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EVALUATION OF TRAFFIC MITIGATION MEASURES FOR TRAVEL TIME RELIABILITY (A CASE STUDY OF KEFFI – ABUJA ROAD)

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ABSTRACT

Nigeria's increasing population over the years coupled with diminishing resources has worsened its transport system especially in the Sub-Urban and Urban Centre like Abuja. As a result, the demand for transport far outstripped the supply and thus causing traffic congestion along the outer ring corridor of Abuja due to the absence of adequate mitigation measures. Thus indicating that the travel time would be unpredictable and the traffic service is less reliable. Supply side management measures are aimed at increasing the existing capacity of the system. The purpose of this paper is to identify the traffic influencing events causing congestion, determine the travel time reliability along Abuja – Keffi corridor and evaluate effective traffic-related measures in reducing congestion along this route. The process of traffic related measure was examined in this study and it was found that a measure related to bus stops provision is most effective in reducing congestion along this corridor. It is recommended that the Federal Capital Territory Administration (FCTA) should introduce bus stops at major and specified places with the intent of making the most safe and productive use of existing road. This measure is found to reduce travel time and is for relatively cheap and capable immediate implementation. The study will impact the community by changing the congestion profile as drivers adapt their departure time to the new travel condition.

KEYWORDS: traffic influencing events, traffic related measures, travel time reliability, transport system, traffic congestion, travel time variability

INTRODUCTION

Traffic congestion is one of the most significant problems facing most modern cities like Abuja. Statistics indicate that road transport is the dominant mode of transportation in Africa (Karekezi, 2002) about 95% in Nigeria; resulting in road traffic congestion. Congestion has, in fact become one of the dominant factors that determine how a city grows and its effect has caused significant increase in undesired long delays, adverse pollutions, increased operating costs and adverse sociological effects along the study road corridor (Karekezi, 2002).

The demand for transport outstrip the supply, while the poor interchange system, high cost of transport and lack of passenger information system are some of the problems facing the average commuters (Ibi, 2004). In the transportation realm, congestion usually relates to an excess of vehicles on a portion of roadway at a particular time resulting in speeds that are slower—sometimes much slower than normal or "free flow" speeds. Congestion often means stopped or stop-and-go traffic (Paniati, **2000)**

The effects of congestion cause increase in undesired long delays, adverse pollutions, potential increase in accidents, increased operating costs and adverse sociological effects (Philpott, 1997). Congestion also causes increase in travel time which may eventually become increasingly variable and unpredictable as congestion increases (TRB, 2003). This implies that the level of congestion on the same highway may not be the same as the traffic – influencing events are never the same from day-to-day. Commuters could be late for work or after-work appointments, business travellers could be late for meetings, and truckers could incur extra charges by not delivering their goods on time (TRB, 2003).

In a typical output of travel demand studies it has been emphasized the importance of travel time reliability for transport users to the point that the value of travel time variability (VTTV) is now - along with the value of travel time savings (Carrion, et. al. 2012), Li, et, al., 2010). A high degree of variability indicates that the travel time would be unpredictable and the traffic service is less reliable (Turochy et, al., 2002). This implies that travellers would not be able to accurately anticipate their travel times before their trip. Previous qualitative studies found that users value the reliability of a transport system more highly than other features (Bates,et, al.,

2001). The studies pointed out that a reduction in variability is as valuable as the reduction of mean travel time or even more valuable in some situations.

The objective of this paper is to analyse travel time reliability resulting from variability in travel time caused by the traffic congestion. It is also to identify the contribution of different factors to travel time in order to examine the appropriate traffic mitigation measures. However, the study is only to guarantee a certain level of quality of service to users and not to improve speed and/or expanding capacity of the road. This paper first describes the study area in terms of weather, population and vehicle composition and the traffic condition along the road corridor, especially at peak period. The conclusion and implication of the study are summarized in the final section.

DESCRIPTION OF STUDY AREA

Abuja is a city in the central part of Nigeria and the Federal Capital of Nigeria. Abuja is about 1250m (about 4100 ft) above sea level, occupying 713km^2 of land area. The city average monthly temperature is in the range 21^0- 25^0 C (69^0 - 77^0 F). The daytime temperatures reach 28-30^{o}C and night-time lows hover around 22-23^{o}C during raining season. In the dry season, daytime temperatures can soar as high as 40^{o}C and night-time temperatures can dip to 12^{o}C, resulting in chilly evenings.

