along the corridor include private individuals, the University, the Student Union of the University and Kwara State Government. The University in conjunction with the Students Union operates High Occupancy Vehicles (HVO), so also does the Kwara State Government while the private operators operate 8-seater midi-buses and 14-seater buses along the corridor. None of the vehicles utilises any ITS tool including AVLE for performance enhancement. A map of the study corridor is shown in Figure 1.

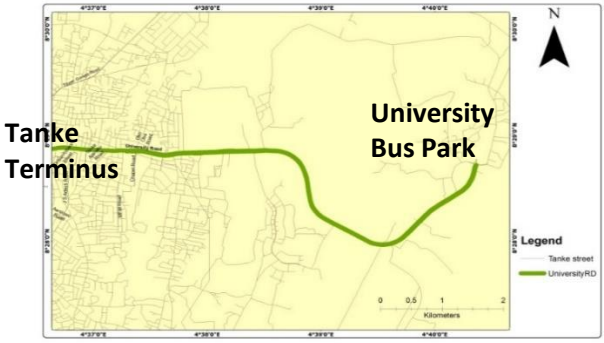

Figure 1: University of Ilorin Bus Transit Scheme Route
(Source: Adapted Google Map)

2. Literature Review

Jimoh and Adeleke (2005) carried out a study on the potential benefits of the application of ITS tools including AVLE in Nigeria and advocated ITS deployment and development by both government and private stakeholders in the Nigerian transportation industry. Using AVLE in planning helps an agency find areas that need improvement so that effective service is preserved, efficiency is increased, and operating costs are cut (Zhong-Ren et al, 1999). Current AVLS combines positioning hardware, a communication package, and an information display system to monitor and track a vehicle's movements in real-time. The real-time positional information of vehicles can be delivered via telephone, touch screen kiosk, internet through website, SMS, and LED display screen at bus stations (Bolella, 2010; Naqvi, 2010). AVLS helps in automatically determining not only the location of a vehicle but alongside its speed. Analysis of AVLS data would give such information as idle times of vehicles, speed violation, non-completion of trips, cancelation of trips, skipping of bus stops, etc. (Naqvi, 2010). AVLE has been promoted as being beneficial to the transit industry by offering transit agencies more flexibility in monitoring and managing their vehicles to better maintain schedules and improve on time performance and reducing customers' wait time as riders can plan trips based on information of vehicle location. It is also reported as increasing riders' perceived security as it can help an agency deal with criminal activity, medical emergencies or mechanical breakdowns (Gomez et al, 1998).

Chira-Chavala et al (1997) conducted a study in University of California, Berkeley, in which a disputed annual saving of $488,000 was realized from the installation of AVLE at Outreach, Santa Clara Valley, California in the year 1996-97, thus reflecting an actual improvement in cost effectiveness. This led to the development of a multi-agency AVL system model shared between other departments in the city besides the transit agency. This implies that once an AVLS is developed, it can be used by different agencies to suit their needs.

3. Materials and Methods

3.1 AVL device installation and application

Two University buses were installed with vehicle trackers and the buses tagged Unilorin 21FG and Unilorin 22FG in the study. The tracker used is

the Xexun TK103-2 model GPS/GSM/GPRS303F. Figure 2 gives the descriptive view and the features of the tracker.

It allows for ease of determining the vehicle travel pattern such as idle times of vehicles, speed, non-completion of trips, route deviation etc. It also has the ability to store such information over a period of time. The tracker installation was done by inserting an active phone line (GSM SIM card) in the tracker and connecting the tracker directly on the battery of the vehicle as a source of energy and properly secured as shown in Figure 3.

After the installation of the device, a tracker account was created using the devices' International Mobile Equipment Identity (IMEI) number and service charge paid. Username and Password were then generated with which the device was identified and monitored using Orange GPS-Trace online mobile tracking software.

Figure 2: Feature of a Xexun TK 103-2 vehicle tracker
(Source: www.google.com/Xexun103-2)

Figure 3: Installation of the AVLE in the bus

Monitoring using SMS was done by placing a call to the tracker phone number and the device responded with an engaged tone and cut the call, after which a short message stating the current location of the bus (latitude and longitude), current speed, date, time and a link of its position on Google map were sent to the caller.

