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***Research Article***

# Influence of Technology on Streamlining Traffic Flow in Nairobi Central Business District

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## Abstract

Nairobi experiences excess traffic congestion and initiatives to relieve it needs a clear plan with clear objectives and strategies. The purpose of this study was to establish the influence of use of technology on streamlining traffic flow in Nairobi Central Business District (CBD). The study was mixed methods in nature and descriptive survey research design was used. The research instruments were questionnaires, interview schedules and observation schedule. Validity of the instruments was assessed through expert scrutiny of the supervisors while reliability was established through split- half method. Data collected was analysed using computer Statistical Software Package (SPSS version 22.0) and was presented in form of percentages, and tables Analysis of Variance (ANOVA) was used to determine whether there were differences between the strategic options and traffic flow. All tests of significance was computed at $\alpha = 0.05$. For the qualitative data a thematic analysis was done. The results showed that the correlation coefficient between application of technology and traffic flow r=0.885 implying strong positive correlation. ANOVA results also indicated that there is a significant relationship between use of technology and traffic flow. In conclusion, the study found that there is need for a holistic integrative approach to strategic options in order to streamline traffic flow in the CBD.

**Keywords**: Technology; Traffic flow; Central Business District; Nairobi.

## Introduction

The ever growing demand for transport results in more and more attention paid to systems that enable efficient management of traffic flows and of the overall functioning of the transportation system. To a commuter or traveler, congestion means loss in time, missed opportunities and frustration. To an employer, congestion means loss of workers' productivity, trade opportunities, delivery delays, and increased costs. To solve congestion problems is feasible not only by constructing new facilities and policies but also by building new information technology in transportation management systems. A growing body of evidence proves that simply expanding a road infrastructure cannot solve traffic congestion problems. In fact, building new roads can actually compound congestion, in some cases, by inducing greater demands for vehicles-travels that quickly eat away the additional capacity. Therefore, many countries are working to manage their existing transportation systems to improve mobility, safety, and traffic flows in order to reduce the demand of more vehicles-use [1].

Traffic management technologies have been developed primarily in Europe, America and Japan. Technologies have been developed in view to counter traffic related problems which are broadly travel delays, parking problems and safety problems. The causes of these problems have been tackled through technology intervention of various levels [2]. Traffic management which is a round the clock operation that ensures that traffic on the road is well distributed and smooth flowing is currently a more complex operation. It is becoming difficult with the constantly increasing traffic volumes to do without the support of information and communication technologies (ICT), which are the backbone of the intelligent transport systems. The use of intelligent transport systems in traffic management leads to a reduction of

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negative impact on the environment and has a positive impact on increasing the safety and continuity.

Intelligent transport systems help operators of transport and emergency responders in monitoring and traffic controlling, and help with detection and response to incidents and in informing the public about the traffic situation by the means of internet, transport equipment and media. During the use of intelligent transport systems, the transport infrastructure is supplemented by information and communication technologies to enhance passenger safety reduce transit time and fuel consumption. With the advent of modern communication and computing devices, low cost sensors can acquire and evaluate data from multiple sources [3]. One of the technology solutions that have been developed around the world for proper travel demand management is carpooling. Case studies from Japan and Singapore show that this technique if properly implemented can improve traffic scenario [4].

A lot of technologies have been developed in the field of signaling systems. The trend of traffic signals has evolved from fixed time programmed signals towards detector based real time traffic signals. Technology inputs have improved both on hardware and software sides of signaling systems. In real time systems, detectors are installed on every intersection that counts the number of vehicles that queue at any intersection arm. The inputs from the detector are processed by controller software and signals are synchronized in such a way that heavy traffic paths are given longer clearways [5].

Another set of technological development is in the form of incident detection systems which contribute substantially to traffic systems. Automatic incident and congestion detection systems have been developed which use on road sensors to send information to control room for immediate recovery. Further congestion is avoided through radio information broadcasts, surveillance television broadcasts and airborne video. Simulation models have been developed to assist in incident recovery and traffic diversion strategies [6].

Passenger and driver information systems have been developed in the form of Comprehensive Automobile Traffic Control systems; Internet based route systems, Electronic route guidance system, telephone information service, Driver Information and early warning systems. All these systems encompass technologies to assist the driver to decide the best transit route. Variable message signs have been designed to inform the driver of the real time parking spaces available, lane traffic conditions, incidents on the lane, weather conditions. Other systems involve better information systems at bus stands that inform the commuter about the bus routes, time of the next bus arrival, fare structure etc. Other associated technologies include Automatic vehicle locating systems which use the conventional Global positioning systems [7].

