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E-Trafiki Model: Electronic Solution Architect for Police Highway Patrolling in Kenya

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Abstract

Among the six world regions, Africa remains least motorized but suffers the highest rates of road traffic fatalities causing deaths and fatal injuries. If these trends continue, traffic accidents will be among the top major causes of death worldwide. Highway patrolling is being used primarily for the purpose of overseeing and enforcing traffic safety compliance on roads and highways. In developing countries, traditional manual patrolling methods are still being used for traffic patrolling which is lagging behind, and it is not matched with the status of national cost-effective development, reducing road accidents, reducing crime and corruption. In this paper, we're going to look this important sector and how electronic patrolling techniques and equipment have been utilized to overcome the traditional method of patrolling. We argue that developing solution architecture to expose traffic policemen to road traffic information electronically can boost their service provision and reduce road traffic accidents while at the same time be productive and cost efficient. Further, we illustrate the development of an e-Trafiki framework to address these aforementioned properties to improve highway patrolling.

Key words: *electronic solution architect, highway patrolling, traffic accidents, traffic information*

1.0 Background

Over the last decade, information technologies are evolving and continuously adopted in various organizations. These technologies have improved the attitudes, perceptions and decision making activities of its. In order to gain a competitive advantage, the development of computer technology has created a strong necessity for organizations to adopt this. However, in the absence of effective utilization of these technologies, computers are unable to enhance increased organization performance (Davis et al., 1989).

Law enforcement agencies are expected to respond to crisis, prevent crimes, protect citizens and conduct investigations. Hence, by utilizing the finest technology available will enhance accomplishments of these tasks (Johnston, 2007). Utilization of information technology can enhance effectiveness in police work if it is integrated with various organizational practices which are adopted to take benefits of data availability (Garicano and Heaton, 2007). If police officers accept utilization of information technology, it can boost their performance and value (Gottschalk & Holgersson, 2006). The nature of police tasks requires handling and processing huge volumes of data. The ability of a computer to handle data and provide timely and accurate information matches the requirements for police to enhance their work activities (Colton, 1972)

The major focus of this paper is enhancing performance of highway traffic police patrols in Kenya. This is due to the rampant road traffic accidents which cause death and fatal injuries. According to WHO (2013), among the six world regions, Africa remains least motorized but suffers the highest rates of road traffic fatalities. A survey by WHO (2013) revealed that 37 of 44 countries have death rates well above the global average of 18.0 deaths per 100 000 population. While the African Region possesses only 2% of the world's vehicles it contributes 16% to the global deaths. Nigeria and South Africa have the highest fatality rates (33.7 and 31.9 deaths per 100 000 population per year, respectively) in the region. More than one in four deaths in the African Region occur on Nigeria's roads, and with six other countries; Democratic Republic of Congo (DRC), Ethiopia, *Kenya*, South Africa, Tanzania, and Uganda, are responsible for 64% of all road deaths in the region. These seven countries must reduce their road deaths considerably if the region is to realize a significant reduction in deaths (WHO, 2013).

In this paper, we seek to illustrate the burden of road accidents in developing countries, and the contribution of innovative ICT applications in enhancing highway patrolling. We model the e-Trafiki solution architecture with the aforementioned properties to improve road traffic patrolling productivity.

1.1 The burden of road traffic accidents in developing countries

According to WHO (2013), among the six world regions, Africa remains least motorized but suffers the highest rates of road traffic fatalities. A survey by WHO (2013) revealed that 37 of 44 countries have death rates well above the global average of 18.0 deaths per 100 000 population. While the African Region possesses only 2% of the world's vehicles it contributes 16% to the global deaths. Nigeria and South Africa have the highest fatality rates (33.7 and 31.9 deaths per 100 000 population per year, respectively) in the region. More than one in four deaths in the African Region occur on Nigeria's roads, and with six other countries; Democratic Republic of Congo (DRC), Ethiopia, *Kenya*, South Africa, Tanzania, and Uganda, are responsible for 64% of all road deaths in the region. These seven countries must reduce their road deaths considerably if the region is to realize a significant reduction in deaths (WHO, 2013).

According to Krug (2001), the major causes of death and disability are road traffic injuries, with a proportionate number occurring in developing countries. Road traffic injuries are currently ranked ninth globally among the leading causes of disability adjusted life years lost, and the ranking is projected to rise to third by 2020 (Murrey & Lopez, 1997). Peden et al. (2004) argues that every year around the world 1.2 million people are killed and up to 50 million are injured or disabled as a result of road traffic collisions. It is expected that morbidity from road traffic collisions will increase in future years, with road traffic collisions moving from ninth to third place in the global burden of disease ranking, as measured in disability adjusted life years (Murrey & Lopez, 1997). In developing countries, due to rapid motorization this problem is increasing at a fast rate (Jacobs & Thomas, 2000).