The monitoring of the vehicles was made public using a plasma flat screen monitor with HDMI capability as the outdoor External Visual Display Unit. This was in lieu of an outdoor screen which is more appropriate

4. Results and Discussion

4.1 Monitoring the vehicles through SMS

A typical response from the Unilorin 22FG AVL device is shown in Figure 2. The tracker's response in Figure 4 indicated that the bus was at the call time located at Latitude 8^{o}.488109N and Longitude 4^{o}.594765E, its speed was zero which implied that it was not in motion at called time. The time stamp showed that the call was placed to the AVL device on 18^{th} of July, 2018 at 4:07 pm.

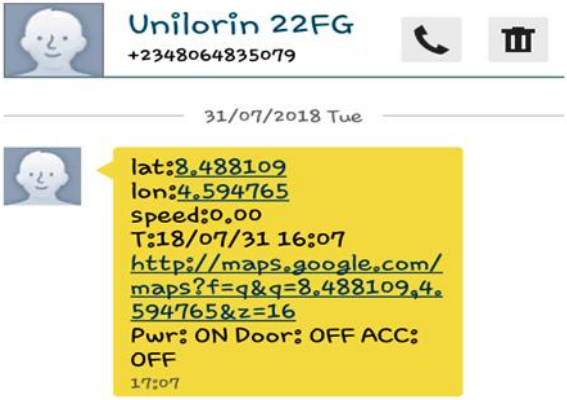

Figure 4: SMS Reply from Unilorin 22FGTracker

Figure 5 shows the bus location on Google map as indicated through the link.

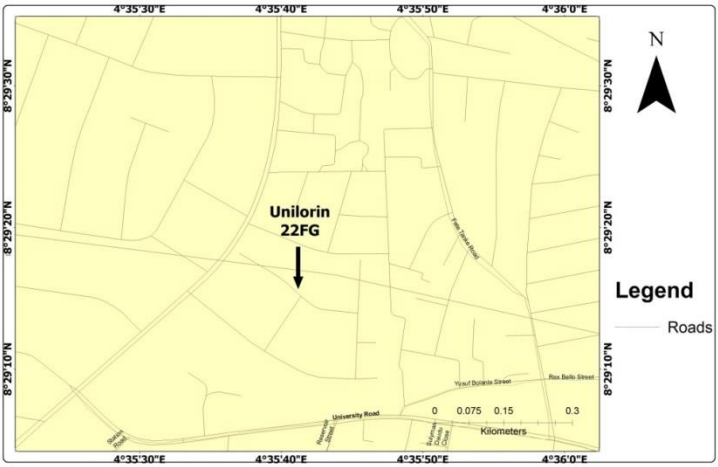

Figure 5: Screenshot of location of University of Ilorin 22FG at the Latitude and Longitude Coordinates from Tracker's SMS

Monitoring using the GSM platform gave an instantaneous vehicular location but not a live feed of the vehicle track. It is thus, not suited for administrators

that may need the history of the vehicles or drivers performance for asset assessment.

4.2 Monitoring using the WEB-based platform

In monitoring using the web-based platform, the vehicle location and other information were gotten by logging into an online tracking platform using the user name and password of the tracker either with a smart phone or computer. The platform gave a live feed of the vehicle track. The login page of the platform is shown in Figure 6 while Figure 7 shows the home page.

The home page is divided into two parts: (i) the map area and (ii) the administrative or monitoring area.

4.2.1 The map area

The map area is on the right hand side of the screen in Figure 6 and it displayed the map of the tracked bus route. The volume of details on the map

