

Deployment of ICT for Effective Transportation System in Nigeria: A Design model of Nigerian Intelligent Transportation System

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Abstract: *Being fully convinced that Nigeria and Nigerians are still unaware of the potentials of ITS, this project points the 'satellite of knowledge of ITS 'as the solution to the National traffic congestion, this work has done justice to explore and expose to the Nigerian populace the benefits, technologies as well as how ITS can be deployed in Nigeria majoring my interest on Advanced traveler information system. In a highly mobile society, accurate and timely traffic information can help travelers reach their destinations quickly and safely. To serve this information need, Advanced Traveler Information Systems (ATIS) that provide real-time pre-trip and en route traveler information are introduced to help drivers avoid congestion and choose timesaving and safe route. This research work highlights examples of countries that have already and are deploying ITS. It equally went further to explain the technologies involved and the working principles, limiting ITS application to only Advance traveler Information System.*

Keywords: ITS, Traffic, ATIS, Travelers

1. Introduction

Intelligent Transportation System could be traced back to the 1960's with the development of the Electronic Route Guidance System or ERGS in the U.S to provide drivers with route guidance information based on real-time analysis. The system used special hardware located at various intersections across the road network, on-board 2-way devices in vehicles that would form the hub of communication between the drivers and the ERGS system, a central computer system that processed the information received from the remote systems.

Two researchers, Kan Chen and Bob Ervin, conceived the acronym IVHS -intelligent vehicle highway systems (IVHS) and were instrumental in expanding its scope and renaming it ITS [1]. ITS takes into consideration complex and asynchronous interdependencies between the many transportation modes and the fundamental goal of ITS is namely;

- a) Minimize the transit time for all travelers and merchandise in transit, subject to fair distribution of the available resources &
- b) Safety assurance;

The availability of computing engines fueled the second major revolution in transportation systems wherein fast and precise computers were exploited to efficiently control and coordinate the transport of goods and people across the system. [1].

In the last few years it is clearly evident that traffic congestion caused by rapid growth of mobility demand with respect to transportation systems has become a severe problem which has impacts not only on the economy but also for the ecological aspects involving pollution, noise emission and many more.

“While many think that improving a countries transportation system solely means building new roads or repairing aging infrastructure, the future of transportation lies not only in concrete and steel but also increasingly in using information Technology. IT enables elements within the transportation system—vehicles, roads, traffic lights, message signs, etc.—to become intelligent by embedding them with microchips and sensors and empowering them to communicate with each other through wireless technologies.”[2].

2. Statement of Problem

The following are the problems faced currently in today's Nigerian transportation system:

- i. Environmental pollution due to long-spent time on a carbon used vehicle.
- ii. Several losses of time, productive hours, due to traffic congestion, loss of lives and property due to road accidents.
- iii. Over dependency on road construction and ignorance of possible solutions presented by intelligent transportation system.

3. Aim of the ITS System

The aim of this research/study is not to dwell on the fixed elements (road design & construction) of the transportation system, nor to evaluate and highlight the prevailing problems bedeviling the Nigerian transportation system but;

- 1) The primary goal of this research is to expand the use and applications of Intelligent Transportation System (Traveler information system) by the road transit sector, which can help in turn, bring about effectiveness of road usage, congestion reduction and crime fighting.

- 2) Educate the public and key players in the Nigerian transport system on the need for ITS and how intelligent transportation system can be deployed in Nigeria.
- 3) To identify the solutions which ITS possess for effective transportation system as well as identify and evaluate the principles of NITS (Nigeria's Intelligent Transportation system).

Transportation system relies much and is built on network & the real value of network lies in the information it provides. This study aims at evaluating, showcasing the contributions, working principles, as well as promises of ICT & ITS for effective transport system. The study describes applications of intelligent transportation systems (ITS), systems that deploy communications, control, electronics, and computer technologies to improve the performance of highway, transit (road), and even air and maritime transportation systems.

4. Review of Literature Relating to ITS

4.1 Review of Past works on ITS

4.1.1 Smart and Green's

Tony and Ghosh, Reports a new, efficient traffic management system that utilizes microprocessors and local area networks to achieve online signal optimization [3].

The RIDOT aims to inform the public of predictable and dynamic sources of congestion through traffic reports on radio stations. For accurate reports, RIDOT plans to consolidate information from visual air traffic patrols, video cameras, RIDOT ground vehicles, public safety patrols, emergency vehicles, and motorists through a standardized information exchange format and by utilizing a combination of computers, modems, and fax machines.

A 24-hour toll-free telephone incident reporting mechanism and a free "SP" dedicated cellular phone line are also planned. In addition, RIDOT plans to improve the use of existing traffic loops and explore alternate detection schemes in high-accident-prone areas [3].