The city center is crowded with a mix business wholesale and retail outlets which attracts customers from all parts of the country. Also, the three outer ring corridors generate high traffic levels due to high rate of daily drift from sub-urban area into the city especially along Abuja – Keffi corridor. This concentration of activities as well as the high traffic levels explains the recurring traffic congestion at peak periods and the need for traffic management operations to maintain acceptable levels of traffic performance.

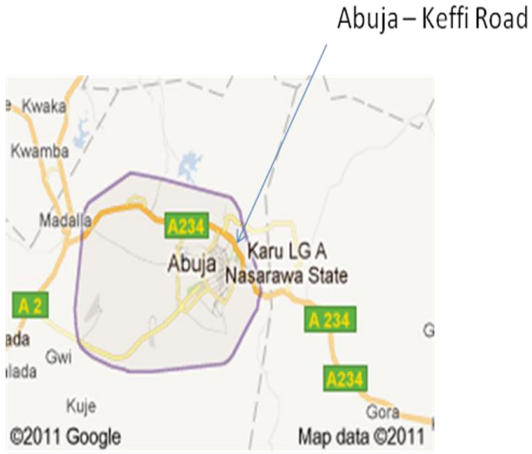


Fig 1: Map of Abuja showing the study road [10]

Statistics has shown that the city population is growing in relation to vehicle ownership and is likely to continue to grow in future. The growth pattern of the population and vehicle registration of Abuja between the years of 2000 and 2010 is shown in Fig. 2. The implication of all these is an unexpected growth in the traffic levels which may lead to overloading of some major sub-urban corridor such as Abuja – Keffi road (Ibitoye et, al. 2012). It can be established that there is a corresponding increase in the number of vehicles being registered to the rise in the population.

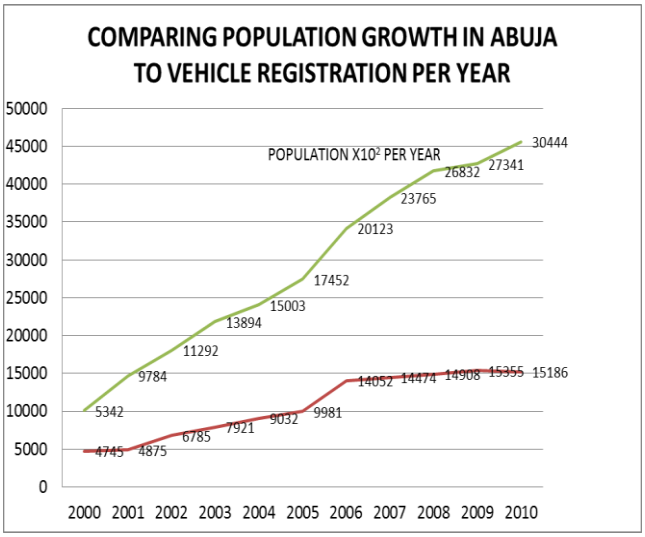
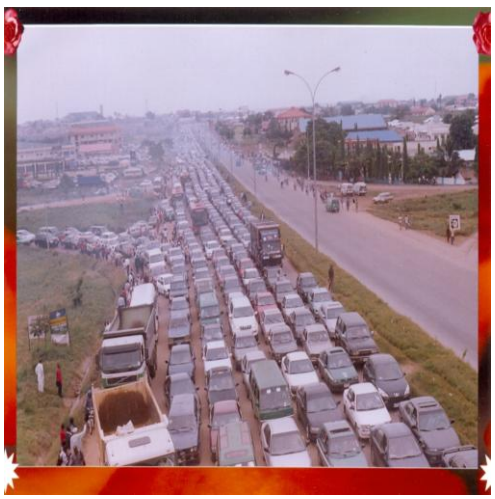


Fig. 2: Growth Pattern of Abuja population and Vehicle Registration [10]

Fig.2 shows the statistics relating population to vehicle registration in the city. It can be established that there is a corresponding increase in the number of vehicles being registered to the rise in the population.

Figures 3 below shows the traffic situations during peak period at Karu junction and Nyanyan respectively. This traffic incidence occurring in erratic patterns in form of unpredictable blocking of lanes contributes significantly to making travel unreliable for commuters.