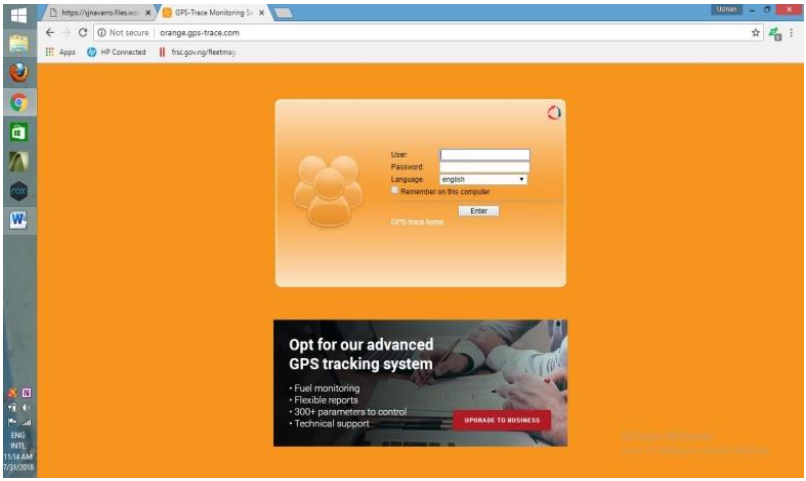

Figure 6: Screenshot of Login Page

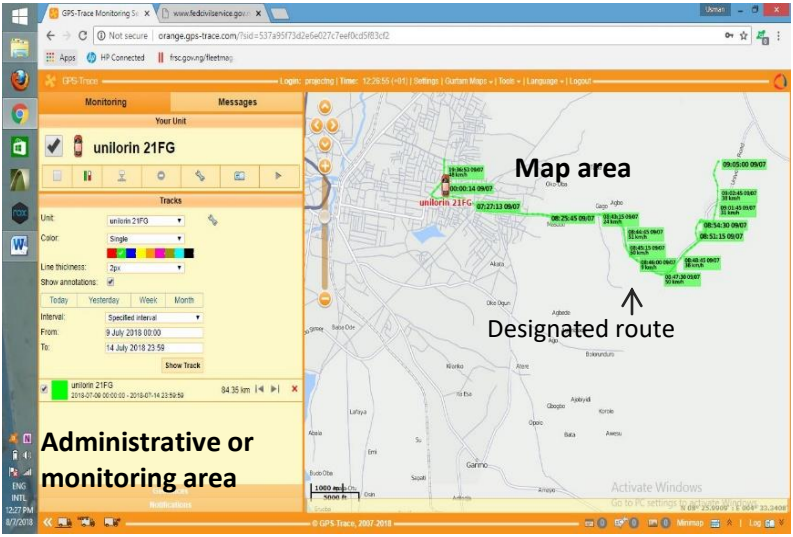

Figure 7: Screenshot of Unilorin 21FG track during a morning operation

depended on the amount of information contained in the base map (the Google map) and the scale of view. The map area in Figure 7 shows the typical daily scheduled vehicle track when on the studied movement corridor as shown on the webpage. The tools in the map area include: the directional buttons, zoom button, the scale line (which shows the map scale) and coordinates (which indicate map feature coordinates).

4.2.2 Administrative or monitoring area

The administrative area showed all the tools needed for administrative function and monitoring purpose. Features in this area are:

i. Unit: it shows the number and the unit name of the bus(es) being tracked. The properties of the AVL device such as tracker identification (IMEI) number, name, device model, GSM line number, etc. can be gotten by clicking the unit property button underneath the unit name.

ii. Color: is used in depicting the vehicle track and can be varied to differentiate the vehicle tracks of the buses. Multiple tracks of a bus at different periods can be specified and viewed for either assessment or

monitoring as desired. Figure 8, for example, shows the track of Unilorin 21FG at two different periods using color difference to distinguish each period.

iii. Calendar: is used to specify the time range or period for which tracking data is required.

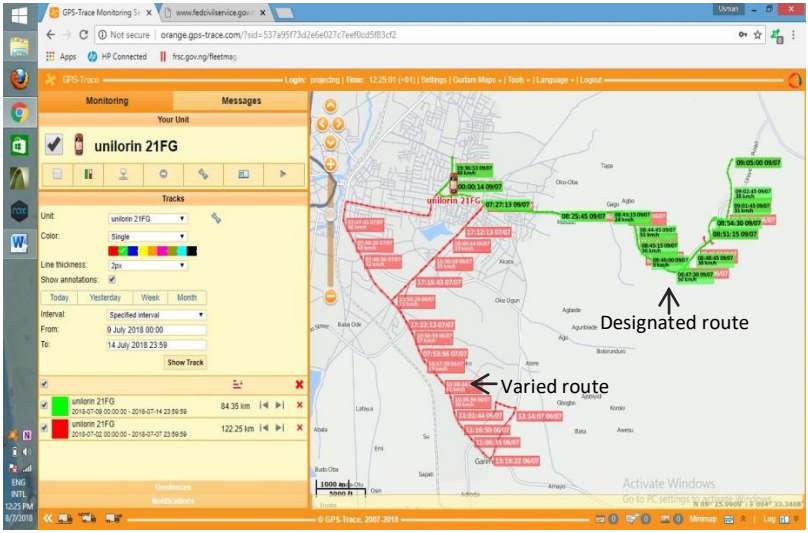

Figure 8: Screenshot of the use of color tool to differentiate bus tracks for two different periods

4.3 Vehicle and Personnel Management

A study of the displayed track as shown in Figure 8 was used by management to confirm when operations commenced and ended. Thus the driver's performance was monitored and deviations from assigned routes were readily detected.