A major reason for the high burden of traffic accidents in developing countries is poor enforcement of traffic safety regulations due to inadequate resources, administrative problems, and corruption. Corruption is a huge problem in some countries, often creating a blame triangle between the police, drivers and the public, the public blames drivers and the police, and drivers blame the police (Nantulya & Reich, 2006).

However, public policy responses to this epidemic have been muted at national and international levels. Policy makers need to recognize this growing problem as a public health crisis and design appropriate policy responses.

1.2 Automatic number plate recognition (ANPR) and speed control systems

ANPR uses optical character recognition on images to read vehicle registration plates. They can use existing closed-circuit television or road-rule enforcement cameras, or ones specifically designed for the task. They are used by various police forces and as a method of cataloging the movements of traffic or individuals.

ANPR use infrared lighting to allow the camera to take the picture at any time of the day, store the images captured by the cameras as well as the text from the license plate, with some configurable to store a photograph of the driver. ANPR technology tends to be region-specific, owing to plate variation from place to place. The cameras used can include existing road-rule enforcement or closed-circuit television cameras, as well as mobile units, which are usually attached to vehicles. Some systems use infrared cameras to take a clearer image of the plates.

The software aspect of the system runs on standard home computer hardware and can be linked to other applications or databases. It first uses a series of image manipulation techniques to detect, normalize and enhance the image of the number plate, and then optical character recognition (OCR) to extract the alphanumeric of the license plate. ANPR systems are generally deployed in one of two basic approaches: one allows for the entire process to be performed at the lane location in real-time, and the other transmits all the images from many lanes to a remote computer location and performs the OCR process there at some later point in time. When done at the lane site, the information captured of the plate alphanumeric, date-time, lane identification, and any other information required is completed in approximately 250 milliseconds. This information can easily be transmitted to a remote computer for further processing if necessary, or stored at the lane for later retrieval.

Concerns about these systems have centered on privacy fears of government tracking citizens' movements, misidentification, high error rates, and increased government spending.

1.2.1 United States of America

United States introduced automatic license plate recognition technology (Jenkins, 2007). In 2007, 150 American cities utilized this technology to catch road traffic offenders who drove through red lights. A photograph of their number plate is taken by the ALPR camera and a ticket is emailed to them indicating the offence they made. This technology has also been used, in several jurisdictions, to catch drivers who violate speed limits (Jenkins, 2007). The ALPR has also been used at the USA border crossings with Mexico and Canada to track auto theft and more recently to track potential terrorists. A study of ALPR technology demonstrated that it is a potential technological utility for homeland security as it emphasized the recovery of two stolen trailers in the state of Ohio (McClellan, 2004).

In 2004, Ohio State studied the effectiveness of ALPR technology over a four month period, using $61,000 in federal funding. Over the four month period, 23 criminal suspects were apprehended by the state highway patrol and 24 stolen vehicles valued at US $220,000 were recovered (McClellan, 2004). As compared to the previous year during the same time period during which ALPR was not utilized, these results were 50% higher. The ALPR technology used in this study was only linked to databases on stolen vehicles and wanted persons and, therefore, did not provide information on unlicensed, uninsured, or prohibited drivers.

1.2.2 United Kingdom (UK)

The United Kingdom has installed an intelligence network with stationary/roadside and mobile (mounted on police cars) cameras across the country, scanning up to 5 million plates a day (Pughe, 2006). As of 2001, Police vans equipped with ANPR were provided to all the police forces in England and Wales. The central ANPR system database is situated at the National ANPR Data Center (NADC) in London which stores plate data and lists of suspect vehicles (Pughe, 2006). When a plate is photographed by an ANPR camera, a text file containing information on the car registration number, the time and date of the scan, and the GPS location of the camera is created. In addition, a JPEG image of the plate is produced, as well as a video image of the plate and a video of the vehicle occupants (Pughe, 2006). A few seconds after a plate is read by the camera, the patrol officer is provided with information regarding the vehicle: whether the car was stolen, if involved in a crime, or if uninsured (Pughe, 2006).

In 2002 to 2003, the UK evaluated the use of ANPR with nine police forces. The results of this initial study indicated that officer productivity increased primarily due to the officers not having to spend as much time waiting for hits after they typed in a plate. Instead, officers were able to spend more of their time investigating hits. This resulted in an increase in arrests to 100 per year, 10 times the national average (PA Consulting Group, 2003). In total, approximately one out of every 200 cars photographed by the ANPR cameras was stopped by an ANPR intercept team; equivalent to approximately one stop per hour. In nearly two-thirds (61%) of these stops, the intercept team took some action (e.g. enforced an arrest). However, the data also highlighted the limited ability of the intercept teams to respond to the volume of hits they received. In effect, police were only able to respond to 13% of hits (PA Consulting Group, 2003). The results also indicated that the police could expect a substantial increase in the amount and value of goods they recovered. On an annual basis, on average, a constable using ANPR technology could expect to encounter: the recovery of 11 stolen vehicles (equivalent to approximately 68,000 pounds); three instances involving the recovery of other stolen goods (equivalent to approximately 23,000 pounds total); seven instances of drug seizures (equivalent to approximately 3,300 pounds total); two seizures of weapons and/or firearms; and five instances of recovery of other stolen property (PA Consulting Group, 2003). This initial study also provided the Home Office with descriptions of the quantity of vehicles on the road violating insurance or other traffic regulations, the number of vehicles used in the commission of other criminal offences, and the number of vehicles owned or operated by persons of interest (PA Consulting Group, 2003).

