ADVANCED INTER-BORDER INFORMATION AND COMMUNICATION TRANSPORT MANAGEMENT SYSTEM FOR AFRICA DEVELOPMENT INTEGRATION: A PROPOSAL

Dukiya Jehoshaphat Jaiye, Abiodun Musa Aibinu,
Abiodun Taliha Folorunso and Habeeb Bello-Salau
Federal University of Technology, Minna, Nigeria
duksat2000@futminna.edu.ng; abiodun.aibinu@futminna.edu.ng;
funso.taliha@futminna.edu.ng & habeeb.salau@futminna.edu.ng

ABSTRACT

Africa's major development challenges are the acceleration of economic growth and the reduction of poverty. The Trans-African Highway network is being developed by the United Nations Economic Commission for Africa (UNECA), the African Development Bank (ADB), and the African Union in conjunction with regional international communities. Trans-border delay is still a major problem in these highway networks even where there is regional paved road. Intelligent Transport System (ITS) is the global response to transportation bottlenecks in term of real-time information dissemination for effective transport management. The main aim of this study is to design an Advanced Inter-Border Information and Communication Transport Management System for Africa Economic Integration and propose mechanism for integrating existing vehicle and truck recognition system into a single database system. The study includes the design of hybrid vehicle plate recognition system for border monitoring and tracking that will run on a secured server with a Distributed Database Management System (DDMS) with user authentication capabilities to prevent unauthorized viewing of generated report by individuals with lower clearance level. The entire system will be designed with mirroring of the database system in Cloud in providing access to information from any part of the continent. In realizing the design, there is the need for Intergovernmental Panel on Inter-border Land Transport System (IPITS) and annual budgetary allocation to the scheme by all the member nations.

KEYWORDS: Communication, Intelligent Transport System, Security, and Trans-border

1.0 INTRODUCTION

A transportation system as an element of regional and national integration can be defined as consisting of fixed facilities, the flow entities and the control systems that permit people and goods to overcome the friction of geographical space efficiently in order to participate in a timely manner in some desired activities as well as ensuring the safety and security of the citizenry as a result of movement of people, goods and other commodity across the border. Border security is the ability to control movement across national borders. This movement which includes people, goods, drugs, weapons etc. across the border can be legal or illegal with one of the most paramount means of transportation across the border being land transportation. The movement of people, goods and other commodity across the border is paramount to the stability, peace and progress of any nation (Anderson, Boucher & Hamlin 2010). As essential as this movement may be to development of a nation’s economy, there is usually undue hardship experienced by travellers across the border in form of stop and search operation of vehicle at highways checkpoints and border controls.

Africa's major development challenges are how to accelerate the economic growth and reduce poverty to the tolerance level. The potential of road development for investment, trade, growth and poverty alleviation has long been recognized. Not only do road transport infrastructures facilitate the direct provision of services to consumers, but it provides intermediate inputs that enter into the production of other sectors and raise productivity. By lowering the cost and time of goods and services movement across African countries, the crusade for continental development, sustainable and self sufficiency programmes will be achieved with ease. The Trans-African Highway network for instance, is said to comprise of transcontinental road projects in Africa which is being developed by the United Nations Economic Commission for Africa (UNECA), the African Development Bank (ADB), and the African Union in conjunction with regional international communities. It is basically aimed at promoting trade and alleviate poverty in Africa through highway infrastructure development and the management of road-based trade corridors. Regrettably, trans-border delay is still a major problem in these highway networks even with regional asphalt roadway surfacing.
Nigeria for instance, is said to have a relatively poor history of international cooperation in road-building, particularly the loosely integrated states, border restrictions were often tightened rather than relaxed as a way of protecting internal trade and as a weapon in border disputes. The need to reduce delays caused by highway checkpoints and border controls or to ease travel restrictions is what software like Automated System for Customs Data (ASYCUDA) is expected to achieve, but so far much is yet to be achieved. Rather than just having international highways over which each country maintains its regulations and practices, there is a need for transnational highways over which regulations and practices are simplified, unified and implemented without causing delays to goods and travellers.