An area-wide traffic control system (ARTC), wherein traffic flow information is frequently exchanged between signal controllers to successfully address frequent occurrences of congestion [4]. The system exhibits improved success over an optimized fixed time control and adequate level of fault tolerance.

4.1.2 Von Tomkewitsch presented ALI-SCOUT.

ALI-SCOUT; a dynamic route guidance system with onboard computers. An automobile receives routing information from a centrally located traffic computer through infrared communications beacons that are strategically located at traffic lights. The central computer utilizes current traffic conditions to determine a route tree, that is, the best routes [5]. The onboard computer receives the route tree and selects the appropriate route based on its destination. The report superbly discusses key issues relative to the use of infrared communications beacons and notes that the approach had been field tested for 700 vehicles. However, it does not provide any performance measures,

and, while it is uncertain whether the approach will scale-up, the use of a central computer to generate the route tree is likely to inhibit the scalability of ALI-SCOUT.

4.1.3 DICAF

Taylor & Francis proposes the use of a distributed architecture wherein the overall task of data collection, processing, dissemination of information, and decision making is distributed among all of the components of the IVHS system. The fundamental philosophy is to intelligently distribute decision making tasks among the entities to maximize local computations, minimize communications, and achieve robustness and high throughput.

A direct consequence of this philosophy is scalability, that is, where the underlying system will continue to function and deliver relatively undiminished performance as the system grows in size with an increasing number of vehicles and highway segments. The intent of the architecture is to influence every driver's routing decision by providing accurate and adequate highway data, timely, to help him/her plan alternatives, rather than dictate routes that inevitably lead to driver resentment and rejection of the system.

Allen, Ziedman, Rosenthal, Stein, Torres, and Halati reports that, in simulation studies, the navigational system characteristics have significant effect on driver route diversion behavior, with better systems allowing more anticipation of traffic congestion [1].

4.1.4 Review from University of Ilorin Department of Civil Engineering

Jimoh & Adeleke, in 2005 reviewed ITS and the facilities that makeup its operation, analyzing its implementation in the Nigerian system arguing that with the current financial and technological strength of the Nigerian Economy little may be achieved in the implementing ITS [6].

4.2 Countries and ITS Deployment

The scope of this assessment is limited generally to ITS technologies and applications previously enumerated, focusing more on the application of ITS in the road transportation network and for the benefit of motorists. Most advanced countries are in some way, shape, or form deploying intelligent transportation systems. Approximately ten countries are taking moderate to significant steps to deploy

ITS applications, including: Australia, France, Germany, Japan, The Netherlands, New Zealand, Sweden, Singapore, South Korea, the United Kingdom, and the United States. (A number of developing countries, notably Brazil, Taiwan, and Thailand are also deploying increasingly sophisticated intelligent transportation systems. China has also committed to making rapid leaps in ITS, and endeavors to become a world leader in the not-too-distant future.)⁸¹ Many of these countries have particular strengths in ITS, notably: real-time traffic information provision in Japan and South Korea; congestion pricing in Sweden, the United Kingdom, and Singapore; vehicle-miles traveled systems in The Netherlands and Germany; electronic toll collection in Japan,

Australia, and South Korea; APTS in South Korea, Singapore, and France. But while there is a coterie of leading countries in ITS, several in particular stand out as world leaders: Japan, South Korea, and Singapore. As market research firm ABI Research concurs, "Japan and South Korea lead the world in intelligent transportation systems."⁸² Singapore appears to be in the upper echelon of ITS leadership as well [2]

4.2.1 Japan

Initially, VICS collected traffic data through sensors embedded in or beside the roadway, traffic cameras, or traffic reports (for example, from police or motorists). But since 2003, traffic and congestion information in Japan has been generated increasingly through the use of probe vehicles, specifically by making VICS-enabled vehicles the probe vehicles themselves. Japan views probe vehicles as "a system for monitoring and collecting data on the precise traffic flow, traffic behavior, positions, vehicle behavior, and weather and natural states by using vehicles as moving traffic-monitoring devices."

4.2.2 South Korea

South Korea's Expressway Traffic Management System (ETMS) collects real-time traffic information through three primary mechanisms: 1) vehicle detection systems (VDS), which are installed inductive loops within expressways at intervals of 1 km that detect information such as traffic volume and speed, 2) closed-circuit cameras deployed every 2 to 3 km, and 3) vehicle probe data. This data is communicated to South Korea's National Transport Information Center (NTIC) via a very high-speed optical telecommunication network deployed to support the country's ITS applications (including also South Korea's Hi-Pass electronic toll collection and electronic fare payment systems.)¹⁰¹ The NTIC, South Korea's integrated traffic information service, aggregates data from 79 different transport authorities [2].