New modernized systems in traffic information and management should make it easier for users to navigate the country's main roads, learning earlier of developments in advance, helping drivers avoid slow-moving traffic jams. The preoccupation of the government of Kenya and the county government of Nairobi in the road transport sector has been majorly the elimination of traffic congestion. Strategies have included installation road traffic lights and CCTV cameras, however, this did not solve the congestion problem. The current study seeks to examine the role of technology on streamlining traffic flow. Since there are a number of technological advancements that can be used, this study focused on role of traffic lights, CCTV cameras and passenger/driver driven information system.

The objective of this study was to establish the influence of use of technology on streamlining traffic flow in Nairobi Central Business District (CBD). The results showed that the correlation coefficient between application of technology and traffic flow is r=0.885 implying strong positive correlation. ANOVA results also indicated that there is a significant relationship between use of technology and traffic flow. In conclusion, the study found that there is need for a holistic integrative approach to strategic options in order to streamline traffic flow in the CBD.

**Research methodology**

This study used descriptive survey research employing mixed methods to gather data. Survey research is used to describe characteristics of a population or phenomenon and compare the values of independent variables

 

being studied. It does not answer questions about how/when/why the characteristics occurred. Rather it addresses the "what" question [8]. A research design is the overall plan for obtaining answers to the questions being studied and for handling some of the difficulties encountered during the research process. According to [9] descriptive survey enables collection of information from respondents with reference to the variables involved through administration of the questionnaire, interview and observation schedules to determine the status of the situation under study.

The study was carried out in Nairobi CBD. Nairobi Central Business District takes a rectangular shape, around the Uhuru Highway, Haille Selassie Avenue, Moi Avenue and University Way. It includes many of Nairobi's important buildings, including the City Hall and Parliament Building. The CBD is bordered to the south-west by Nairobi's largest park: Uhuru Park. The Mombasa to Kampala Standard Gauge Railway (SGR) runs to the South-East of the CBD. The main reason for choosing Nairobi CBD is that it suffers from some of the worst traffic congestion in the world and traffic build-up in the streets of Nairobi is costing businesses millions of shillings in fuel consumption, car damage and time wasted on the road [10].

According to data from [11] and [12] there are 50 traffic marshals and 115 traffic police respectively working in the CBD. Therefore, the target population to which this study sought to generalize the findings was composed of 50 traffic marshals and 115 traffic police. Data was also collected from key informants including 1 traffic police commandant, 1 traffic marshal commandant, and 2 roads engineers. Total target population was 169. Population is the group of individuals who are the focus of the study to which research results would be generalized. The sample size for the study was 89. The study was nonprobability sampling procedures to sample the Traffic Police and the Traffic Marshals. Sampling is the process of selecting a sample from the whole population that can be used to fairly represent the population [1].

For this study, the researcher used purposive sampling technique. In purposive sampling each element is selected for a purpose, usually because of the unique position of the sample elements. The purposive sampling procedure that was deemed appropriate for this study is snowballing. The researcher began by identify one traffic police officer and then asking him/her to recommend other officers working in the CBD. This is because it would not have been possible for the researcher to reach the respondents in any other way. The researcher settled for whole population of 50 traffic marshals and 30% of the total number of traffic police which is 35 traffic police. This is because traffic flow in the CBD is managed by the traffic marshal while the traffic police are used to investigate accidents and chase up people who are spotted by cameras breaking highway laws. The sample also included 4 key informants [12].

Primary data was collected using questionnaires, interview schedules with key informants and observation schedule. Secondary data involved review of documented materials mainly policy documents. This is because the study adopted mixed methods research design. The interview schedule and observation were used for cross validation. The researcher got content validity using expert scrutiny by the supervisors. Their comments and suggestions were incorporated in the final draft of the research instruments. Content validity is the degree to which data solicited using a particular instrument represents a comprehensive coverage of specific domains of indicators or content of a particular concept [3]. According to [4], validity is the degree to which results obtained from the analysis of the data actually represented the phenomenon under investigation.

