Journal of Geography and Regional Planning Vol. 3(2), pp. 029-034, February 2010
Available online at http://www.academicjournals.org/JGRP
ISSN 2070-1845© 2010 Academic Journals

Full Length Research Paper

Impact of freight flows on city logistics in a megacity of a developing economy

Adebambo Olayinka Somuyiwa

Department of Management Science, Transport Studies Unit, Ladoke Akintola University of Technology, P. M. B. 4000, Ogbomoso, Oyo State, Nigeria. E-mail: miyagi89@yahoo.com.

Accepted 13 January, 2010

The demand for freight transport is an inevitable issue within the context of socio-economic and political relationship of the society. For instance, it enhances city logistics relatively to land use, traffic and delivery characteristics. Of all these salient issues, traffic is considered the most important because it subsumes congestions, especially along major corridors of the city. Similarly, previous studies pointed out 'on-the-road' congestion costs. To these cost must be added the loss of efficiency and/or sales at individual and commercial premises when deliveries arrive late. It is in the light of this that this paper investigated the effects of logistical and supply chain trends on the level and nature of demand for freight transport in Lagos. Methodology adopted was inferential statistical techniques and simple descriptive methods. The study identified gaps in the provision of infrastructural capacity and logistics services in the study region. The study further recommended that city logistics should be enhanced so that the city will be economically buoyant, socially vibrant and environmentally friendly.

Key words: Freight, flows, logistics, megacity, developing, economy.

INTRODUCTION

Freight transport is a very transport part of most economics and social activity. Industries rely on some of goods movement to maintain commerce, which may range from large shipments of bulk commodities to package delivery within and outside Lagos State. Freight transportation plays an important role in the economy of Lagos State, as the demand for goods transport is strongly dependent on the level and nature of economic activities (Oni, 2004). As transportation is part of a production process, it ensures that bits and pieces are assembled through the use of logistics chains, allowing for the delivery of the necessary inputs for production, including the necessary materials and labour, and allows the finished product to be delivered to the market for customers. Suffice it to stress that, the demand for freight transport is an inevitable issue within the context of socio-economics and political relationship of the society. However, the movement of freight is an important but often overlooked aspect of the transportation system. While much research and planning has centered on passenger transport (Somuyiwa, 2009; Ogunsanya, 2004), freight transport analysis has received relatively little attention, consequently, has implication on traffic situation that is often considered the most important, because it subsumes congestion, especially along major corridors of the city. Similarly, previous studies have revealed the effects of congestion on logistical efficiency relate to the whole country rather than the city of Lagos. It is interesting to note that some of these studies pointed out on-the-road' congestion costs.

For instance, various authors, Oyesiku (2002), Adeniji (2002), Auclair (1999), World Bank (2001), Coyle et al. (2000) and UNCHS (1998) asserted that travel speeds in cities are decreasing and the travel environment for pedestrians and people-powered vehicles are deteriorating in development countries, due to the inefficiency of the entire road transport system of the sixteen developing country city with populations of more then 4 million studied, five major cities in this group (Bucharest, Jakarta, Kinshasa, Lagos and Manila) experienced an average one-way journey to work of about one and quarter hours or more.

This urban challenge, that is, road traffic congestion is, however, expected to aggravate in the nearest future

particularly in developing countries, as a result of the projected world urban population explosion, in which about fifty percent of the world population is expected to live in cities by mid 21st century (World Bank, 1999). This projection justified the need for scientific enquiry into the generic characteristics of what road traffic congestion, a social disorder, as it affects travel pattern and free flow of goods and services in metropolitan Lagos. Surprisingly, over the years, capacity expansion has been regarded as a major panacea to minimization of road traffic congestion in metro Lagos. Ironically, the construction of new roads and expansion of old ones by successive administrations in Lagos has never ameliorated the problem. Demand has always superseded supply, because vehicular volume for passengers and freight as well as human population in Lagos has continued to increase over the years.

The city of Lagos, a renowned world fast growing city, has over the years been experiencing problem of road traffic congestion. This problem has consequently rendered the city immobile over time and space (Taiwo, 2005). The ubiquity of road traffic congestion in metropolitan Lagos reduces accessibly to spatially located urban resources and land uses. Thus, have negative impact on socio-economic growth and development of the city. Road traffic congestion in Lagos is synonymous with the pronounced problems of longer transit time between origin and destination of goods, hence, culminating to high cost of transportation, excessive energy consumption and its attendant effects of air and noise pollution.