The modern day technological advancement in vehicular design and automated road infrastructure is tending toward classification and reclassification of road users and in particular the vehicle drivers through the use of the various Intelligent Transport System (ITS) models. ITS is the global response to transportation bottlenecks in term of real-time information dissemination for effective transport management (Anderson, Boucher & Hamlin 2010). The EU and American regions of the world have benefited immensely from this technological innovation that Africa need to key-in for accelerated sustainable development before the global targeted year 2020.

Hence, the main aim of this project is to propose the design of an advanced Inter-Border Information and Communication Transport Management System for Africa Countries for economic integration. The focus of the paper also includes among other things: development of vehicle control recognition database system for Nigeria and other African countries; design hybrid vehicle plate recognition system for border monitoring and tracking, and development of a communication system for effective transmission of vehicle particulars at Border points.

2. LITERATURE REVIEW

Borders are constructed to designate a territory united by a common political/legal system; it defines the citizenship and sovereignty of a country, the limits of economic regulation including currency, tariffs, and taxes. Although there appear to be definitive political boundaries between countries on large-scale geopolitical maps, it should be understood that in most circumstances, borders are essentially virtual. In some cases, the very definition of land borders has been the cause for conflicts between countries. Land borders are distinguished by ports of entry (POE) and areas in between, hereafter referred to as frontier borders. The long distances and variability of terrain associated with land borders makes this type of border particularly challenging to manage. Therefore, it is important to understand how the country defines it borders and whether those borders are accepted by its neighbours. A country's border security then is dependent on its coverage and the issues associated with each zone of its border, how it manages its POEs and frontier borders in accordance with its border doctrine, and how well it performs the functions of immigration, customs, and border policing.

According to Afua (2013), the 2012 crisis in Mali, and by extension, the Sahel, has brought several critical questions to the fore in terms of border management. The ease and speed with which rebels, weapons and contraband materials were smuggled into the Sahel from Libya further exposed the inadequacy of established structures in terms of agencies, systems, policies, laws and procedures relating to border security management. The illicit traffic associated with people and goods must also be detected together with other economic factors that also influence border management. The spirit of global village and technology diffusion necessitate integration and cooperation of one sort or the other that require management. These challenges can be broadly divided into human, commodity, political, and economic challenges.

2.1 Border Management Challenges

Border management is often faced with a number of challenges which includes the sheer volume of legal movement of people and goods traffic that impact on design and operations of ports of entry. There are political and other economic factors that also influence border management systems which can be examined using three mutually exclusive perspectives for analysis: the border itself (defined as POEs and the areas in between referred to as frontier borders); the national or country perspective wherein the government defines its sovereign limits and border policies; and the regional/global context in which the border systems operate. Each of these perspectives can be considered as a system independently and collectively as interactive whole. Figure 1 show system architecture for possible communications linkages for operational and strategic level cooperation and coordination. This system architecture according to Ruth (2008) can provide a country a reference tool by which to examine different elements of the border management system toward more strategically deploying a system of personnel, physical elements, and information systems to implement border policies regulating the flow of people and goods across national boundaries and to defend against national security threats

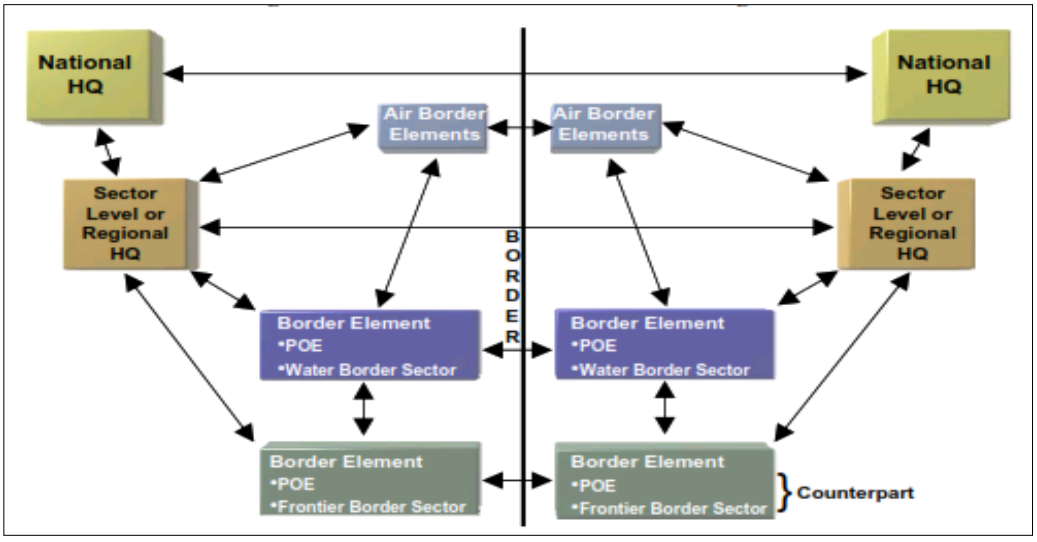

FIGURE 1 Multilevel Communications Linkages
Source: After Ruth A. Duggan (2008)