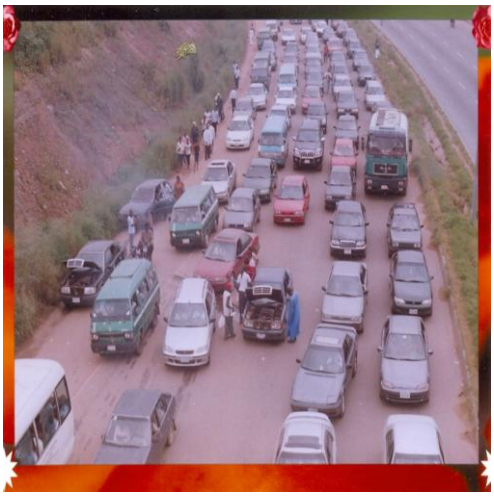


Fig 3: Traffic Situation at Karu Junction and Nyanyan respectively [10]

Travel Time Reliability

The method of *95th percentile travel times* was used to measure travel time reliability. It estimates how bad delay will be on specific routes during the heaviest traffic days. The one or two bad days each month mark the 95th or 90th percentile, respectively. Users familiar with the route (such as commuters) can see how bad traffic is during those few bad days and plan their trips accordingly.

Two hours video coverage each was recorded for both peak and non-peak periods (weekday and weekend) at the three critical congested locations along the road. The travel time of vehicles during peak and non-peak period at each location was analyzed using random selection method while playing back the video at 15 minutes interval. The events that impede traffic flow and cause travel to be unreliable often occur in combination.

An analysis of how the combination of these events affect the travel time reliability was carried out along Abuja – Keffi road for the weekday and weekend during peak and non-peak period respectively. The possible trips and travel time are plotted to illustrate the travel time variation. Few roadside interviews were also conducted to test the view of travellers on daily trip.

It was revealed that it becomes hard for travellers to predict how long time to commute to work. It appears even more difficult for travellers to plan their work trip as most offices resume work by 8.00am and the road section is always filled up beyond capacity between the hours of 7am and 9am (see Fig. 4). This uncertainty in travel time could introduce extra travel time and cost into the daily trip in order to account for time variability thereby resulting in travel time reliability.

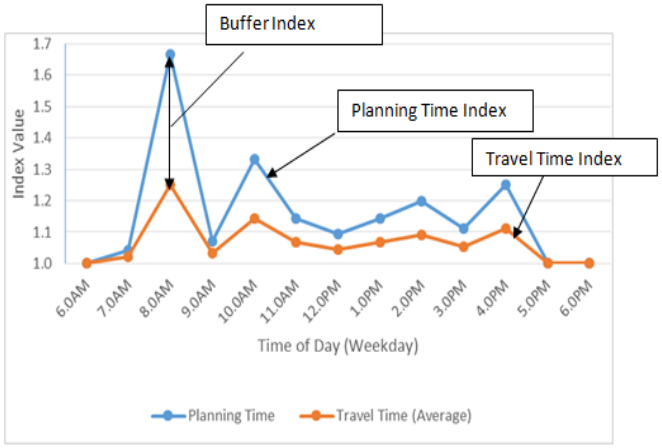


Fig. 4: Reliability measures compared to average congestion measures

The *planning time index* represents how much total time a traveller should allow to ensure on-time arrival.

The travel time index is a measure of average conditions that tells on average, travel times are during congestion compared to during light traffic.
The *buffer index* represents the extra time (or time cushion) that travellers must add to their average travel time when planning trips to ensure on-time arrival.

Traffic Mitigating Measures

These measures are aimed at increasing the existing capacity of the system in order to improve traffic flow of all modes and reduce travel time. This measures intend to make the most safe and productive use of the existing road or transport system. Thus, maintaining network reliability by achieving a level of service that meets the user's needs for mobility and enhancing the quality of the driving environment (Akinyemi, 2003).

This paper examines the type, causes of congestion and likely mitigating measures that can improve the traffic performance of the study road. It was observed that congestion on this road can be categorised as recurring and non-recurring. Recurring is as a result of large number of people and vehicles travelling at the same time (during peak commuting), thereby resulting in the number of vehicles on the road exceeding the available capacity.

Non-recurring congestion is caused by spontaneous traffic incidents or accidents such as vehicle breakdown, merging traffic, non-provision of mountain lane for trucks, weather events, etc. These events eventually reduce available capacity and travel time reliability. In addition, indiscriminate parking of vehicles, picking and dropping of commuters along the study locations contribute to recurring traffic-influencing events causing congestion and unreliable

travel time. Lack of Bus turnouts is noticed on the study road despite the available usable right of way. The purpose of the bus turnout is to avoid blocking a lane of traffic and to improve passenger safety during boarding and deboarding. Thus, mitigation measure is warranted.

Based on the above investigation, a study on the concentration of commuters was carried out at seven different locations (stops) during morning peak period (8.00 – 11.00); at an interval of 15 minutes as presented in Figure 5.0. It was observed that lack of proper bus turnouts for vehicles leads to lane indiscipline, and congestion within short period when boarding and alerting of commuters. The stream of private vehicles using the road along with public transport cause traffic increase which increase the traffic density as well as reducing the road traffic performance.

