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Traffic Congestion in Dar es Salaam: Implications for Workers' Productivity

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Abstract

Inadequately planned transport systems result to traffic congestion, a challenge that has for long been a thorn in Dar es Salaam, the city most affected in Tanzania. Although traffic congestion has been a major concern in Dar es Salaam, marked reluctance has been noticed in taking measures towards a lasting solution thus, it is of diminutive surprise that limited studies and documentations on the same are in existence. Therefore, this study assesses traffic congestion in Dar es Salaam and particularly its implications for workers' productivity. Travel time and productivity indexes were established from a sample of 96 workers who used public transport along Morogoro and Mandela Roads. Travel time index (TTI) is the ratio of the average travel time during peak period to the travel time during off-peak period. Findings reveal that TTI was 2.19. Workers spent about 2 times of the average commuting time to work and 3 times of the same commuting from work to their various residences. About 2.5 hours were lost on traffic jam per day and that people worked 1.4 times less than the required time due to traffic congestion. It was further established that in 10 working days, almost 3 days were lost to traffic congestion. Since there are ongoing efforts to improve the transport system through the Bus Rapid Transit (BRT) project, it remains to be seen as to what extent traffic congestion will be reduced. In either case, this study provides a benchmark for comparisons.

Keywords: congestion, productivity index, traffic jams, transport systems, TTI, urban planning

1. Introduction

Traffic congestion may be a sign of growth in an economy but it is an issue of serious concern (Harriet *et al.*, 2013). Studies portray that traffic congestion is a major transportation challenge in large and growing cities (Basondole, n.d; Chakwizira *et al.*, 2014; Chama, 2013; Eisele *et al.*, 2011; Harriet *et al.*, 2013; Olukemi, 2010). The predicament of poorly planned and overpopulated cities like Dar es Salaam is even worse in reference to traffic congestion (Kiunsi, 2013). According to Kiunsi (2013), rapid population growth, poor road infrastructure, city structure, poor public transport, and rapid increase in number of cars in Dar es Salaam have been blamed for traffic congestion. The aforementioned quandaries have in turn escalated secondary challenges like traffic jam, faulty traffic light systems, inadequate traffic police officers to mitigate jam, narrow road spaces and reckless driving of especially commuter buses (commonly known as *daladala*), motorbikes (*bodaboda*) and tri-cycles (*bajaji*) (Elisonguo, 2013; Msigwa 2013; Ng'hily, 2013).

It is estimated that the volume of traffic in Dar es Salaam is over 400,000 with more than 6,000 being commuter buses (Basondole, n.d). According to Msigwa (2013), an estimated 70% of all vehicles in Tanzania are in Dar es Salaam therefore, it is no wonder that the big volume of traffic coupled with poor road infrastructure and city structure drastically slows down the vehicular travel speed. The average vehicular speed is estimated at 25.6 km/hr and it is feared that should no strategies be taken, it is projected to reach 10 km/hr by 2030 (Basondole, n.d). Kiunsi (2013) spells that the vehicular speed is between 20 km/hr to 30 km/hr at a distance of 25 to 30 km from the city centre, within the city centre and its surrounding the speed is reduced to between zero and 10 km/hr with the peak in the mornings between 7.00 to 9.00 am and evenings between 03.00 to 08.00 pm (Elisonguo, 2013; Kiunsi, 2013).

Traffic congestion poses a wide range of negative impacts on people, patients rushing to hospitals, businesses, and government revenues let alone other environmental impacts such as air pollution (Chama, 2013; Elisonguo, 2013; Harriet *et al*., 2013; Msigwa 2013; Ng'hily, 2013; Olukemi, 2010). It is estimated that traffic jam cost the country up to 20% of annual profits of most businesses. Daily losses to traffic jam is estimated at a whopping TZS 4bn and TZS 1.44 trillion annually in Dar es Salaam alone (Basondole, n.d; Msigwa, 2013). Commuter bus owners are the biggest losers as they make fewer trips and use more fuel due to traffic jams (Ng'hily, 2013).

The traffic jam dilemma has been blamed for rampant patient and accident casualty deaths that would otherwise be prevented as patients kick the backet on their way to hospitals (Msigwa, 2013). Further still, workers trapped in traffic jam waste both valuable work and rest time hence impeding on productivity and consequently escalating stress levels.