For effective functionality, it is of great benefit for there to be direct communications between border elements and sectors in all domains, especially regarding changes in smuggling or trafficking routes which can reduce the potential for conflicts and but aid in interdiction.

2.2 Information Systems

Information systems include local communications, intelligence, data management, and data analysis, and are critical to user's interface for interpretation of what the technology is indicating. Radios and telephones may be used for local communications with security forces, data communications between sensors and control stations, and the data communicated between border elements and regional/national headquarters. The capability to receive timely intelligence can impact border personnel performance, Ruth (2008). Border management organizations need data and information to assess the performance of border systems and to manage resources. Ready access to information about persons coming into the country through booking and itinerary information, visit requests, manifest data, and cargo data (such as schedules) can provide border personnel with additional information to facilitate risk assessment or to determine elevated security actions. The Reference Architecture consists of three basic points of view or perspectives that can be used to characterize border management systems. Each perspective has associated facets and component elements as illustrated in Figure 2.

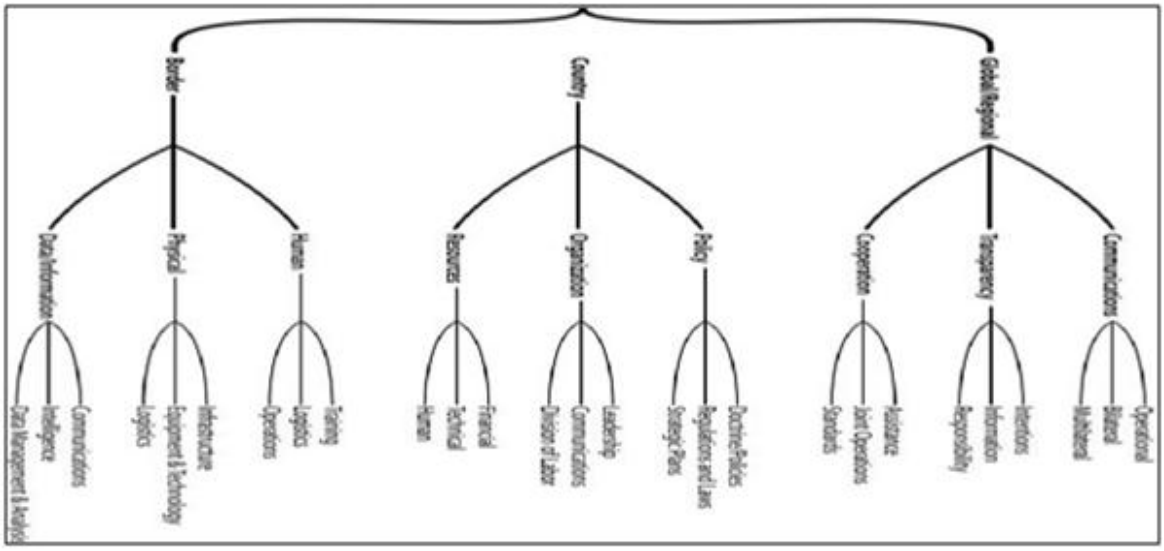

FIGURE 2 Border Management component elements.
Source: After Ruth A. Duggan (2008)

2.3 Integrated Border Management

Integrated Border Management (IBM), as a concept of border management was first applied by the EU as a support activities in the Western Balkans region between 2002 and 2006. This was to enhance the border police and customs in coordinate their work at national and international levels as it affect the expansion of the European Union (and Schengen zone) eastwards. The EU in 2004 created Frontex, an agency dedicated to "the management of operational cooperation at the external borders of the Member States of the European Union."