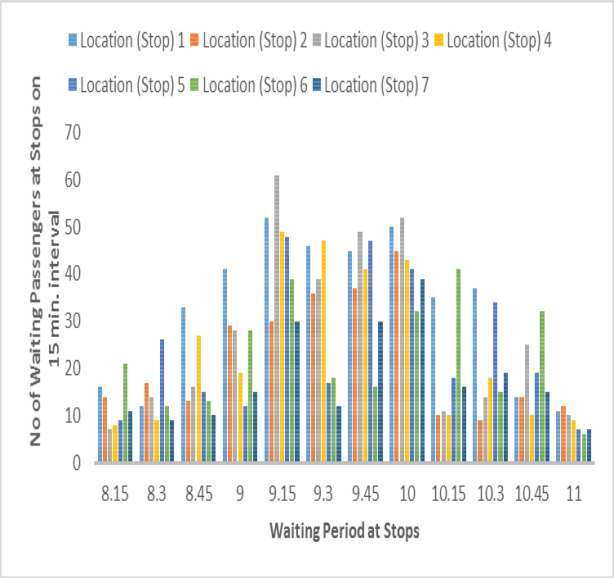


Figure 5.0: Concentration of Commuters along Study Road

Introduction of bus turnout, bus pullout, bus bay, bus lay-by or off-line bus stop is essential, most especially where there are concentration of passengers. There is sufficient right-of-way along the road corridor to accommodate bus stops and bus bays at the seven locations without interfering with the traffic flow. Bus turnouts if located along this road will provide an en route bus with an off-street service point that does not interfere with traffic movement and provides a safe waiting area for transit users. It will also reduce the risk of commuters being knocked down while alerting or boarding public transport. Since the cost implication is low and it can be implement immediately, it may therefore be considered as a reasonable strategy for reducing congestion along the study road.

RESULTS AND DISCUSSIONS

As shown in Figures 4, the index value for planning time is 1.65 compared to index value of 1.25 for the travel time during peak hour (7.00am – 9.00am). This implies that for a trip that takes 15 minutes in light traffic a traveller should budget a total of 25 minutes to ensure on-time arrival 95 percent of the time. Thus, the travel time becomes unreliable during the weekday as unusual circumstances can dramatically change the performance of the road, thereby affecting both travel speed and throughput volume. The road then becomes susceptible to traffic delay and may result in jam density. This implies that every traveller needs a buffer or extra time to ensure a high rate of on-time arrival and thereby helps in the development of variability measures.

Figure 5 shows the concentration of passengers waiting along the road. They ae more concentrated between the hours of 8.30 and 10.30am in all the location with the highest on average observed in location 1. Also, more concentration specifically, was observed between hours of 9.00 and 10.00am in locations 2, 3 and 4. Due to indiscriminate picking of passengers along the road by the public transport congestions are built as vehicles move along the study locations. The shockwave effect of slow moving vehicles always disrupt the planning time of individual travellers. This effect is noticed as a sharp increase in planning time between this periods (see Figure 4) leading to unreliable travel time. Thus, there is need for the introduction of Bus stops at these locations to enhance passenger safety in a number of ways (Road Service, 2009). These include:

- Preventing passengers trying to board or alight in hazardous situations such as intersections, or where bus is turning and is not using the curb lane.
- Enabling a bus driver to only look out at the approach of each bus stop.
- Preventing a free for all boarding and alerting from buses by passengers and thus reducing time spent at boarding.
- Using Bus bays to allow buses arrive at stop, while the flow of traffic on the roadway is not impeded

CONCLUSION

The study has been able to identify types and causes of congestion and likely mitigation measures to compensate for the reliability of average travel time. It observed that increasing traffic leads to increasing severity, spatial extension and duration of congestion. The interaction between travel demand, traffic flow, congestion, travel time variability, and individual scheduling choices should be understood by the commuters and thus warrants the need to introduce bus stops at locations where commuters are concentrated.

It was found out in this study that good transport with major bus turnouts would make significant contribution to travel time reliability. Such transport patterns could provide movement of large number of people while occupying a relatively small portion of road space. A good transport with well-located bus-turnouts could help to eliminate congestion which is the major problem along the study route and also improve the overall safety and efficiency of the road network.

Therefore, like many developed countries, it is recommended that Nigerian government should imbibe the idea of providing proper bus stops and on-street parking along road network to improve traffic fluidity so as to enhance mobility and safety.

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