4.2.3 Singapore

Singapore is a world leader in intelligent transportation systems based on its:

- use of probes vehicles to collect traffic information,
- use of electronic road pricing (that is, congestion charging),
- nationwide deployment of adaptive computerized traffic signals,
- and use of traffic management ITS applications.

Singapore's Land Transport Authority (LTA) has responsibility for all modes of transportation in the country and oversees implementation of intelligent transportation systems in Singapore. The country's ITS Master Plan envisions "an optimized and efficient land transport network leveraging ITS to enhance commuters' travelling experience." The three strategic thrusts of Singapore's ITS Master Plan include [2]:

- Deploying and integrating ITS across Singapore,
- Developing partnerships between the private sector and government agencies (as well as other stakeholders), and
- Viewing ITS as a platform for industry development.)



Figure 1: Congestion pricing gantry at North Bridge Road, Singapore [7]

5. Application of ITS

Intelligent transportation systems (ITS) are advanced applications which, without embodying intelligence as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks [7]. Although ITS may refer to all modes of transport, EU Directive 2010/40/EU (7 July 2010) defines ITS as systems in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes of transport.[8]

ITS applications can be grouped within five primary categories [2]:

- Advanced Traveler Information Systems (ATIS),
- Advanced Transportation Management Systems (ATMS),
- ITS-Enabled Transportation Pricing Systems,
- Advanced Public Transportation Systems (APTS), and
- Fully Integrated ITS Systems (VII and V2V Systems).

5.1 Advanced Traveler Information Systems

Advanced Traveler Information Systems (ATIS) provide drivers with real-time travel and traffic information, such as transit routes and schedules; navigation directions; and information about delays due to congestion, accidents, weather conditions, or road repair work. The most effective traveler information systems are able to inform drivers in real-time of their precise location, inform them of current traffic or road conditions on their and surrounding roadways, and empower them with optimal route selection and navigation instructions, ideally making this information available on multiple platforms, both in-vehicle and out. As Figure 1 illustrates, there are three key facets to the provision of real-time traffic information: collection, processing, and dissemination, with each step entailing a distinct set of technology devices, platforms, and actors, both public and private. This report will examine several countries' strategies regarding the provision of real-time traffic information.

5.2 Advanced Transportation Management Systems

Advanced Transportation Management Systems (ATMS) include ITS applications that focus on traffic control devices, such as traffic signals, ramp metering, and the dynamic (or “variable”) message signs on highways that provide drivers real-time messaging about traffic or highway status. Traffic Operations Centers (TOCs), centralized traffic management centers run by cities and states worldwide, rely on information technologies to connect sensors and roadside equipment, vehicle probes, cameras, message signs, and other devices together to create an integrated view of traffic flow and to detect accidents, dangerous weather events, or other roadway hazards. Another advanced transportation management system that can yield significant traffic management benefits is ramp metering. Ramp meters are traffic signals on freeway entrance ramps that break up clusters of vehicles entering the freeway, which reduces the disruptions to freeway flow that vehicle clusters cause and makes merging safer.

5.3 ITS-Enabled Transportation Pricing Systems

ITS have a central role to play in funding countries’ transportation systems. The most common application is electronic toll collection (ETC), also commonly known internationally as “road user charging,” through which drivers can pay tolls automatically via a DSRC-enabled on-board device or tag placed on the windshield (such as E-Z Pass in the United States). The most sophisticated countries, including Australia and Japan, have implemented a single national ETC standard, obviating the need, as in the United States, to carry multiple toll collection tags on cross-country trips because various highway operators’ ETC systems lack interoperability. This particularly has been a problem for the European Union, although the European Committee for Standardization is working to resolve this challenge (and has made considerable progress). Another ITS-enabled alternative countries are evaluating for financing their transportation systems is a vehicle miles traveled (VMT) fee system that charges motorists for each mile driven. VMT fee systems represent an alternative to the current fuel taxes and other fees that many countries and states use to finance their transportation systems. Holland’s “Kilometerprijs” (price per kilometer) program is slated to be the world’s first nationwide VMT system implemented for both passenger vehicles and heavy vehicles. The Kilometerprijs program will replace fixed vehicle (ownership) taxes to charge Dutch citizens by their annual distances driven, differentiated by time, place, and environmental characteristics.