Underpinning the idea of IBM is that individual border agencies are generally more effective when cooperation is in place. That means cooperation within the agency itself (intra-agency); between the various agencies involved in border management in the same country (inter-agency); and cooperation with the border agencies of neighbouring countries (international). Conversely, when cooperation is lacking in any of these three dimensions, effective border management is diminished. Ultimately, IBM is expected to result in smoother, hassle-free, border crossing for travellers. The EU's own definition of IBM is:

"*National and international coordination and cooperation among all the relevant authorities and agencies involved in border security and trade facilitation to establish effective, efficient and coordinated border management, in order to reach the objective of open, but well controlled and secure borders".*

The U.S. Department of Transportation, Federal Highway Administration (USDOT/ FHWA) in 2009 conducted several projects to measure truck crossing and delay time at major U.S. land ports of entry. The projects identify and evaluate technologies that 1) easily and precisely measure commercial vehicle crossing time, 2) are readily transferable to other ports of entry, and 3) can measure passenger-vehicle crossing time. The first phase of the project, now completed, selected Radio Frequency Identification (RFID) technology to implement and evaluate. (Anderson et al., 2010) Carried out a model for International Border Management Systems in Albuquerque, New Mexico. While (McCord et al., 2014) work on documenting truck activity times at international

border crossings, (Ashley et al., 2011) in Sandia National Laboratories works on International Border Management Systems (IBMS) Program: Visions and Strategies uses Intrusion detection technology, Buried fibber optic cable, Unattended Ground Sensors (UGS), Ground radar systems and Radiation detection equipment.

In 2003, the Washington State Department of Transportation (WSDOT), in partnership with U.S. Customs, U.S. Department of Agriculture, the ports of Seattle and Tacoma, marine carriers, trucking firms, and Canadian transportation agencies, completed three integrated Intelligent Transportation Systems (ITS) deployments. These systems are designed to identify, monitor, and pre-process cargo in intermodal containers that are trucked over the Washington/British Columbia border. Two of the systems is said to be using a standard, window-mounted vehicle transponder that provides commercial vehicle related information while the other uses a container door seal that is a disposable transponder to provide security and cargo information. Also, the Ministerial Council of Europe in 2005 recognizing that border security and management is a matter of the national sovereignty and responsibility of states developed a border Security and Management Concept for Organization for Security and Co-operation in Europe (OSCE) to enhance mutual member state benefit.

Anderson, et al., (2010) in their report 'International Border Security and Customs Assistance Initiatives: A Guide to The Stimson Database' demonstrated the need for data base updating for effective border management. While Okumu (2011) in his paper on Border Management and Security in Africa, emphasize the need for capacity building and interoperable among professionals.

2.4 African Union Border Programme (AUBP)

The EU defined IBM to include trade facilitation to establish effective, efficient and coordinated border management, in order to reach the objective of open, but well controlled and secure borders. However, the African border management setting demands extension of this horizon farther than just cooperation and coordination among border management agencies though these still provide the main building blocks for our framework. Such scaling up of the scope is, therefore, accomplished in this Strategy with the inclusion of two other key factors identified during the need assessment phases: capacity building and community involvement

The Declaration on the African Union Border Programme (AUBP) and the Modalities for the Pursuit and Acceleration of Its Implementation made in Addis Ababa, Ethiopia, in March 2010,paved the way for the development of this Strategy for Enhancing Border Management in Africa. This Declaration builds on a number of initiatives which include the Declaration of the African Union Border Programme and Its Implementation Modalities of July 2007 and the 2004 – 2007Strategic Plan of the African Union Commission, AU-BM (2012). One of the purposes of this border management is the prevention and elimination of cross-border crimes such as illegal trafficking of weapons, drugs, goods and people; illegal migration; piracy, insurgency and terrorism; illegal exploitation and destruction of natural resources; auto theft; and cattle rustling. Most of these criminal acts are belligerently pursued systematically in such a way that it spread out regionally and globally.

The other reason for strategically enhancing border management in Africa is to greatly enhance capacity building through institutional reforms, acquisition and proper use of modern technology, and continuous training of personnel based on the needs and changing nature of African borders. The magnitudes, severities and complexities of border management problems in Africa calls for urgent actions to be taken in order to turn borders into zones of peace, security, stability and development. The Strategy isa consolidation of regional and continental efforts, present and future, aimed at contributing to the AU objectives of promoting integration, peace, security and development of the African continent through efficient and effective border management.