The challenges associated with traffic congestion in Dar es Salaam have attracted the interest of several scholars as to study the issue in an effort to derive possible solutions. Such studies include Basondole (n.d), Elisonguo (2013), Centre for Economic Prosperity (CEP) (2010), Kiunsi (2013), and Msigwa (2013). However, those studies with the exception of Elisonguo (2013) only discuss the problem and its possible solutions based primarily on literature review rather than primary data. Such studies focus mainly on the cost of traffic jam in monetary terms on bus owners and the would-be tax collected by the government. Also, Elisonguo (2013) measured the social economic impact of traffic congestion in Dar es Salaam by interviewing a sample of employees and drivers based on opinions rather than measuring the travel time index (TTI) and productivity index of workers. Therefore, this study measured TTI in Dar es Salaam and particularly its implications for workers' productivity. TTI is the ratio of the average peak period time to the travel time at free-flow conditions (Eisele *et al*., 2011; Prevedouros, 2008). It helps to measure the efficiency of urban transport systems, planning for development patterns, and for benchmarking (Prevedouros, 2008; Schrank*et al*., 2011). According to Eisele *et al*. (2011), travel time is an important measure of transportation system performance that can be easily communicated to both technical and non-technical audience.

The overall objective of this study was to create a deeper understanding of traffic congestion in Dares Salaam and its implications for workers' productivity. Since the government has of recent embarked on improving public transport in Dar es Salaam through the so called 'fast track buses' or 'Bus Rapid Transit' (BRT) project, this study will provide a benchmark for further performance measurement of the same (see *e.g*. Ahferom, 2009). Specifically, this study sought to achieve the following objectives:

i) To estimate the travel time index in Dares Salaam

ii) To estimate the productivity index as a ratio of required working hours and actual hours worked.

2. Method

2.1 Study Design and Location

This is a descriptive study conducted in Dares Salaam, also the business capital and the most populated city in Tanzania (see *e.g*. Chama, 2013; Chakwizira *et al*., 2014; Elisonguo, 2013; Harriet *et al*., 2013; Olukemi, 2010). The city has a population of 4.4 million people, which is about 10% of the Tanzanian population (National Bureau of Statistics (NBS), 2012) and a population density of 3,133 people per square km. The national average population density is 51 people per square km. As previously mentioned, about 70% of the county's total vehicles are in Dar es Salaam, making it the most populated city. In Dar es Salaam city, data was collected along Morogoro and Mandela roads. Morogoro and Mandela roads were purposively selected as they did not only have high rate of traffic jam but were also commonly used by workers. Traffic congestion is most critical on all major road intersections of Morogoro Road at Ubungo, Magomeni, and BibiTiti Mohamed and Mandela Road at Tabata and Buguruni intersection (Kiunsi, 2013). According to Kiunsi (2013), other and perhaps lesser traffic congestion problems are along: Nyerere Road at Tazara, Chang'ombe, Msimbazi; UN/Kinondoni junction; and Old Bagamoyo Road at Mwenge.

2.2 Sample Size and Sampling Technique

Our study population consisted of workers who used public transport in Dar es Salaam. Our definition of workers includes both public and private sector employees as well as self-employed individuals who use public transport on regular basis. We targeted workers because our objective was to measure and ascertain the implications of traffic congestion for workers' productivity. We used a convenient sample of 96 such workers (see *e.g*. Bernard, 1995; 95). The sample size of 96 was derived from equation (1) for infinite population (Snedecor & Cochran, 1989).

$$n = \frac{1.96^2 p(1-p)}{e^2} \tag{1}$$

Where p is the percentage of cases with the desired attribute (in this case the percentage of workers affected by traffic congestion) and e is the desired level of precision or the error margin. If the value of p is not known in advance, a default value of *50%*, which gives a maximum variability, is usually selected. For the same reasoning, we used $p=50\%$ with $e=10\%$. Although the common level of precision is $e=5\%$, the value of *10%* was found to be appropriate for this study as we did not aim at meeting any level of statistical significance.

