Logistics Inefficiencies of Urban Transportation System in Ghana

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Abstract

As a crucial driver of supply chain, urban transportation facilitates socio-economic development and enables businesses to be competitive in the global economy. An effective urban transportation system reflects in the efficient logistic system and customer satisfaction. It links people and business to the services they need and foster growth amongst individuals and businesses. This study aims at assessing the challenges facing urban transportation in the Kumasi Metropolis. Deductive approach with survey strategy was used in the study. Primary data was collected through questionnaires and observations. The study ran linear regression with the aid of statistical package for social sciences (SPSS) to analyze the quantitative data to find the correlation between effective urban transportation and transport infrastructure, Public transport services and traffic management. The qualitative data was analyzed through deduction and inferences. The study found that the challenges facing transportation system in the Kumasi Metropolis was seen to be as a result of inadequate transport infrastructure, ineffective public transport services and ineffective traffic management system. The need for improvement in transport infrastructure with effective traffic management system by the city authorities is a necessity for effective urban transportation system.

Key word: Urban transportation, Transport infrastructure, Traffic management System, Logistics efficiency

Introduction

Urban transportation problems have negative consequences on the socio-economic development of a nation. For example traffic congestion, which is one of the major problems plaguing urban transportation system in most metropolis across the globe (Yildirim 2001), has serious effect on economic and social activities both at the micro and macro level. Urban transportation systems in most developing countries face major challenges. The existing road transport infrastructure capacity in most cities in the developing economies has reached critical level and is unable to meet the huge demand from the increasing number of vehicles. The challenges have been attributed to continuous growth in urban population, private vehicle ownership, ineffective traffic management system and the ineffectiveness of public transport services which are the causes of traffic congestion with dire consequences on social and economic activities (World Bank, 2011). Lee (2001) reports that the vehicle ownership rate is estimated to increase from about one vehicle for every four persons in the year 2000 to about two vehicles for every five persons in 2020. It is imperative, therefore that effective urban transportation be developed to accommodate the increasingly high rate of vehicle ownership in order to improve upon the effectiveness of transportation system in cities.

Most organisations are becoming increasingly aware of logistics efficiency as a decisive competitive factor, and that logistics performance is crucial to organization's operations. To be competitive, organisations must ensure that logistics cost are kept to the lowest possible than their competitor (Persson 1991). Barad and Even Sapir (2003) and Zhang *et al*. (2005) assert that in order to provide responsive and better customer services, there is the need for efficient logistics system. An efficient logistics activity is a function of effective transportation system. However, it appears that the quest to develop transport infrastructure and traffic management system to improve urban road transportation in the Kumasi Metropolis seems to have been given low attention. The seemingly urban road transport ineffectiveness in the metropolis has compromised efficient logistics performance. This is seen in the unreliable logistics delivery times, unpredictable lead times, high holding cost from excess inventory, and high distribution cost, contributing to high cost of business and low customer satisfaction. Against this backdrop, this study aims at examining the challenges confronting road transportation in the Kumasi metropolis.

Logistics Systems in an Economy

Logistics is considered as part of the supply chain process that plans, implements and controls the efficient, effective flow (both forward and reverse) and storage of goods and services, and related information from one point to another in order to meet customer requirements (Lambert, 2006; Miller, 2012; Grant *et al.*, 2006). The economic gains derived from logistics activities are enormous in national development (Lambert 2006). The profit leverage effect can be seen in the fact that when a dollar is saved through efficient logistic system, the impact it makes on the profitability of the organization is much more than a dollar increase in sales (Grant *et al*. 2006, Fisher 1999. This makes for competitiveness at the micro level and macro level (Tilamus 1997;Tseng *et al*. 2005). To interpret logistics, Tilamus (1997) suggests five key terms to be considered. They are logistics, inbound logistics, material management, physical distribution and supply chain management. Here logistics describe the entire process of materials and products moving into, through, and out of firm. Inbound logistics is concerned with movement of material received from suppliers whilst material management deals with the movement of materials within the firm. Physical distribution is also concerned with the movement of goods outwards to the final consumers whilst supply chain is the framework which links logistics with the user's communication network and the firm. The main components of logistics system are further reported as logistics services, information systems and infrastructure resources (Tseng *et al.*, 2005). The interaction of the three main components in the logistics system is describes as that logistics services support the movement of materials and products from inputs through production to consumers as well as associated waste disposal and reverse flow; the logistics services comprise physical activities such as transportation system and storage as well as non-physical activities which include supply chain design, selection of contractors and freightage negotiations. Thus effective and efficient logistics system depends on effective transportation system.