5.4 Advanced Public Transportation Systems

Advanced Public Transportation Systems (APTS) include applications such as automatic vehicle location (AVL), which enable transit vehicles, whether bus or rail, to report their current location, making it possible for traffic operations managers to construct a real-time view of the status of all assets in the public transportation system. APTS help to make public transport a more attractive option for commuters by giving them enhanced visibility into the arrival and departure status (and overall timeliness) of buses

and trains. This category also includes electronic fare payment systems for public transportation systems, such as Suica in Japan or T-Money in South Korea, which enable transit users to pay fares contactless from their smart cards or mobile phones using near field communications technology. Advanced public transportation systems, particularly providing “next bus” or “next train information, are increasingly common worldwide, from Washington, DC, to Paris, Tokyo, Seoul, and elsewhere.

5.5 Vehicle-to-infrastructure Integration (VII) and Vehicle-to-vehicle (V2V) Integration

Vehicle-to-infrastructure integration is the archetype for a comprehensively integrated intelligent transportation system. IntelliDrive envisions that DSRC-enabled tags or sensors, if widely deployed in vehicles, highways, and in roadside or intersection equipment, would enable the core elements of the transportation system to intelligently communicate with one another, delivering a wide range of benefits. For example, IntelliDrive could enable cooperative intersection collision avoidance systems (CICAS) in which two (or more) DSRC-equipped vehicles at an intersection would be in continuous communication either with each other or with roadside devices that could recognize when a collision between the vehicles appeared imminent (based on the vehicles’ speeds and trajectories) and would warn the drivers of an impending collision or even communicate directly with the vehicles to brake them.²⁴ IntelliDrive, by combining both vehicle-to-vehicle and vehicle-to-infrastructure integration into a consolidated platform, would enable a number of additional ITS applications, including adaptive signal timing, dynamic re-routing of traffic through variable message signs, lane departure warnings, curve speed warnings, and automatic detection of roadway hazards, such as potholes, or weather-related conditions, such as icing

6. Characteristics and Benefits of ITS

Some of the special characteristics of ITS include but not limited to the following:

- a. Information dispels and wears out ignorance:** The single biggest cause of driver impatience that leads to reckless driving, incidents, road rage, and accidents is ignorance. When a traveler encounters an obstacle and does not know what lies ahead, a rational or irrational fear may arise in that he or she might not succeed in reaching the destination on time, which, in turn, may have untold consequences
- b. Automated computation:** Unlike in many transportation systems across the world where the decision making and the computation of the arrival times are still estimated manually, future system architectures must employ automated decision-making computer systems to yield accurate information and achieve precise control and coordination
- c. Accuracy of information is crucial:** Information must be accurate, timely, relevant, and consistent. Otherwise, drivers will begin to question the value of the ITS technology and may even abandon it prematurely. Any out-of-date piece of data can quickly assume the form of misinformation with severe unintended consequences.

d. Respect for drivers' freedom is of paramount importance: Except under true emergency conditions, the ITS architecture should neither attempt to control nor dictate a driver's behavior.

e. The individual traveler must constitute the focus: The ITS architecture must be fundamentally centered around each individual driver or traveler, subject to safety and fair resource availability for all

f. The design of asynchronous, distributed algorithms for control, coordination, and resource management: Since the constituent units and the resources of any transportation system are geographically dispersed, it is logical for future system architectures to exploit distributed algorithms.

g. Continual checking for operational errors: By their very nature, complex. Systems may contain design errors that manifest irregularly during operations and elude detection but are severely damaging

5.1 Benefits of ITS

Applying information technology to a country's transportation network delivers five key classes of benefits by:

- Increasing driver and pedestrian safety,
- Improving the operational performance of the transportation network, particularly by reducing congestion,
- Enhancing personal mobility and convenience,
- Delivering environmental benefits, and
- Boosting productivity and expanding economic and employment growth.

7. ITS Technologies

The technologies underlining the development of ITS includes:

- Information technology/processing
- communication
- Controls &
- Electronics

Some of the networking technologies used in ITS include the following:

- 1) Global Positioning System (GPS):** Embedded GPS receivers in vehicles' on-board units (OBUs, a common term for telematics devices) receive signals from several different satellites to calculate the device's (and thus the vehicle's) position.
- 2) Dedicated-Short Range Communications (DSRC):** DSRC is a short- to medium-range wireless communication channel, operating in the 5.8 or 5.9GHz wireless spectrum, specifically designed for automotive uses.
- 3) Wireless Networks:** Similar to technology commonly used for wireless Internet access, wireless networks allow rapid communications between vehicles and the roadside, but have a range of only a few hundred meters.
- 4) Mobile Telephony:** ITS applications can transmit information over standard third or fourth generation (3G or 4G) mobile telephone networks. Advantages of mobile networks include wide availability in towns and along major roads..