2.4.1State of Border Management Infrastructure and Facilities

In an effort to justify the need to initiate and develop a border management strategy for Africa, a review of the current situation of African borders is highly necessary as given below according to Wafula(2010):

i. Africa has 109 international boundaries whose total length is approximately 45,000kilometres, but of these boundaries, less than 35% are clearly demarcated. African boundaries are characterised by a high level of porosity and poor management.
ii. There are about 350 official border-crossing points (BCPs), which means that there is about 1 BCP for every 120 kilometres of border in Africa; most control posts are set back between 16 and 20 kilometres from the border.
iii. There are some land borders between neighbouring countries that have no access by road, rail or watercraft—for example, the border between Central African Republic and the Congo Republic, or between Tanzania and the DRC.
iv. The 109 international borders divide 177 cultural or ethnic groups.
v. Only 414 roads cross international borders, 69 of which have no customs posts along their entire length.
vi. There are only 20 cross-border railway and ferry routes.

2.4.2 Sources of Border-related Insecurity in Africa

Most parts of the African continent are characterized by insecurity, underdevelopment and conflict. Some of the underlying causes of these problems are cross-border criminal activities ranging from cattle rustling, automobile theft, smuggling of weapons and commodities to terrorism. Borders in Africa are often unmanaged or poorly managed by personnel that are ill-equipped, understaffed, ill-trained and unmotivated to prevent cross-border crimes and to facilitate harmonious and prosperous interactions between countries. The continent is therefore grossly vulnerable to various forms of insecurities that threaten development, integration, peace, security and stability. The way forward for real-time and cost effective for Africa trade and security integration is trough Africa's ITS oriented development.

3.Methodology

In an effort to develop a mechanism for integrating existing vehicle and truck recognition system into a single database system and as well design a hybrid vehicle plate recognition system for border monitoring and tracking, the integrated mechanism is viewed as various building blocks :the Data Sources, Database Development and integration, the VPN information and

communication System, the Vehicle Plate Recognition System and the overall System Performance and Matching as shown in Fig 3.

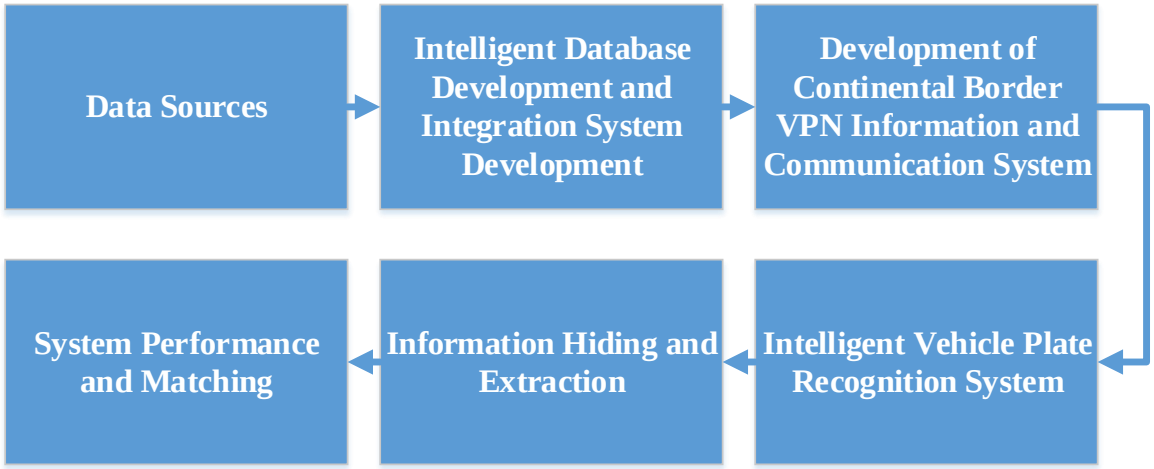

FIGURE 3 Block Diagram of the Project

3.1 Data Sources

Detailed review of: existing Intelligent Transport system; Vehicle recognition System; Vehicle Plate Number Recognition System; Database Development etc will be carried out in order to establish the current state of the art displayed in Fig 3.Data will be collected through on-line survey and ground field surveys using structured questionnaires. The study will also carry out a detailed study of vehicle and cargo movement to know the existing vehicle/cargo movement which will felicitate knowledge of what kind of load is most expected in those border, destination and identification of vehicle drivers and vehicle owners.