Sequel to this, the business environment today has introduced outsourcing of parts of the supply chain of logistical activities to reduce production costs. Further, hence competition force increases economies of scales and efficiency and thus, outsources large parts of their production to other parts of the country. Surprisingly, this has resulted in an even production, and various distribution outlets (customers) is to a large extent influenced by transportation factors.

In the light of this, despite the large volumes of goods transported from and to Lagos metropolis, there is no concrete research that actually identifies the final destinations of the goods. The only information that is available is the area relative to the location within and outside Lagos State, as declared by the identified companies. Hence, this does not necessarily represent the final destinations of the goods.

Similarly, it is usually complex to forecast freight transport due to dynamics of origins, destinations, values, volume and weight of the goods being transported. It is then imperative that various origin and destination of these goods are relatively known, so as to facilitate an effective and efficient analysis of freight transport as well as transport planning of Lagos Metropolitan City (Mckinnon, 1998; Nockold, 2001). Thus the paper seeks to analyse type composition of flows and redistribute the flows to destination points which is necessary.

MATERIALS AND METHODS

Monitoring freight transportation within the context of logistical efficiency is generating interest in academia, hence, they are been undertaken as elements in integrated logistics and supply chain management that all subsumed transportation planning. The impetus has come from the drive to make distribution not only cost effective, but also enhance customer's satisfaction without consequence on the environment and within the framework of comparative advantage.

It is in this light, that the paper attempts to propose policy framework for freight transportation for the most populous black city in sub-Saharan Africa, with the aim to enhancing city logistics. Data for this paper were both primary and secondary, that were collected from various major companies that involved in freight transportation and other related agencies like customs officials, data was compiled yearly for each of the composite type of commodity. Hence the period understudy is from 1997 - 2006. The choice of this period was predicated on the level of currency as well as the rate of investor; foreign and local after relative consideration of political stability. These set of primary data included number of vehicles used and types, capacity, areas of origin and destinations, volume and weight of goods being transported as well.

Study area

Lagos metropolis is located in South-western Nigeria. The boundaries of the area is the territory within latitudes 6°23 N and 6°41°N and longitude 3°9°E and 3'28E. Metropolitan Lagos, however, constitute less than 2.5% of Nigeria's total land area of 923,768 km²; meanwhile, Lagos accommodates over 6% of Nigeria's total population of 1991 National Census. The metropolitan area accounted for the seventeen out of the twenty local government areas in Lagos State (Figure 1). Basically the state lies on low lands, with about 17,500 ha of built-up area of which residential areas occupy the single largest proportion of 8, 739 hectares (51.9%), commercial 821 ha (4.8 %), industrial, 1,444 ha (8.4%), institutional and special use 2,366 ha (13.7%) open spaces 453 (2.6%) and transportation 3,205 (18.6%) (Olayiwola et al., 2005). It is interesting to note that the population characteristics of the state are heterogeneous with most parts of the nation being represented. Again, despite the relocation of the Federal Capital to Abuja, Lagos State remains, undoubtedly, the economic nerve centre of the country. It harbours almost all the headquarters of the multinational companies in the country.

Lagos, occupies a pre-eminent position based on all urban indicators, most especially demography. It should be noted that all other cities are relatively small in terms of commercial, industrial and trading activities in comparison to Lagos. Demographically, the density of Lagos is much higher than other cities in Nigeria. According to Taiwo (2005), while Nigeria's population density is 100 persons per square kilometre (psk), that of Lagos is about 2,400 persons/ km² with annual population growth rate of between 5.0 to 5.5%.

In terms of transportation, Lagos area is naturally endowed with navigable creeks, lagoons and water body that are suitable for urban transit services. It also has rail line that links the commercial southern part of the city with the dormitory settlement of the North. As a result, Lagos has the potential of benefiting from a seamless transportation system. Ironically, road transport dominates more than 90 percent of all intra -urban movement (Oni, 2004).

According to Taiwo (2005) there are about 2,600 km of roads in Lagos. These roads are frequently congested with over 1 million vehicular density of over 222 vehicles/km against country average of 11km. The major identified corridors with predominant heavy vehicular traffic are Lagos-Abeokuta road, the Lagos-Badagry road axis and the Ikorodu road.