5) **Radio wave or Infrared Beacons:** Japan's Vehicle Information Communications System (VICS) uses radio wave beacons on expressways and infrared beacons on trunk and arterial roadways to communicate real-time traffic information. (Arterial roadways are moderate capacity roadways just below highways in level of service; a key distinction is that arterial roadways tend to use traffic signals. Arterial roadways carry large volumes of traffic between areas in urban centers.) VICS uses 5.8GHz DSRC wireless technology.

6) **Roadside Camera Recognition:** Camera- or tag-based schemes can be used for zone-based congestion charging systems (as in London), or for charging on specific roads.

7) **Probe Vehicles or Devices:** Several countries deploy so-called "probe vehicles" (often taxis or government-owned vehicles equipped with DSRC or other wireless technology.

8. The Old System Review

The weaknesses of the old system of transport management in Nigeria was analyzed, after making some enquiries via consultations from students of civil engineering and construction and survey from road users the following questions were analyzed;

- Why is there so much traffic congestion in the Nigerian transport system
- What technology is currently in place to provide traffic information

The answers to these questions were gotten by properly analyzing the present system. The comprehensive research carried out on the existing system enabled us arrive at relevant facts where helpful in the model of Nigeria's intelligent transportation system. The system applied in Nigeria transport sector provide some great limitation and challenges which include:

- Poorly manage & control traffic without pre- informed alternative route guidance
- Disobedience to traffic rules
- Police check points contributes to traffic congestion
- Little or no route monitoring facilities

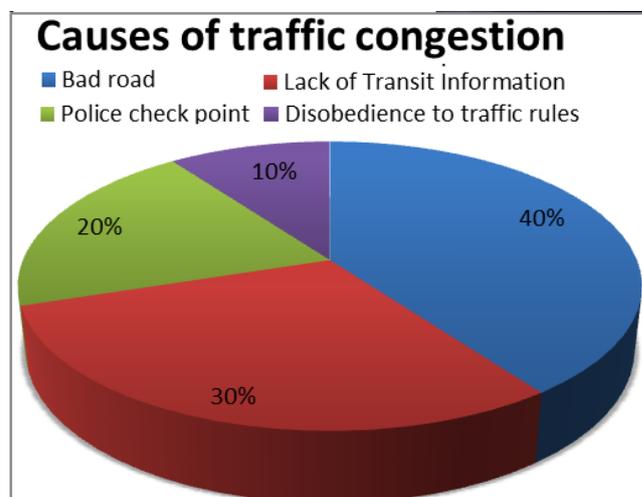


Figure 2: Causes of traffic congestion analysis

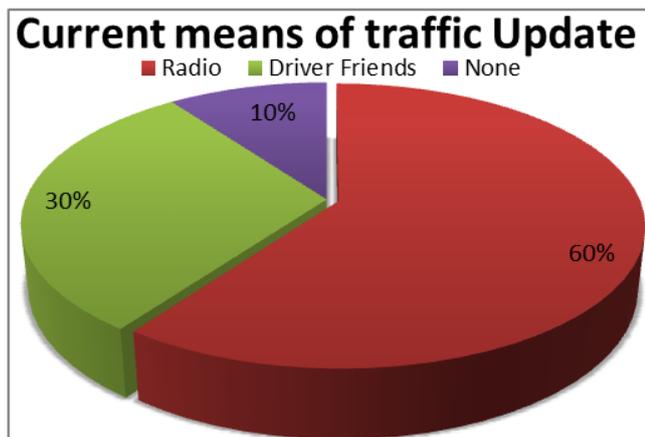


Figure 3: Current means of transport

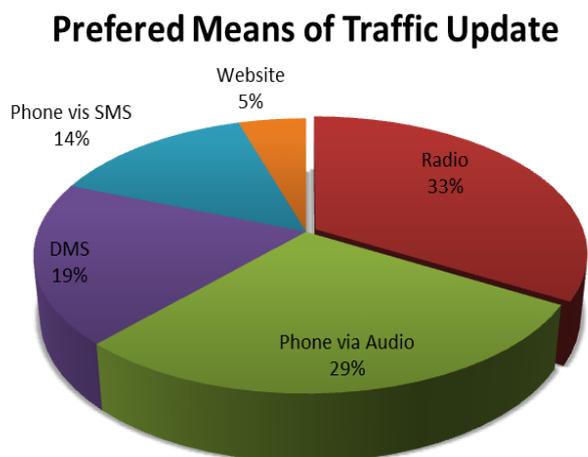


Figure 4: Preferred Mean of Transport in Nigeria

9. The new ITS model for Nigeria

What intelligent transportation systems do is empower actors in the transportation system—from commuters, to highway and transit network operators, even down to the actual traffic lights themselves—with actionable information (or, intelligence) to make better-informed decisions, whether it's choosing which route to take; when to travel; whether to mode-shift (take mass transit instead of driving); how to optimize traffic signals; where to build new roadways; what the true cost of roadways are and how best to price their use; or how to hold providers of transportation services accountable for results. The big opportunity at hand is to bring information to bear on transportation networks, transforming them into truly intelligent transportation systems.