Transportation Challenges of Logistic Performance

Transportation is an essential logistical driver of supply chain that contributes to economic growth (Viyayaraghaven, (2007). It has played a central role in both local and international trade. Lee (2001) further asserts that growth in domestic freight movement has shown positive correlation with the growth of real gross domestic product (GDP) over the years. Underinvestment in transport infrastructure has negative effects on logistic system and the entire social and economic activities (Chopra and Meindle, 2007; Kulash, 1999; Eddington, 2006; Grant *et al.*, 2006; Miller, 2012). The immediate effects of ineffective transportation are the rising cost of logistic activities and business services. For example, it is observed that perishable goods rarely reach their destination in the same fresh condition and this reduces the shelf life of these products to a few days. This poses a great risk to business since products under such a condition do not sell at economic prices. Other effects may be more subtle but more lasting and of dire consequences. This includes an erosion of a nation's long-term competitiveness through higher cost of products, increased balance of payments deficit by making products less competitive. Indeed the rapid growth of China and other Asian countries are due to stimulating demand for more sophisticated infrastructure to support transportation and logistics (Rodrigue et al, 2005).

The short-to-medium term effect of underinvestment in transport infrastructure is traffic congestion which serves as a compromising factor of logistics efficiency (Tanigichi and Thompson, 2007; Stantchev and Whiteing, 2005). This leads to high cost of transport services. Traffic congestion, increases man-hours and fleet size requirements, and forces business to raise prices of their products and services to remain in businesses posing a threat to both time and place utility in the supply chain.

The long-term effect of transport infrastructure inadequacy is even more debilitating as it leads to multiple charges. Thus, ineffective urban transport system poses a threat to both time and place utility in the supply chain (Rodrigue et al., 2002; Eddington, 2006; Grant *et al*. 2006). Jocoby and Hodge (2008) however, outline some benefits of effective transportation system through adequate investment in transport infrastructure as:

- Low sourcing cost
- Reduced fleet, cost
- Low warehousing cost and
- Low inventory cost because business can adopt just-in-time (JIT) approach.

They further delineate that adequate transport infrastructure and effective traffic management system improve transportation system's capacity and reduce congestion, thereby improving reliability in the urban transportation system. This reduces variability in transit time and makes predicting and forecasting performance easy with greater sense of accuracy. Again improved transit reliability reduces inventory level and influences just-in-time (JIT) logistics system. Arasan, (2012) describes effective urban transportation factors as adequate road network, traffic management system and reliable public transport services. Nadiri (1998) also says that investing in adequate transport infrastructure improves the effectiveness of urban transportation. Shapiro et al, (2002) assert that an effective public transport service is prerequisite for ensuring effective transportation system in urban areas in terms of reducing congestion. Schreffler *et al. (*2012), Godwin *et al*. (1998) suggest that effective traffic management can improve utilization of road networks at much lower cost than constructing new and expanding existing ones. They argue that public transport services as part of traffic management strategy offers good opportunity and strategy for ensuring effective transportation system in cities**.** This requires substantial investment in transport infrastructure which includes roads, railway, bridges, tunnels, ports airports, urban transport infrastructure and inland container depot (intermodal infrastructure) as well public transport services, road network, signage and traffic management systems, parking lots, bus stops, vehicles and transport terminals (ESCAP, 2005; Arasan, 2012; Rodrique et al., 2009) in order to ensure efficient logistics system and effective traffic flows on roads (Eddington, 2006; Munuzuri et al., 2005).

Methodology

This study focused on three main categories of factors that affect urban transportation system effectiveness. These are:

- Physical transport infrastructure (which covers road network, bus stops, parking spaces and terminals),
- Public transportation services (which covers the services of mass transit , mini buses and cars), and
- Traffic management system (which considers dysfunctional road signals vehicle breakdowns on roads, drivers and pedestrians indiscipline).

In this study, the following assumptions were made that:

- If transport infrastructure has relationship with effective urban transportation, then limited packing area and terminal, limited road space and bus stops may contribute to traffic congestion.
- If public transport service has relationship with urban transportation system, then effective urban mobility is a function of availability of mass transit, mini buses, cars and sport utility vehicles (SUVs).
- If traffic management and control system has correlation with urban transportation system, then dysfunctional road signals, vehicle breakdowns, drivers and pedestrians indiscipline may be significant causes of congestion.