We used convenience sampling technique in public buses to identify respondents. Although convenience or opportunity sampling is susceptible to bias and or outliers because of high cases of self-selection (see *e.g*. Farrokhi, 2012), it was still appropriate for this study due to absence of sampling frame. Nonetheless, researchers minimized incidences of self-selections by randomly approaching commuters seated at the front, middle and rearmost of the bus to participate in the study. Also, descriptive statistics did not show any incidences of outliers. Generally, the limitations of convenience sampling depend on the type of analysis to be conducted (Farrokhi, 2012). In this descriptive study, no threats were expected in terms of data quality as a result of our sampling technique.

2.3 The Questionnaire and Data Collection Procedure

Data that informed this study was collected using a questionnaire and personal observations (see *e.g*. Chama, 2013; Chakwizira *et al*., 2014; Elisonguo, 2013; Harriet *et al*., 2013; Olukemi, 2010). The tool was tested prior to being administered to the convenient sample of 96 workers. Questionnaire items consisted of questions on: demographic information (*e.g*. sex, age, level of education and occupation); frequency of traffic jam; *daladala* boarding place/stop; location of work station; time taken to arrive at the work station (with and without traffic jam); time taken to commute back home (with or without traffic jam); required working hours per day; and average actual hours worked per day. These items were considered adequate in estimating TTI and workers' productivity.

Researchers boarded the *daladala* to observe, to identify respondents and to administer the questionnaire between June-July, 2014. Contrary to the use of floating car test vehicle equipped with Global Positioning System (GPS) instrumentations or Bluetooth system (see *e.g*. Eisele *et al*., 2011), we found that boarding on public buses was the appropriate method for this study given the road infrastructure and availability of facilities. Identified passengers were requested to fill in a short questionnaire aboard the *daladala,* which were returned before they reached their final destinations. Filling in the questionnaire was voluntary and respondents' anonymity was protected. Researchers also measured the time taken from initial *daladala* stop to various bus stops up to the final destination several times for each route. We attempted to commute in the morning, in the afternoon and in the evening on both working days and weekends. This facilitated in making comparisons between typical peak hours on week days and weekends.

2.4 Analysis

Data was analyzed using mathematical computations and simple descriptive statistics such as percentages, mean, standard deviation, and maximum and minimum values (see *e.g*. Chama, 2013; Harriet *et al*., 2013). We also included some 95% confidence intervals for the mean in estimating TTI and productivity index (PI). TTI was estimated using equation (2) as the ratio of the average time taken to commute during the peak period and the travel time that would be taken to commute the same distance in free-flow (Eisele *et al*., 2011; Prevedouros, 2008).

$$TTI = \frac{T_{Jam}}{T_{NoJam}} \tag{2}$$

Where T_{Jam} is the average time taken to commute from the home bus stop during peak hours and T_{NoJam} is the time taken to commute the same distance during off-peak hours (free-flow conditions). Transportation system performance can be measured by either vehicular speed or travel time (Eisele *et al*., 2011). According to Eisele *et al*. (2011), travel time measures are consistent, address transportation and land use systems, and are responsive to concerns of residents, businesses and travellers. Moreover, TTI has been proven valuable mobility analysis and transportation system performance (Eisele *et al*., 2011). TTI can be described according to the ranges shown on Table 1. A TTI greater than or equal to 2.0 represents a very poor transport system with intolerable traffic jam.

Table 1. TTI description

SN	TTI	Description
1	≥ 2.0	Very poor
2	1.6 – 1.9	Poor
3	≤ 1.5	Tolerable

Source: Prevedouros (2008; 13)

Workers productivity index (PI) was estimated using equation (3) as the ratio of the number of required working hours per day and the average number of actual hours worked per day.

$$PI = \frac{T_{\mathrm{Re}quired}}{T_{Actual}} \tag{3}$$

Where $T_{Required}$ is the required working time or hours per day and T_{Actual} is the average actual hours worked per day. Possible values of PI can be described as shown on Table 2. A PI of 1.0 signifies that an employee is working normally as per requirement.

Table 2. Description of productivity index

SN	PI	Description
1	1.0	Normal working
2	<1.0	Over working
3	>1.0	Under working

Source: Authors

An alternative measure of labour or worker productivity is the ratio of output per hour worked. However, it was impossible to measure workers output other than the time they spent at work. We were limited by the fact that employees performance thus productivity was measured by the time stayed in office or at work premises and not by other specific outputs in most work places. Previous studies such as Harriet *et al*. (2013) used a similar approach of estimating worker productivity in terms of time spent at work station.