ANPR technology continues to be used across the UK. For instance, the Hampshire Constabulary uses ANPR to prevent and detect terrorism, serious crime, volume crime, and fatal and serious injury road traffic accidents (Hampshire Constabulary, 2007). The Metropolitan Police Service operates four ANPR units who work across London. There are deployment teams who are used to assist in targeting hot spots for vehicle and other crime.

1.2.3 Turkey

Several cities in Turkey have implemented the City Security Administration System consisting of a registration plate number recognition system on the main arteries, city exits and police patrol cars, 2 cameras per lane - one for plate recognition and the other for speed detection. The major aim was to improve public order and traffic surveillance. A number of cameras are able to detect red light and speed violations instantly, while some can detect lost or stolen cars as well as warn the police. All data on operations are collected on a single database, enabling the creation of security plans based on these data (Telecompaper, 2010). The system is mostly used to enforce average speed over preset distances and photo evidence with date-time details which are posted to registration address if speed violation is detected. As of 2012, the fine for exceeding the speed limit for more than 30% is approximately USD 175 (KES 14,000). Hence, considerable revenue was collected apart from enforcing road traffic rules.

In Ankara, the platform uses 1,400 high-resolution cameras installed for 825 systems at 513 locations. 298 of the cameras can revolve 360 degrees. A number of cameras can detect lost or stolen cars and warn the police while others can detect red light and speed violations. The project is conducted in cooperation with the Ankara Police Department. Vehicle owners who violate traffic rules are served with a ticket, while photos as well as 12-second video recordings are used as evidence (Telecompaper, 2010).

1.2.4 Kenya

New digitalized traffic lights and traffic cameras were installed in Nairobi County. The World Bank funded the project to a tune of KES 400 million and was focused mainly in the central business district. The cameras are able to capture registration numbers of offenders' vehicles and photograph their faces which will then be relayed to the server room situated at the county headquarters. The county will be in a position to write a ticket to the offender indicating the time and place where traffic rules were breached. The cameras will ensure that there is hard and tangible evidence especially when charging offenders in court. Traffic offenders have not been going to court because there was no way of tracing them, but the new system will be able to capture and store a photo and registration number. The cameras will also be able to record crime scenes as they happen (Capital news, 2013).

The Kenya National Road Safety Trust provided speed cameras to traffic policemen. But these are handheld speed cameras that can only take photo evidence and measure the speed on oncoming vehicles. Policemen position themselves and hide in areas of blind spot. However, this camera is not linked to any information system technology.

1.3 Challenges of utilization of ANPR utilization

ANPR uses optical character recognition on images to read vehicle registration plates. The ANPR software may face a number of possible difficulties making it difficult to recognize writings on plates. These difficulties include: poor image resolution as a result of number plates being far away, blurry images due to motion blur, poor lighting and low contrast due to reflection or shadows, objects obscuring part of the number plate (tow bar, or dirt on the plate), different font on plates particularly popular for vanity plates, and lack of coordination between countries or states - two cars from different countries or states can have the same number but different design of the plate.

Since March 2008, the Federal Constitutional Court of Germany ruled that some areas of the laws permitting use of ANPR in Germany violated the right to privacy. The court found that the "retention of any sort of information (i.e. Number Plate data) which wasn't for any pre-destined use (e.g. for use tracking suspected terrorists or for enforcement of speeding laws) was in violation of German law" (Jenoptic, 2008).

1.4 The proposed e-Trafiki Model

This paper illustrates the contribution of ICT to highway traffic patrol in developing countries. ICTs in highway traffic patrol have the potential to facilitate greater access to information that drive or support knowledge sharing. ICTs essentially facilitate the creation, management, storage, retrieval, and dissemination of any relevant data, knowledge, and information that may have been already been processed and adapted (Glendenning and Ficarelli , 2012).