To assess reliability of the questionnaire, split-half reliability estimate was used. In the split-half reliability method, the instrument is given once and then split in half to determine the reliability [9]. The questionnaire was administered to 15 respondents who were not part of the study sample. The scores that were yielded were correlated to get reliability coefficient. The reliability test yielded a reliability coefficient of 0.72. Since this study had adopted a reliability level of 0.7 which is recommended by Nunnally (1978) as the minimum level of reliability, the instrument was found to be reliable. Permission to conduct the main study was first sought from the National Council for Science and Technology through the school of Business and Economics of Jaramogi Oginga Odinga University of Science and Technology, and subsequently from the Traffic Department of Nairobi, the Nairobi County and

 

Ministry of Roads. The questionnaires were self-administered, while the interview schedule and observation were done by the researcher. Data was analyzed using computer aided software SPSS version 22 and presented in descriptive statistics such as frequencies, means and percentages and presented using tables and inferential analysis were to provide coefficient of determination of values. Qualitative data derived from interview schedules was presented as prude in thematic narrative.

**Results and discussions**

The researcher used data from respondents from traffic police department and the Nairobi city county traffic marshals. The information in terms of gender is given in the table 1. Table 1 shows that there were more male respondents than the female as recorded 53(70.67%) and 22(29.33%) respondents respectively. The research advocates several hypotheses for this possible cause of disproportionate representation of males and females in the traffic police department and the Nairobi city county marshals. It is likely that no single explanation accounts for all of the disproportion, but combination of factors like gender parity, rigorous nature of the police service and non-implementation of the one third gender rule in the Kenya constitution 2010.

Table 1. Respondents' Gender

| Gender | Frequency |
|---|---|
| Male | 53(70.67%) |
| Female | 22(29.33%) |
| Total | 75(100%) |

Source: Research Data, 2017

From Table 2, it is evident that among the respondents, majority of them belong to the age groups of 45- 49 years, and 40- 44 years (26.67% and 21.33% respectively). From the above table it is observed that majority of respondents fall within age group of 40 to 49 years. This can be attributed to the fact that for one to be deployed to traffic department, the officer should have served in other police departments and gained some working experience in the Police Service, while the Nairobi City County trained the people who were already working as city Askaris to be Traffic Marshals. This implies that the majority of the respondents were in the 40 and above age bracket and their opinions could be different from those of persons in the 25- 29 age bracket. The opinions of this age group would have been significant especially when looking at the application of technology on streamlining traffic flow.

Table 2. Respondents' Age

| Age | Frequency |
|---|---|
| Below 25 years | 1(1.33%) |
| 25-29 years | 5(6.67%) |
| 30-34 years | 10(13.33%) |
| 35-39 years | 13(17.33%) |
| 40-44 years | 16(21.33%) |
| 45-49 years | 20(26.67%) |
| 50-54 years | 8(10.67%) |
| 55-59 years | 2(2.67%) |
| Above 60 years | 0(0.00%) |
| Total | 75(100%) |

Source: Research Data, 2017

The results in the above table 3 show descriptive statistics on the influence of technology on traffic flow. The results indicate that 60% reported use of both traffic lights and manual traffic control leads to congestion, 45.33% data from different sources in real time is key to traffic management, 42.67% automatic incident and congestion are needed in the CBD, 56% sensors need to be connected to traffic control signal, 38.67% passenger and driver information system can assist in traffic flow, 49.33% installation of real time detectors would improve traffic flow, 61.33% early information on traffic would help drivers and passengers make informed decisions, 33.33% traffic lights and CCTV cameras have solved the congestion problem. 70.67% education and public awareness on carpooling can help in traffic management. The above results indicate that the application of technology is the way to go if the traffic congestion in the CBD is to be managed and smooth traffic flow achieved. These results concur with studies by [7] who reported that real time detectors work in such a way that heavy traffic paths are given priority, while [8] states that automatic incident and congestion detection systems which uses sensors to send information to control room for immediate recovery. Further congestion is avoided through radio information broadcast.