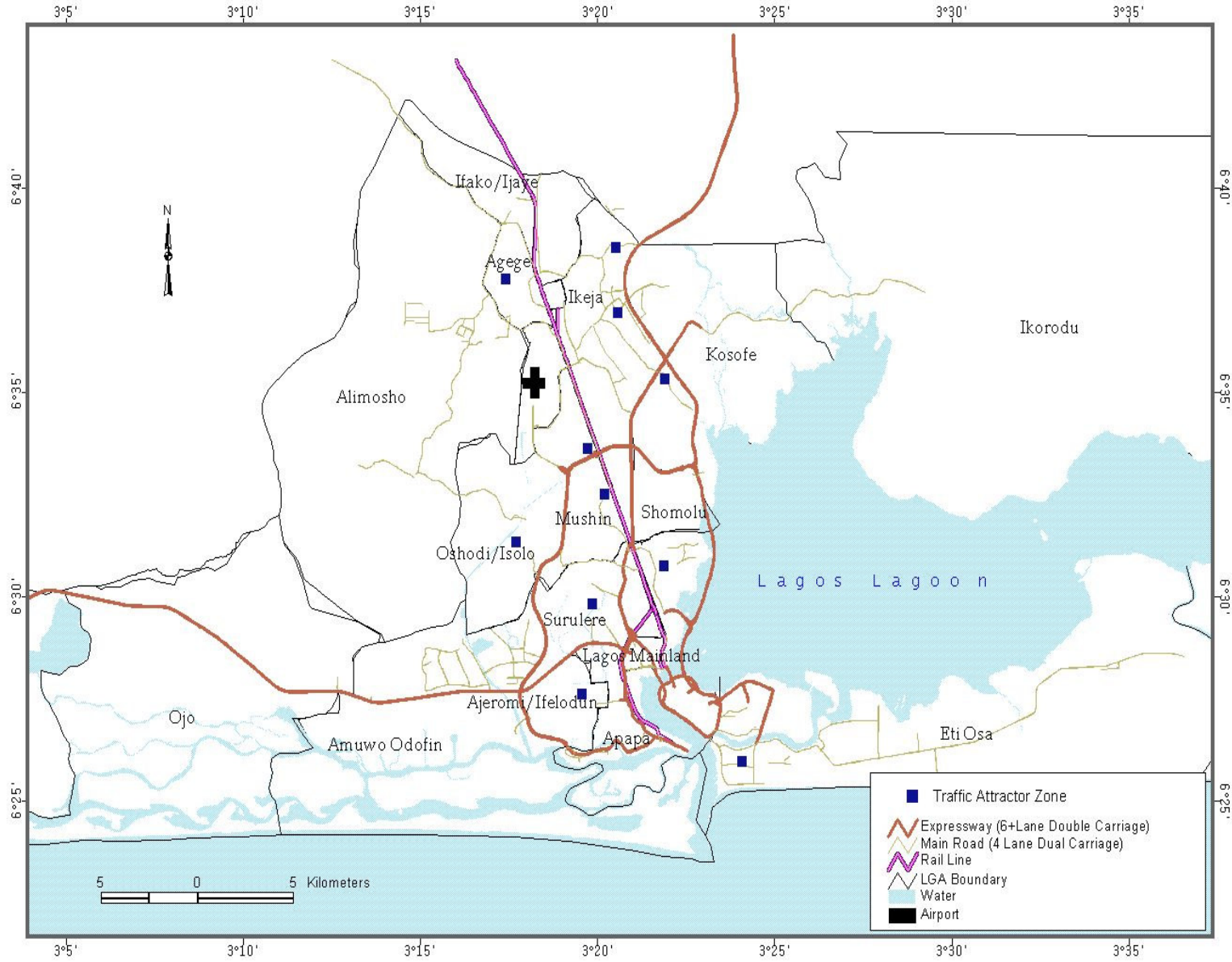

Figure 1. Metropolitan Lagos.
Source: Encarta, (2008).

Freight transport indicators and terms

Freight transport parameter

In developing planning strategies for freight transport, it is important to take account of six key parameters (FTA, 2000).

Volume of foreign movement: Official statistics invariably measure this quantity in terms of weight (tones-lifted or tonne-kms). In sectors producing and distributing low density products, volume-based measures such as pallet-loads or cubic meters, are more appropriates.