Based on these assumptions, the study postulated the following simple linear equation:

$$y = \beta_o + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \mu$$

Where y= the dependent variable (effective transportation System)

X_1= Variable One (Transport Infrastructure)

X_2= Variable Two (Public transport services)

X_3= Variable Three (Traffic management and control system)

μ = Error term

$\beta_1 - \beta_3$ = Parameters to be estimated

β_0= Constant term

The Study Population and Sampling Techniques

The respondents that were chosen for the study were drivers of all categories of vehicles (cars, SUVs, buses trucks and motor cycles) and commuters. Five road links out of the twenty-one major road links in the Kumasi metropolis were selected for the study in the order of traffic congestion level as has been established by the Department of Urban Roads (table 1) and the corresponding volume of traffic flow (table 2). On the basis of the average traffic volume of 63.46 vehicles per minute, a quota of 60 drivers was allocated to each of the five road links, making for a sample size of three hundred (300). The quota distribution composed of 48 cars and SUVs, 10 buses and trucks and two motor cycles, based on the 2009 traffic mix in the metropolis as established by the Ghana Statistical Service (table 3). In addition, 150 commuters working in the formal sectors were also involved in the study with a quota of 30 for each road. This makes a total of 450 respondents. Systematic random sampling was used to select the respondents based on every fourth respondent met.

Table 1- Key Roads in Order of Congestion Level

Rank	Name of Road	Functional Class	Study Length (km)	Congestion Index (CI)
1	Mampong Road	Principal Arterial	5.0	13.8
2	Suyani Road	Principal Arterial	3.3	8.9
3	Antoa Road	Pricipal Arterial	5.5	6.0
4	24th Feb. Road	Principal Arterial	5.4	5.8
5	Harper Road	Principal Arterial	2.5	5.6

Source: modified from Urban Roads Report (2004)

Table 2-Volume of Traffic Flow Analysis

Road Link	Peak Total Volume Per Hour	Peak Total Volume Per Minute
Manpong Road	5,394	89.9
Sunyani Road	4,219	70.3
Antoah Road	3,,860	64.3
24th Feb. Road	3,202	53.4
Harper Road	2,148	35.8
Wtd. Average	**3,764**	**63.46**

Source: modified from Urban Roads Report (2004)

Table 3- Distribution of average traffic mix in Kumasi

Type of Vehicle	Average Percentage Share
Cars/SUVs	81.5%
Buses &Trucks	16 3 %
Motor Cycle	6.2 %
TOTAL	100%

Source: Modified from Ghana Statistical Service (2009)

Results and Discussions

The oval response rate of 96.7% was realized for the study. Both self-administered and interviewer-administered questionnaires were used for the study. This allowed for responses from the respondents with varying characteristics, some of whom might require guidelines and further explanations to questions. The questionnaires used were closed type with five point likert scale, ranging from 1= Strongly Disagree to 5= Strongly Agree. Respondents were given the chance to tick or rank the most appropriate response(s). Two different sets of questionnaires were used. The first set was used to collect information from drivers whilst the second set was used to collect responses from commuters. The questionnaires were delivered to the respondents by the researchers. In some cases, the researchers read out and explained the questions to the respondents whose literacy level were low and were unable to read and understand for relevant responses. Also, field observations were made on the five key road links understudy to record relevant issues on transport infrastructure, availability and reliability of public transport services and the transport management and control system as they pertained on the field. The use of questionnaires and observation as data collection instruments was for the purpose of triangulation.

The researchers used inferential statistics with linear regression to analyze the quantitative data with the aid of statistical package for social sciences (SPSS). The qualitative data were analyzed with deductions and inferences. Table 4 shows the results of the regression analysis of the factors that directly affect effective transportation system in the Kumasi Metropolis.

Table 4 - Factors Affecting the Transportation System in Kumasi Metropolis

Variable	Co-efficient	t- Value	P-Value
Transport Infrastructure			
Limited Parking Area	-0.4217***	-5.54	0.000
Limited Road Space	-0.3309***	-4.98	0.000
Limited Bus Stop	-0.3660***	-6.70	0.000
Public Transport System			
Mass Transit	0.0122	0.32	0.748
Mini-Bus Availability	0.0074	0.13	0.893
Car/SUV Availability	-0.0567***	-3.81	0.000
Traffic Management			
Dysfunctional Road Signals	-0.3096***	-4.31	0.000
Drivers Indiscipline	-0.0213	-0.55	0.584
Pedestrians Indiscipline	-0.0543	-1.51	0.131
Vehicle Breakdown	-0.1907***	-5.42	0.000
Constant	8.6572	3.88	0.000
No. of Observation	435		
F-Statistics	17.62		
P-Value	0.000		
R^2- Value	0.47601		
Adjusted-R^2	0.45502		