Figure 8 shows a trip labeled 'Deviated Route' which is the vehicle's track when the vehicle did not operate on the studied movement corridor labeled 'Designated route', for example, when used for some other assignments such as students' excursion or on hire services. The AVLS allowed prospective rider at such times to be aware of the bus changed movement and thereby make alternative plan for his trip e.g. using some other mode instead of waiting endlessly for the bus.

4.4 Information Dissemination to Commuters

The External Visual Display Unit connected to the processing computer unit as shown in Figure 9 was improvised to show live video feeds of the vehicles tracks to commuters at the bus terminals. Commuters also tracked the vehicles through android phones and computers.

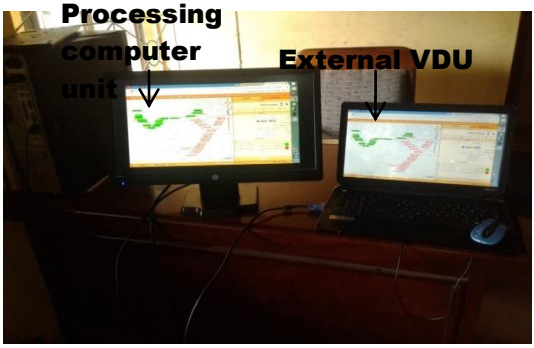

Figure 9: Screenshot of the Processing Computer Unit Connected to an External Video Display Unit using an HDMI cable

4.5 Issues and Challenges Relating to Application of AVL System for Effective Transportation in Nigeria

The following issues and challenges emanated from the study which need to be addressed to accelerate the deployment and development of the use of AVLS and other ITS subsystems in Nigerian public transit systems.

Lack of Administrative Will: The unwillingness of administrative heads in the Nigerian transportation sector (directors and managers in the transport sectors) to invest in research and development of ITS technologies in solving challenges bedeviling the country's transport sector was identified in the study through interaction with administrative heads and operators of transit vehicles along the studied corridor. The challenge can be addressed when transit operators through enlightenment appreciate the benefits that are inherent in the application of AVLS.

Lack of Funds: Transportation is an item that has remained dominant in Nigeria's budgetary allocation. However, very little, if at all, is budgeted for research and development of ITS including its subsystem of AVLS. In order to achieve an effective transport system, government's transport agencies/universities departments and research institutes should adopt well-

planned budgetary programmes in the development of AVLS/ITS enabled transit systems which will go a long way in improving transit efficiency.

Lack of Technology and Expertise: The lack of adequate expertise in the application of AVLS was an issue that came to the fore in the study. Most of the AVLS technology components are imported into Nigeria. The high cost of acquiring the technology and requisite skills are considered to be responsible for the dearth in the application of the technology in the country. These challenges can be surmounted by investing in the technology through its development and deployment coupled with the training of needed technical expertise.

Poor Internet and GSM Communication Services: Efficient telecommunication/internet network is very important in planning and running an AVLS based transport system. Over the years, telecommunications in Nigeria has evolved from fixed land lines to wireless mobile network, internet telephoning and transfer of data using the internet. The challenges that have risen are the high cost and poor service by service providers thus, posing a very big challenge to effective utilization of the AVLS which application programmes run on telecommunication and internet. Poor network experienced during the study led to delay in transfer of data and in some instances outright unavailability and inaccessibility of vehicle track data. Vehicle tracking for effective monitoring may be impossible or done at additional cost that will be needed to augment and boost the existing poor telecommunication services.

5. Conclusion and Recommendations

5.1 Conclusion

The study revealed that the studied public transportation system can be described as unpredictable in its expected operations on the studied students' movement corridor. This is due to the fact that it is the same buses utilized for the transit scheme that are also used for students' excursion and hired services to the public which often result to the interruption and/or suspension of students' operation services unannounced to commuters. The application of AVLS gave the advantage of better fleet management through effective monitoring of vehicles and drivers. Commuters were also better informed on the movements of the vehicles. The applications of AVLS and other ITS technologies by transit operators along the studied corridor will also stimulate and enhance the development of needed technologies and skills in ITS.

5.2 Recommendations

The following recommendations are drawn from the study:

A sustained AVL system should be setup by the management of the University Bus Transit Scheme. This would involve the positioning of suitable outdoor Visual Display Units at the bus parks and also the provision of a system of registration whereby users can login to the trackers webpage to access data on vehicle movement either through the computer or mobile phone.

There is the need for better public awareness in the study area of the applications of AVLS and other ITS technologies towards enhancing public transit services performance.

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