3.2 Intelligent Database Development

Intelligent Database Development and Integration (IDDI) will involve development and integration of various databases from vehicle information collected at the border points. This will be run on a secured server with a distributed database management system (DDMS) with user authentication capabilities which prevent unauthorized viewing of generated report by individuals with lower clearance level. The inclusion of five different clearance levels will be appropriate for the proposed system.

3.3 Development of Continental Border VPN Information and Communication System (CBVPN-ICS)

The development of the CBVPN Information and Communication System (CBVPN-ICS) shown in Fig 4 – 6 will be segmented in such a way that the CBVPN-ICS design will be divided into three inter-related modules for performance testing at sub-module level. The flow charts in Fig 4 show the design and development of appropriate vehicle and border management system. Simulation and analysis of some cases scenarios from the design will be carried out and this will involve mathematical calculations, system comparison and used of equipment suppliers information to validate some of the developed systems.

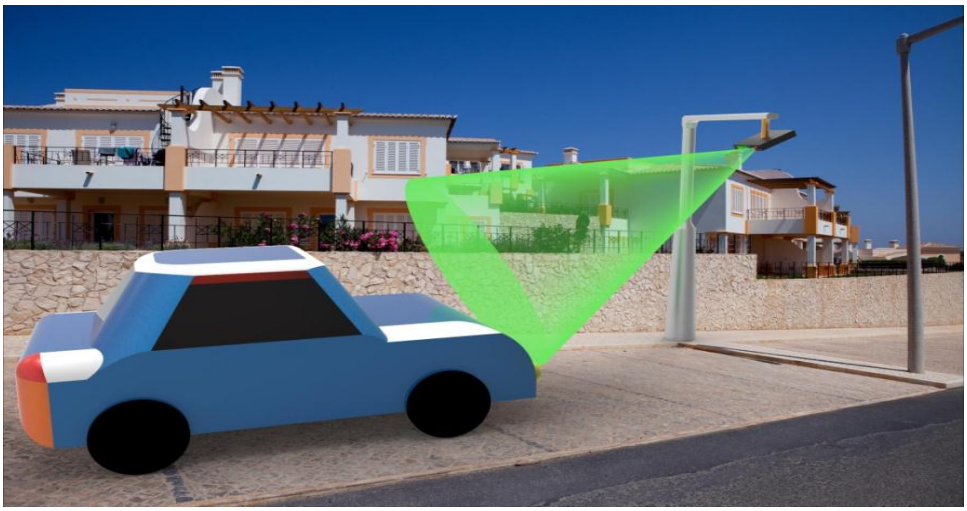

FIGURE 4 Advanced inter-border information and communication transport management system