 

Table 3. Descriptive statistics on influence of Technology Factors

| Statement | SA | A | D | SD |
|---|---|---|---|---|
| The use of traffic lights in conjunction with manual and control by traffic police leads to congestion | 17(22.67%) | 45(60%) | 6(8%) | 7(9.33%) |
| Use of data from different sources (CCTV, traffic signals) in real time and processing information to take immediate decision is key to traffic management | 27(36%) | 34(45.33%) | 8(10.67%) | 6(8%) |
| Automatic incident detection and congestion detection need to be installed in the CBD. | 19(25.33%) | 32(42.67%) | 14(18.67%) | 10(13.33%) |
| Sensors need to be connected to traffic control signal to keep sending information on traffic congestion | 18(24%) | 42(56%) | 9(12%) | 6(8%) |
| Passenger and driver information system such as internet based routed, electronic route guidance system and telephone information services can assist in traffic flow. | 18(24%) | 29(38.67%) | 11(14.67%) | 17(22.67%) |
| Traffic flow would be improved if real time detectors would be installed at intersections | 29(38.67%) | 37(49.33%) | 7(9.33%) | 2(2.67%) |
| Information on traffic needs to be early to help drivers/ passengers make informed decisions | 46(61.33%) | 28(37.33%) | 0(0.00%) | 1(1.33%) |
| Road traffic lights and CCTV cameras have solved the congestion problem | 18(24%) | 25(33.33%) | 20(26.67%) | 12(16%) |
| Education and public awareness on benefits of carpooling can help in traffic management | 15(20%) | 53(70.67%) | 2(2.67%) | 5(6.67%) |

Four point key response scale: 4. Strongly Agree (SA) 3. Agree 2. Disagree (D); 1. Strongly Disagree (SD). **Source:** Research Data, 2017.

In addition, [5] reported that traffic signals synchronization that regulates traffic flow and incident management is two operations that are very useful. When properly implemented, monitored and aggressively managed, they can decrease the average travel time significantly and enhance smooth traffic flow. These findings are further supported by [1] whose findings indicate that broadcasting traffic information would work effectively in managing traffic flow. The results on use traffic lights and manual traffic control are supported by a study by [9] who reported that Traffic lights at the roundabouts in the CBD are automatically controlled during peak hours and used in conjunction with manual hand control during peak hours. In addition, the act of combining both automatic traffic lights and police manual hand in controlling traffic was found to cause confusion among road users and this in turn led to traffic congestions particularly at peak periods. In [7] it was also reported that Traffic lights are ineffective in managing traffic.

Table 4 showed clearly that there is a strong positive relationship between use of technology and traffic flow. Pearl Pearson's Coefficient of correlation was used to establish the relationships and r=0.885. The Pearson product-moment correlation coefficient (or Pearson correlation coefficient, for short) is a measure of the strength of a linear association

 

between two variables. The Pearson correlation coefficient, *r*, can take a range of values from +1 to -1. A value of 0 indicates that there is no association between the two variables. The strong positive relationship between use of technology and traffic flow means that these options if managed well can help in management of traffic flow in the CBD. This is supported by a case study carried out by [1] for traffic solutions which concluded that traffic management approaches and dedicated control systems can manage high traffic volumes and counteract congestions. This includes modern traffic detection such as video surveillance and modern video cameras could be solutions of choice. Incident warning and traffic lights are also important tools for handling high traffic volumes.

In [1] Intelligence Transport Systems was also examined and concluded that they improve transportation system. Responding on application of technology, the key informants were in agreement that Intelligent Traffic System should be embraced to help in identifying congested areas and responding appropriately.

Table 4. Correlation between Strategic options and traffic flow

| Correlations | | | |
|---|---|---|---|
| | | Use technology | of traffic flow |
| Use of technology | Pearson Correlation | 1 | 0.885** |
| | Sig. (2-tailed) | | 0.002 |
| | N | 75 | 100 |
| Traffic flow | Pearson Correlation | 0.885** | 1 |
| | Sig. (2-tailed) | 0.002 | |
| | N | 100 | 75 |

**Correlation is significant at the 0.05 level (2-tailed).

**Source:** Research Data (2017)

## Conclusions

In establishing the influence of technology the study found that the technological systems such as sensors, automatic incident and congestion detectors, real time detectors, centralized traffic flow and passengers/ driver information form an integral part of effective traffic flow. Creating public awareness and education on benefits of carpooling is also part of technology that would help in managing congestion and streamlining traffic flow in the CBD. It is therefore important that technology be embraced in order to help in streamlining traffic flow in the CBD.

## Conflict of interest

Authors declare there are no conflicts of interest.

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