3. Results

3.1 Respondents

General information of our respondents was described in terms of sex, age, level of education and occupation. These aspects were considered important in this study as they provide the general characteristics of the respondents. Table 3 shows the general characteristics of a sample of 96 respondents who were surveyed during the data collection process. Although our study aimed at finding an equal number of men and women for our respondents, we were able to access more women than men. As shown on Table 3, approximately 54% of our respondents were female. We hypothesized that more females would use public transport than males because anecdotal evidence suggests that the phenomenon of private car ownership is higher among males than females. However, this result may not be conclusive due to the nature of the convenience sample used.

Majority of our respondents (approximately 74%) ranged between the ages of 20 and 39. Again, we hypothesized that middle aged and relatively elderly persons were better off and could afford private transport in comparison to their younger counterparts most of whom have been recently employed or self-employed. About 52% of our respondents were self-employed while the rest were either employed in the public or private sectors. In terms of education, 88% of our respondents had either attained secondary or post secondary education. We expected that we would receive differing responses/opinions on traffic congestion as influenced by diverse levels of education.

Table 3. Characteristics of respondents

Age (years)	Percentage	Education	Percentage
20-29	34.4	Primary	11.5
30-39	39.6	Secondary	40.6
40-49	15.6	Post-secondary	47.9
50-59	5.2		
60-69	5.2		
Total	**100**	**Total**	**100**
Occupation	**Percentage**	**Gender**	**Percentage**
Self employed	52.1	Male	45.8
Private sector employees	27.1	Female	54.2
Public sector employees	20.8		
Total	**100**	**Total**	**100**

3.2 Travel time index

The mean TTI as workers commute from home to their work station was estimated to be 2.19 with a minimum of 0.90, a maximum of 4.55 and a 95% confidence interval for the mean of [2.06;2.32] (Table 4). This means that on average, workers spend more than twice the required time to commute the same distance. In other words, if the normal travel time in absence of traffic jam is 20 minutes, then workers would spend an average of 20 minutes times 2.19, which equals to 43.8 minutes due to traffic jam. The maximum TTI of 4.55 indicates that workers spent up to 4.55 times the required time to get to their various work stations.

In reference to commuting back home from work stations, the average TTI was 3.00 with a maximum of 6.00. Again, this implies that workers spend up to 6 times the required time to commute from work stations to their homes. As aforementioned, a TTI of greater than 1.90 indicates a very poor (inefficient) transport system (Prevedouros, 2008). In this case, our results prove that the public transport system in Dar es Salaam is highly inefficient.

Table 4. Travel time index in Dar es Salaam

	Min	Max	Mean	StdDev	95% Confidence Interval	
					Lower	Upper
TTI to work	0.90	4.55	2.19	0.66	2.06	2.32
TTI from work back home	1.40	6.00	3.00	1.06	2.79	3.21

3.3 Productivity Index

The average productivity index was 1.39 with a maximum of 2.67 implying that workers worked by nearly 1.4 times less than would be required while others worked about 2.7 times less than required (Table 5). As shown on Table 2, a PI of greater than 1.0 implies under working. Workers lost an average of 2.48 hours to traffic congestion while some spent up to 5 hours per day stuck on traffic jam (Table 5). With this result, it can be safely put that workers spend valuable time commuting rather than working hence; a detriment to their productivity. Although we cannot claim that all the excess time in traffic jam was work hours, our interest was in how many minutes or hours one reports late to work as a result of being caught up in a jam and if they left their work station earlier than required to avoid traffic jam on their way back. Basically, we asked respondents two questions: the amount of time they were required to work and; the average actual amount of time they worked as a result of delays in traffic jam.