*** indicates 1% significant level
Source: Researchers' computation 2012

The results indicated that limited parking space and terminals, limited road space and limited bus stops were negatively related to effective transportation system in the metropolis and were statistically significant at 1% respectively. The correlation coefficient were -0.422, -0.331 and -0.366 respectively. This indicates that the challenges of the transportation system can be explained by physical transport infrastructure inadequacy in the metropolis. Concerning public transport services factor, the assumption was that effective urban mobility may be the function of reliable and adequate mass transit services, availability of mini buses and availability of cars/SUVs in the metropolis if relationship exist between the variables. It was found from the analysis that the use of maxi buses (mass transit) and mini buses was positively related to effective transportation system in the metropolis but was not statistically significant. The estimated coefficients of correlation were 0.0120 and 0.0074 respectively. This indicates that the use of maxi buses and mini buses encourage effective transportation system in the metropolis but due to their inadequacy in number, their positive impact on effective transportation system in the metropolis is insignificant, that is not clearly realized. It was also observed from the study that under transportation system, too many cars/SUVs availability was negatively related to effective transportation system in the metropolis and was statistically significant at 1% with coefficient of correlation of -0.057. This indicates that increase in the use of cars (saloon cars and SUVs) in the metropolis contributes negatively to of the transportation systems.

Lastly, for the traffic management system factors, we assumed that the occurrence of traffic congestion may be dependent on dysfunctional road signals, drivers' indiscipline, pedestrians' indiscipline and vehicle breakdown on roads if correlation exists between traffic management system and effective urban transportation. It was found from the study that dysfunctional road signals and vehicle breakdown were negatively related to effective transportation system in the metropolis and were statistically significant at 1% with their respective correlation coefficient of -0.310 and -0.021. This means that challenges in the transportation system in the metropolis is also highly encouraged by the increasing number or situation of dysfunctional road signals and broken down vehicles on the roads in the metropolis. On a similar situation, it was also observed under this factor that drivers and pedestrian indiscipline were also negatively related to effective transportation system but were not statistically significant. Their coefficient of correlation was -0.34 and -0.191 respectively.

This indicates that even though these also contribute negatively to effective transportation system in the metropolis, they are not major problems compared to the dysfunctional road signals and broken down vehicles in the system. The findings above did not contradict that from the observations made by the researchers as the prevalent situation were common. It was realized from the observations made that transport infrastructure in the metropolis were inadequate. The roads capacity has reached their limit. There were evidence of ineffective traffic management and control system. Vehicular breakdown on roads were also seen, sometimes without warning signs to caution road users. Drivers picking up and dropping off passengers at unapproved bus stops were common sights. Mass transit services were not adequate to meet passengers demand and commuters waiting in queue for transport during peak hours (morning and evening) was common evident.

Diagnostic Statistics

It is evident from the study that estimates for the F – statistics and the R^2 were 17.62 and 47.60% respectively and were statistically significant at 1%, indicating a good fitness and correctness of the specified distribution assumption. The F – statistics test the hypothesis that, the factors captured the estimated model are the major factors that influence (positively and/or negatively) effective transportation system in the metropolis and that due to its significance in the estimated model, this hypothesis can be accepted. The R^2 is the measure of the percentage of variations in the endogenous (Effective Transportation System) variable which is being explained by the exogenous (Inadequate Traffic/Transportation Infrastructure, Transportation Systems and Traffic Management and Control Factors) variables, it ranges between 0 and 1 (0% to 100%). For the linear regression model used for the study, it is estimated at 47.60%. This indicates that 47.60% of the variations in the endogenous (Effective Transportation) variable are explained by the exogenous (Inadequate Traffic/Transportation Infrastructure, Transportation Systems and Traffic Management and Control Factors) variables.

Conclusion and Recommendations

The factors affecting the transportation system in the Kumasi Metropolis was assessed based on three main criteria: the transport infrastructure, mass transit system and traffic management and control system. The transport infrastructure, assessed in terms of capacity of road network, parking lots and terminal, and bus stops adequacy, was seen to be inadequate as most of the road sections have reached critical capacity where the volume of traffic flow is more than the road networks can handle. This poses a challenge to the transportation system in the metropolis. Furthermore, the mass transit services was also seen to be inadequate to meet demand in the metropolis and this has therefore allowed the dominance of too many cars (taxi and mini bus) providing transportation services in the metropolis. The result is travel delays and commuters long wait in queues for transportation services, especially during rush hours (mornings and evenings). It is believed that increase in mass transit services will improve logistics system in the metropolis as long as the traffic management and control system are strengthened to be effective. It is recommended that the mass transit service within the metropolis should be improved and expanded by increasing the number of metro buses, providing adequate bus stops, terminals and bus routes, and expanding narrow lay-bye to prevent packing and stopping of vehicles at unapproved places. Furthermore, the observation from the study that logistics uncertainties seem to have an impact on businesses should be further researched.

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