The new system design view (which my research gives a full description of its deployment procedure for Nigeria) focuses on the following benefits;

- Increasing safety,
- Improving operational performance, particularly by reducing congestion,
- Enhancing mobility and convenience,
- Delivering environmental benefits, and
- Boosting productivity and expanding economic and employment growth.

The proposed new system is able to achieve the above benefits by possession of the following capabilities;

- Way finding technologies & route guidance mechanisms
- Sensor & dedicated short distance communication technologies
- Wireless & wired technologies etc.

9.1 General ITS communication network technical specifications:

- Fiber optic backbone use single mode fibers to support 1310 -1550nm
- Fiber optic backbone capable of supporting 10 Gb or higher bandwidth
- Fiber optic backbone support MPLS and other communication protocols
- Wireless backbone consist of Microwave Links of 200 - 500 mbps
- WiMax Base Stations utilized the 4.9 Ghz Public Safety frequency.
- WiMax base station has a minimum range of 4-5 kilometer
- WiMax Base Station supports a maximum of 25 simultaneous subscribers
- Network supports real time video, data and voice across the island
- Network must be scalable with 999.99% availability
- Traffic signals and CCTV cameras (IP) to use GEAPON network equipment

9.2 Data Flow Process of ITS.

There are three key facets to the provision of real-time traffic information: collection, processing, and dissemination, with each step entailing a distinct set of technology devices, platforms, and actors, both public and private.

A. Input / Data Collection Facilities;

- 1) Video detectors
- 2) Video surveillance camera and CCTV
- 3) Fixed sensors
- 4) Vehicle probe

B. Processing facilities;

- 1) Traffic management centers with control equipments
- 2) Computers hardware & software processed remotely & by human administrators

C. Output/dissemination facilities;

- 1) Telephone
- 2) Television
- 3) Internet
- 4) Dynamic message signs
- 5) onboard telemetric unit
- 6) Highway advisory radio

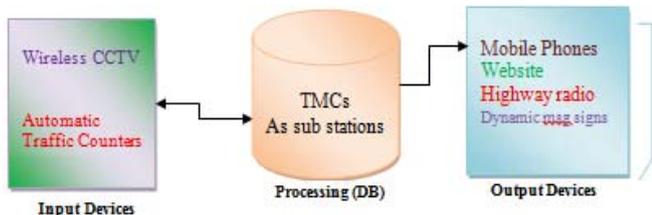


Figure 5: Dataflow diagram of the ITS system

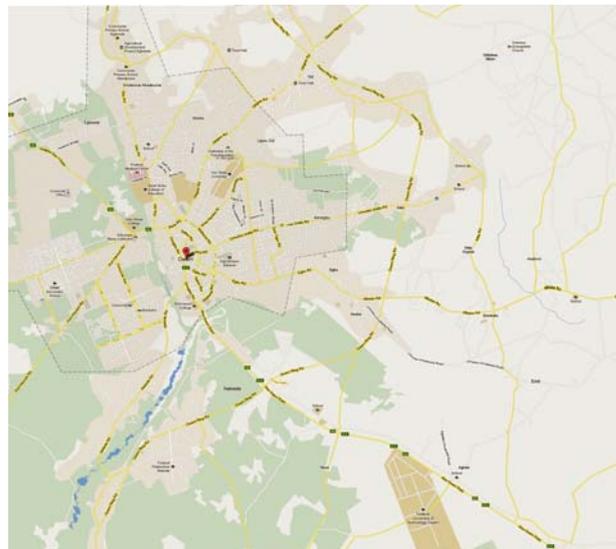


Figure 6: Owerri city map (From www.google.com/map)

9.3 Project Case Study (Owerri Municipal)

Owerri is a city located in Imo state in eastern part of Nigeria. It is not necessarily an industrialized city but known for its commercial activities. As the capital city of Imo state, its major public activities is built around public services and several private operations such as banks, Schools, major sales and distribution outfits, shopping mulls etc. Typically, Owerri is known as a center of Academic activities with four major tertiary institutions namely; Federal University of Technology owerri, Imo state university, Federal poly Nekede, Alvan Ikoku Colledge of education and Imo state polytechnic. These institutions coupled with lots of commercial activities only but characterizes the human and vehicle state as “congested” especially during peak hours. Also with located nearby towns of which most occupants find their ways to the city for work or for commercial activities. Owerri is also a major bypass for other major cities such as Onicha, PortHarcourt, Aba & Umuahia, therefore adding to the road network usage.