Table 5. Productivity index

	Min	Max	Mean	StdDev	95% Confidence Interval	
					Lower	Upper
Productivity Index	1.09	2.67	1.39	0.25	1.34	1.44
Time lost (hrs) to traffic jam	1.00	5.00	2.48	0.98	2.28	2.68

4. Discussion

Our findings indicate that TTI ranged from 0.90 to 4.55 with a mean of 2.19 when commuting from homes to work stations and worsened in the evenings from 1.40pm to 6.00pm with a mean of 3.00 when commuting back from work stations to homes. Owing to the fact that more than TZS 1.44 trillion was lost annually to traffic congestion in Dar es Salaam alone, this situation is a burden to the economy and discourages attempts to improve the quality of residents' lives (CEP, 2010; Msigwa, 2013). As workers spend two hours on the road for a distance that would normally take 25 minutes, they may not only reach their work stations already tired but also frustrated hence; decreasing productivity. According to Chama (2013) and Olukemi (2010), this escalates stress levels due to failure to meet deadlines or missing important appointments and increasing lost opportunities. Further still, workers have to forego personal socialization and recreation as time for such stress relieving activities is spent on traffic lengthy queues.

Although traffic jam is expected in highly populated cities, the case of Dar es Salaam is worse than many other and perhaps more populated cities. For instance, the average TTI in US urban areas is 1.20; Los Angeles with a population of about 10 million people had a TTI of 1.38, which is the highest in the US. New York with a population of about 8 million people had a TTI of 1.28 and Washington DC had a TTI of 1.33 (Schrank*et al*., 2011). This implies that population is not an exclusive factor attributing to high TTI. Apart from road infrastructure and the city structure, reckless driving and improper overtaking by *daladala* drivers, motor bikers, and tri-cyclers worsens the traffic jam dilemma. Prosecuting and or punishing perpetrators may reduce road blockage.

The movement of large/heavy trucks exceeding 10 tons contributes to traffic jams especially during rush hours in the evening. This is a common phenomenon along Morogoro, Mandela and Nyerere roads. CEP (2010) recommends for restriction of heavy trucks on such busy roads during rush hours.

Our findings indicate that employees work up to 1.40 times less than was required due to traffic congestion. An average of 2.5 hours was lost each day due to traffic congestion. This suggests that in 10 days, about 25 work hours were lost, which is an equivalent of 3 days assuming an 8 hour work day. Literally put, in every 10 working days, an employee worked just 7 days due to traffic congestion. This appears to be an extreme case of a very poor transport system. In urban Ghana, for instance, Harriet *et al*. (2013) find that up to 1 hour (approximately 10% of work time) was lost to traffic congestion when workers commute from homes to work stations. Comparatively, as a result of traffic congestion worker productivity in Dar es Salaam is nearly three times less than that of urban Ghana.

In order to improve productivity, it is imperative to ensure that all parts of the city are accessible. Absolute accessibility is defined as the number of residents or jobs reachable within 25 minutes' driving time from a given point (Hartgen & Fields, 2009). According to Hartgen & Fields (2009), moving through free-flow traffic throughout a city could boost productivity for workers by as much as 30% in highly congested regions. They further estimate that reducing traffic congestion by 10% improves productivity by over 1%. Although 1% may seem an almost negligible difference, it may mean tens of billions of money in economic gains in some cities.

Although this study was limited to only two routes namely Morogoro and Mandela roads, TTI showed that Dar es Salaam operated on a highly inefficient transport system that is in turn detrimental to workers' productivity. Increasing traffic congestion directly reduces the growth of the city's economy and the nation at large. With inefficient transport system people arrive to work late or have to wake up early in the morning hence reducing their rest time and increasing stressing levels at the same time. Stressed workers are counterproductive. Also, inefficient transport system delays delivery of products to market, deters logistics and supply chains and trade. An effective transport system is needed to sustain economic growth and development of Dar es Salaam and the country at large. Therefore, we recommend that stakeholders and relevant authorities should place reduction of traffic congestion at the core of city economic development strategies in Dar es Salaam. Despite the fact that we acknowledge the ongoing efforts to improve the public transport system through the BRT project; we believe that traffic congestion in Dar es Salaam may not be solely solved by fast track buses alone. Other measures including restricting the movement of heavy trucks during rush hours, prosecuting and punishing reckless drivers or generally law enforcement, and re-planning the city structure by relocating public services such as hospitals, schools, offices, shopping centres, and other activities is equally important. Moreover, this study serves as a benchmark for further performance measurements when fast track buses become operational.

Future studies could collect more data for peak and off-peak times along BRT and other roads to compare and ascertain the extent to which BRT system can reduce traffic congestion.

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