FIGURE 5 The Barcode Manifest Reader

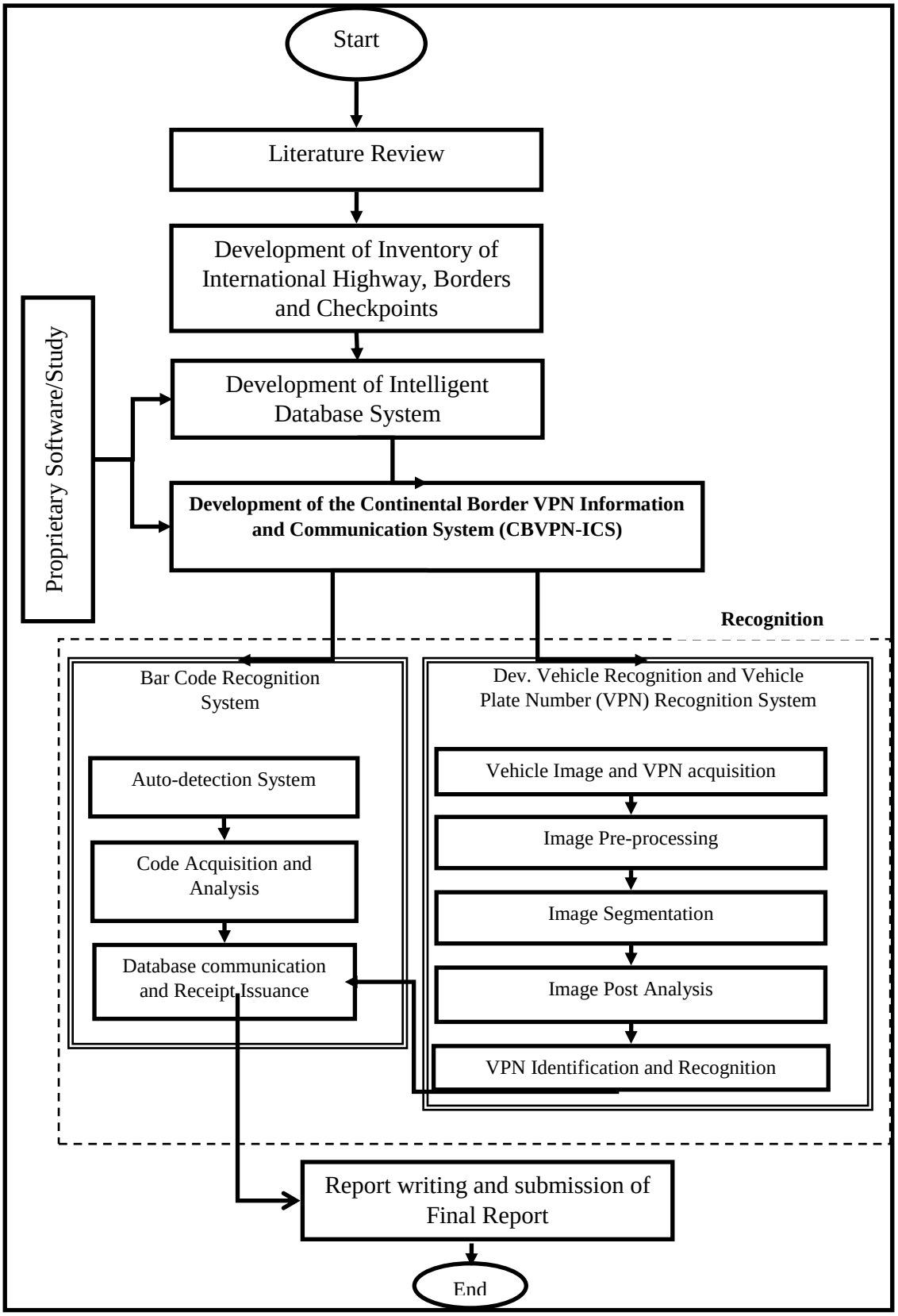

FIGURE 6 Project Methodological Flow Chart

4. SYSTEM IMPLEMENTATION STRATEGY

The information collected about the vehicle (which include its origin and destination, type and weight of cargo, information about the driver and the vehicle owner, as well as the history of the vehicle's journey and crime records)will be encoded with special algorithm and printed on a paper document as Bar Code. Features extraction using Bar Code Recognition System (BCRS)will be incorporated into the system. The information will be uploaded into the databases for online accessibility to all the operatives of the system as illustrated in fig 7. Thereafter, the forms are printed as part of the journey manifest.