9.4 Brief Description of Owerri Road Network & Infrastructures.

I generated the city map using Google-map showing the road network of Owerri municipal, and also from a personal visit to the city I gathered the various major and arterial ways in the city. I discovered that most of the major routes are tarred with lots of inter-connected nodes or inner city roads, while construction of more roads are still be carried out by the state government.

Table 1: Road network in Owerri (tarred)

Express Roads	Inter-State Roads	Inner-City Routes	Hotspots & Junctions
Onitcha-Owerri rd.	Worldbank rds	Tetlow road	Assumpta –control
Portharcourt-Owerri rd	Orlu road	New owerri road (from control, opposite orlu road)	Orlu-Control junction
Aba-Owerri road	Orlu-works road	Nbaise-by douglas	FMC junction-bu orlu
Umuahia-Owerri road.	Bank road	School road (wethderal by douglas)	Douglas by bank road (from control)
	Control area	Douglas by Wethderal	Bank-by tetlow junction
	Wethderal road	New market to concorde road	Douglas-Nbaise junction
	Okigwe-IMSU road		Dan anyam stadium junction
	Umuoba-Urata road		Jerobin junction
	Egbu road		Wethderal by ITC junction
			Aba-Naze junction

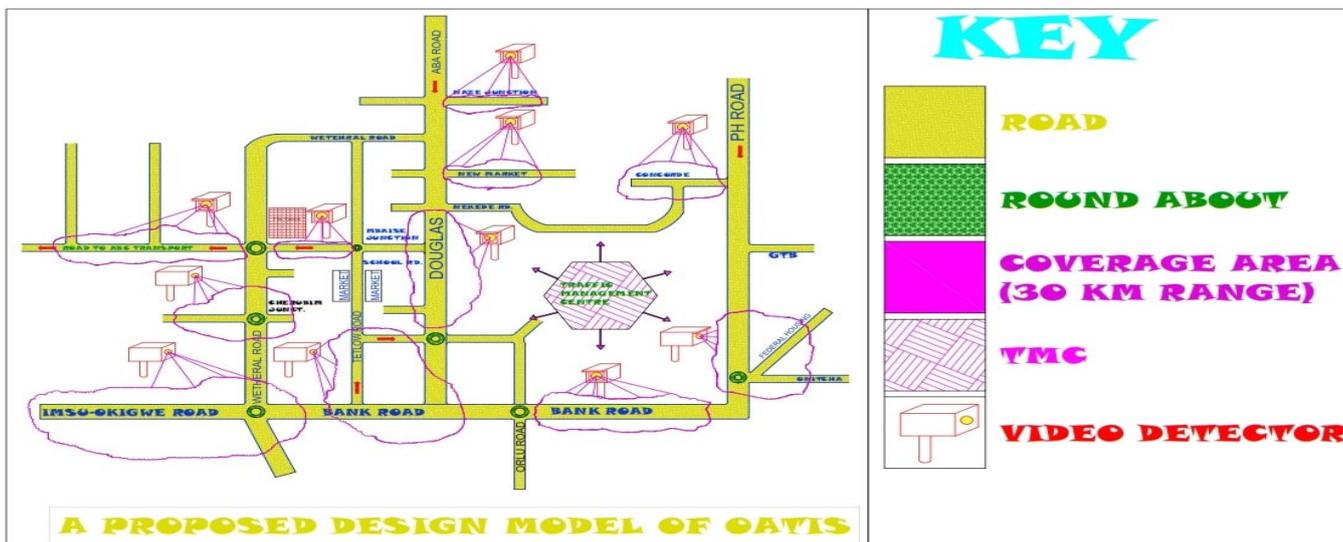


Figure 7: Proposed network model for owerrii municipal

9.9.5 Inputs of Owerri ATS of the ITS model

For the deployment of Owerri ATIS the following input materials are needed;

- a. Upgrading traffic signal controller equipment to support IP communication
- b. Procurement of video management equipment and software applications.
- c. Procurement of Advance Traffic Signal Management Software (recommended but not within the scope of this project modeling)
- d. Procurement of CCTV cameras and supporting software
- e. Procurement of dynamic message road signs & development of the controlling software.
- f. The construction of three (3) distributed Traffic Management Centers in Owerri.
- g. Upgrading traffic signal poles to support CCTV camera installation
- h. Procurement of wireless communication network (broadband) as well as fibre optic cables for the networking of the field devices and the three traffic management centers.