The continued growth in number of rampant road traffic accidents leads to death and fatal injuries. According to WHO (2013), among the six world regions, Africa suffers the highest rates of road traffic fatalities. Law enforcement agencies are expected to respond to crisis, prevent crimes, protect citizens and conduct investigations. Hence, by utilizing the finest technology available will enhance accomplishments of these tasks (Johnston, 2007). Utilization of information technology can enhance effectiveness in police work if it is integrated with various organizational practices which are adopted to take benefits of data availability (Garicano and Heaton, 2007). If police officers accept utilization of information technology, it can boost their performance and value (Gottschalk & Holgersson, 2006).

ANPR cameras have been integrated with traffic lights, speed cameras and surveillance cameras to fight crime as well as traffic offenders. But there is need for a more integrated approach in developing countries. Consider solution model in figure 1 that integrates services of Kenya revenue authority (driving licenses and number plates database), National police service commission (criminal & road traffic offenders database), Public and insurance companies (vehicle insurance databases). The courts, traffic police, media agencies and public are availed the necessary information required to make decision on criminals and road traffic offenders. Making such informed decisions would definitely improve road traffic patrolling to reduce road traffic accidents.

The centralized e-trafiki system should be linked to ANPR cameras to ensure that a few seconds after a plate is read by the camera, the patrol officer is provided with information regarding the vehicle: whether the car was stolen, if involved in a crime, if uninspected, or if uninsured. This will aid traffic police in making informed decisions. Speed cameras should also be linked to enforce speed limits. An electronic ticketing/citation system should be linked to the e-trafiki system to automatically document and issue road offenders with tickets/citations, via email and/or SMS alerts. The e-tickets/citations will save lots of time spent by motorists in cell and court proceedings.

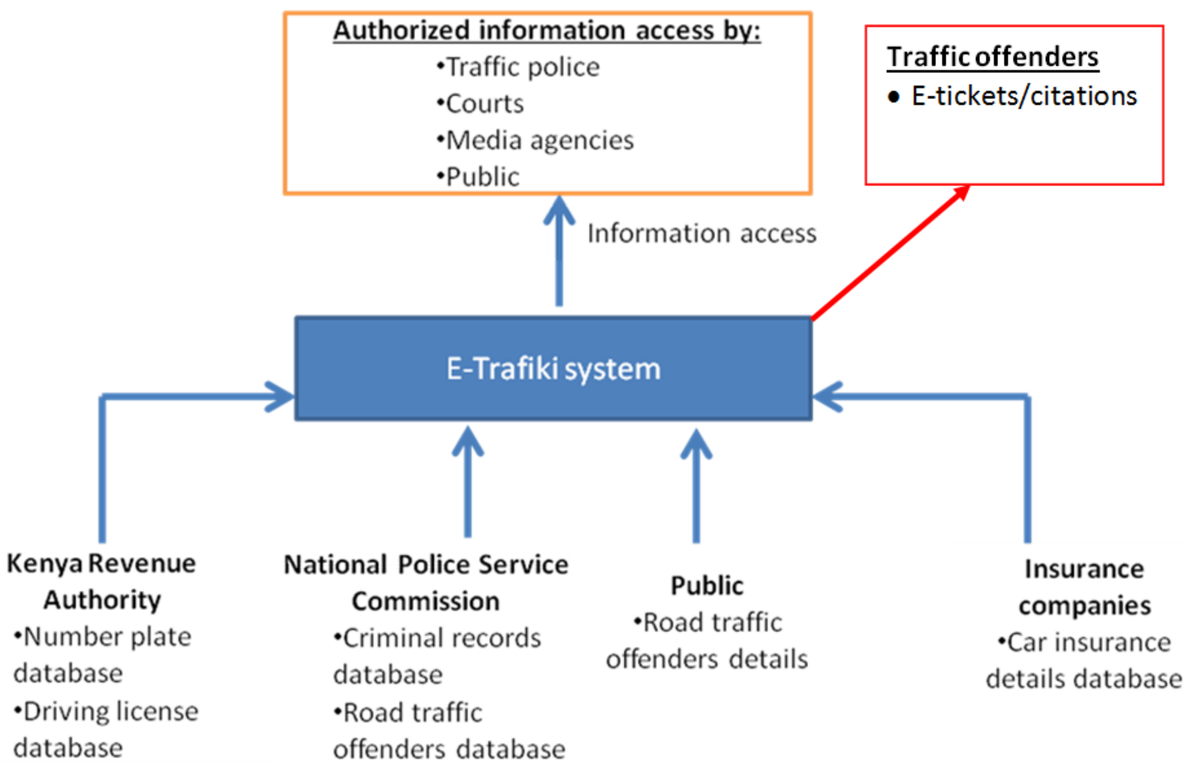

Figure 1: e-Trafiki model

Conclusions

This paper illustrates the contribution of ICT to highway traffic patrol in developing countries. There is need to fight road carnage and crime in developing countries. The e-trafiki model suggests an integrated approach to utilize data from various organizations. Such a model will facilitate greater access to information that will drive or support knowledge sharing to enhance decision making and reduce road carnage.

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