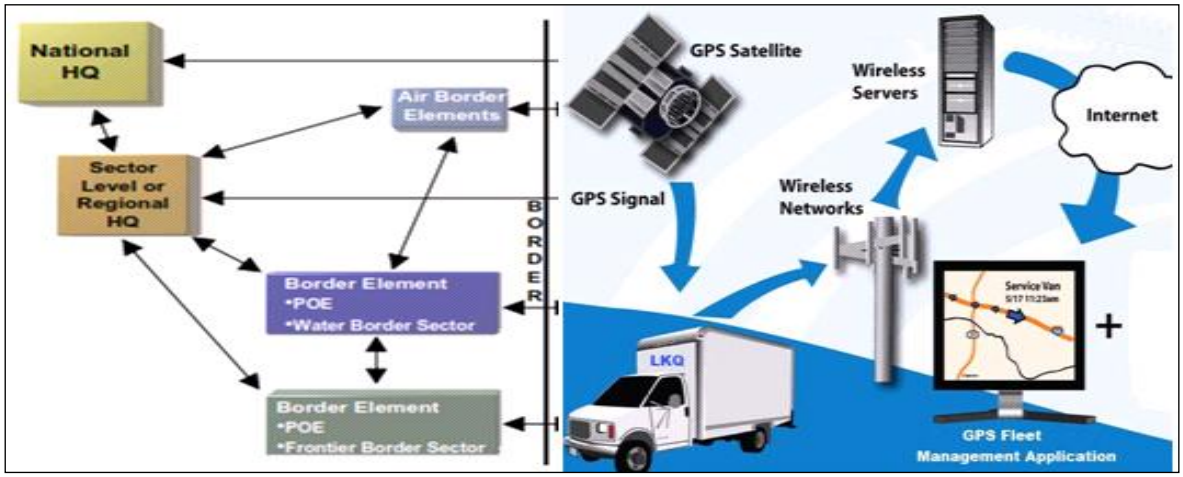

FIGURE 7 Multi-stakeholder Border Communications Networks

During the VPN recognition process in the Image and BCRS, the extracted character matching technique to be adopted include: Autocorrelation and Mean Square Error (MSE).An image that is a perfect reproduction of original will have an MSE of zero, while an image that differs greatly from the original image will have a large MSE. Other benefits from this proposed work include:

a) Creation and integration of a single database consisting of the both vehicle and truck registration and recognition data.
b) Development of an hybrid plate number recognition designed to recognise plate numbers, especially Nigerian Plate numbers
c) An efficient border monitoring and management system which effectively uses the Hybrid plate number recognition system designed.

5. CONCLUSION AND RECOMMENDATIONS

In the wake of globalization, movements of people and goods across nations have tremendously increased thereby requiring enhanced ICT based border management structures to more efficiently and effectively manage the cross-border flow. Other continents of the world are far ahead in the application of Intelligent Transport System (ITS) to border management strategies that best facilitate the legitimate movement of people and goods with little or no delay, while maintaining secure borders. Conscious of the implications of ineffective and inefficient border management structures in Africa, series of conventions and capacity building programmes has been on through the African Capacity Building Centre (ACBC) for more than 10 years. But what

remains is the full adoption, funding and building efficient ITS based border infrastructure across African.

The following is therefore recommended for African nations and in particular, Nigeria.

i. All African nation to key into the central digital vehicle plate number system,
ii. Each country to build a database for all commercial vehicles especially for those that have to do with inter-border movements,
iii. Enhancing international cooperation and supporting harmonization of national policies and practices within regional contexts towards common international norms;
iv. Collectively standardizing the vehicular manifest that will contain data on origin and destination, type and weight of cargo, information about the driver and the vehicle owner, as well as the history of the vehicle's journey and record of crime,
v. All the member nations can key into a good communication satellite like the NigeriaSatcom for easy propagation of real border information across the continent,
vi. All the 414 major roads or more as a against the present 69 across the borders should have border post that is fully equipped with ITS based infrastructural facilities to enhance trade and security across the continent,

REFERENCE

1. Anderson, JL, Boucher, AJ & Hamlin, HA (2010), International Border Security and Customs Assistance Initiatives: A Guide to the Stimson Database, Washington DC: Stimson Centre.
2. Ashley N, McDaniel M, Mohagheghi A & Command USC, (2011), International Border Management Systems (IBMS) Program: Visions and Strategies, California: Sandia Report.
3. Duggan, R. (2008), A Model for International Border Management Systems, California: Sandia Report.
4. McCord, M. et al., (2014), Documenting Truck Activity Times at International Border Crossings Using Redesigned Geofences and Existing Onboard Systems. Journal of the Transformation Research Board.
5. Afua ALamptey (2013). Rethinking Border Management Strategies in West Africa: Experiences from the Sahel. Kofi Annan International Peacekeeping Training Centre (KAIPTC). www.kaiptc.org
6. Ruth A Duggan (2008). A Model for International Border Management Systems. Sandia Report Sand2008-6256. http://www.ntis.gov/help/ordermethods.asp?loc=7-4-0#online
7. United Nations Convention on the Law of the Seas, 2006, http://www.un.org/Depts/los/
8. ACBC Annual Report June 2014–December 2016, African Capacity Building Centre
9. AU-BM (2012). Draft African Union Strategy for Enhancing Border Management In Africa, African Union Border Program, Addis Ababa, Ethiopia.
10. WafulaOkumu (2010)**.** Border Management and Security in Africa.African Union Border Programme (AUBP), Addis Ababa, Ethiopia.