9.6 Traffic Management Centre (S)

The Traffic Management Centers serve as the major point of connectivity between the array of field devices and the TMC. Real time information in the form of video and data is collected and analyzed at the TMC. Real time information on traffic conditions will be disseminated to the general public via local media, internet and smart phones

In my literature review of chapter two, I reviewed a lot of past works done on ITS, I discovered the Central control system of monitoring, processing and dissemination of information to the road users has a lot of bias and was criticized by most professionals in the field of ITS. Solutions preferred was the Distributed traffic control system, where the field dedicated devices are intelligently controlled by automated devices along the road network without having only one dedicated control center which stands the risk of failure. However, a consideration of the financial and technological involvements and suggest a decentralized traffic control system (for Owerri), which involves construction of three traffic control centers (to reduce cost government offices could be deployed) along major centers of Owerri municipal and all three centers linked up by the internet to communicate with each other for proper dissemination of information.

10. Conclusion

The rapidly increasing vehicle population in Nigeria, spurred by the population boom has contributed to the burden of traffic management in the Nation. No doubts, the government have employed various means such as contraction of more roads, initiating road safety rules and policies, etc to curb the problem but to no avail.

From this studies, little or nothing have been done in the field of ITS in Nigeria. As a matter of fact, majority of

people in Nigeria knows little or nothing about Information technology's impact in the transportation sector, meanwhile most developed (and even developing countries) of the world have & are maximizing the benefits of ITS to solving traffic congestion.

The adoption of location and information based technologies both in vehicles, infrastructure, traffic management, and traveler information services continue to show drastic improvement in the effective and efficient mobility of people and goods.

However, the design and implementation of an intensive ITS program hinges on the following developments;

- a. Technology: The development and implementation of ITS, is important to the successful management and operation of ITS in Nigeria. These technologies include Electronic equipments such as sensors, detectors, communication devices and global navigation satellite system (which we already have).
- b. Cooperative effort: ITS can only be made possible in Nigeria through a cooperative effort between the Government, industries and private companies as well academic/research institutions. I strongly recommend the sponsorship of further research of ITS by students at various level to fully appreciate the potentials as well as the working modalities of ITS.
- c. Modeling of Nigeria traffic: The pictorial model I developed captures the various elements of ATIS, with details of components deployed, but further studies must be carried out to modify or develop the real or ideal (practical) model that can effectively characterize the traffic situation in Nigeria or owerri in specific.
- d. Supply Chain: seamless interconnectivity of the various branches of the transportation sector is essential to provide effective, efficient and secured movement of goods and services while improving the conservation of natural resources and reducing the environmental impact of effects of carbon emissions.
- e. Human capital development: The need for a fully developed human capital for the effective deployment of existing and emerging technologies of ITS cannot be overemphasized.
- f. Energy and sustainability: ITS deployment in Nigeria relies heavily in the energy and power sector of Nigeria. A close work with the energy sector is needed in the promotion of fuel efficient transport policies and practice.

11. Recommendation

As discussed in the chapter three of this work, Intelligent Transportation system can only be achieved through partnership and collaborative efforts of the concerned disciplines and institutions. It is not a one-man task. Being fully aware that the existing models of ITS as adopted in other developed countries may not work in the Nigerian context, I have taken it upon myself to review various models adopted by other Nations and have designed a Pictorial model as well as cost benefit analysis of the Owerri Advanced travelers information system to suite the financial and technological strength of the state.

However, a plethora of issues and challenges have to be tackled before Nigeria can have a fully operating ITA.

The following strategies are recommended for the effective deployment of ITS in Nigeria:

- a. Establishing ITS standards applicable throughout the urban and rural sections of Nigeria.
- b. Setting up between academics, industries and government agencies.
- c. Repair of worn out roads in most urban and rural road networks as well as expansion (to a reasonable degree) existing road network to accommodate the large number of road users.
- d. Setting up rules and regulations of traffic that would aid ITS implementation.
- e. Setting up aggressive yet achievable short and long term goals for transportation system.

If ITS must be deployed in Nigeria, most importantly Nigerians (stakeholders) must be aware of the potentials presented by ITS and believe in the possibility of its deployment in Nigeria.

11.1 Future Scope

Intelligent transport system is a very important component of any society that seeks to grow its transportation sector. This work focuses more on the integration of Advance travelers' information system. Other areas which include the ITS enabled transportation prizing system, Advance public transportation system among others, are areas that could be worked on in future.

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