Modal split: This is the division of freight traffic between modes expressed in weight terms (tones-lifted or tonne-kms).

Nature of the vehicle: Within a particular mode, traffic can be sub-divided between different types, sizes and weights of vehicle.

Vehicle utilization: Weight and Volume-based utilization measures determines how much traffic measured in vehicle kins is required to handle the volume of freight movement (measured in tonne-kms).

Routing of flows: This defines the pattern of flow at different spatial scales.

Scheduling of deliveries: This determines the flow of freight traffic through time. It is interesting.

Table 1. Composition of Industrial group in Lagos metropolis.

Industrial group	Composition (%)
Engineering	12.2
Forest product	6.3
Chemical	33.6
Food	35.9
Others	12

Sources: Manufacturing Association of Nigeria Lagos (2009), Lagos State Chambers of Commerce and Industry (2009) and Author's field work (2009).

to stress that all these would be taken into consideration in the analysis at the subsequent subsection.

Industrial structure of Lagos metropolis

Lagos is the most advanced and Industrialized metropolitan in the country and sub Saharan Africa. Its people enjoy a very high standard of living. Basic commodity oriented industries play a key role in the Lagos economy, making Lagos a strong market for high-value processed consumer goods. Transportation, communication and trade are in the suburb of the state. Farming is concentrated in the suburb of the state. The leading commodities produced in these parts of the country are vegetables, daily products and grain, while other substantial proportion are brought from other parts of the country because of the availability of market. The economy of Lagos is heavily oriented towards international trade and is open to foreign investments.

The Lagos industry as well as the economy as a whole is undergoing a rapid restructing process during the past decade following a relatively suitable political climate. The business sector is traditionally based on raw material industries such as paper and pulp, iron and other metals. However, the main competitive factor of the country today is knowledge and the flexible uses of knowledge, even the supply of indigenous raw materials are still important elements of the industry. This is witnessed by the city's very fast expansion in the telecommunication industry. There are many industrial companies in Lagos. These include eleven (11) sectoral groups as classified by MAN (2005). These are:

(1) Food, beverages and tobacco sectoral group.
(2) Chemicals and pharmaceuticals sectoral group.
(3) Domestic and industrial plastic, rubber and foam sectoral group.
(4) Basic metal, Iron and steel and fabricated metal products sectoral group.
(5) Pulp paper and paper products sectoral group.
(6) Printing and publishing sectoral group.
(7) Electrical and electronics sectoral group.
(8) Textile, weaving apparel, carpet sectoral group.
(9) Leather and footwear, wood and wood products including furniture sectoral group.
(10) Non-metallic mineral products, motor vehicle and miscellaneous assembly sectoral group.
(11) MAN export sectoral group.

However, it must be stressed that, for analysis reason, they will be compositely grouped into five: Engineering, forest products, chemicals, food and others. These are represented in the Table 1.

In terms of total production, the engineering industry accounts for more than 12.9% of total production. However, food process takes the lead with 35.9%. This is followed by chemical industry that includes refined petroleum products, pharmaceuticals. However, forest product that include Pulp, Paper board and other wood products have 6.3%.

Distribution of the industries in Lagos metropolis

The sizes of industries under consideration are the ones with number of employees that are greater than 500. In other words, they are medium and large scale industries. The geographic distribution of these types of industries is mostly in industrial areas that include: Apapa (Sea ports areas, for outwards and inward of goods), Ikeja, Central Business Districts (CBD), Marina, Victoria Island and Ikoyi majorly for services Industries. Hence all these places will serve as nodes and trajectories for origin and destination in the analysis.

ANALYSES AND DISCUSSION

In this section, the descriptive statistics, correlation co-efficient and paired t-test for the freight groups for all the Industrial areas are analyzed. Similarly, those routes earlier identified in the methodology section were used to determine the classes of vehicles used by these companies. For instance, counting along the major routes revealed that, Third mainland, Ikorodu road Eko bridge, Western avenue and Agege motor road are often being used by these vehicles in that order as shown in Table 2

This pattern might not be unconnected to the fact that most of these routes are directly linked to all the identified industrial areas. For example, Third mainland, Ikorodu road and Western Avenue are linked to Apapa and other CBD Zones, while Western Avenue and Agege motor road are linked to Ikeja. Consequently, they are been used to move some of the goods either from origin to destination or vice versa. Similarly, Agege motor road often links adjourning state (Ogun State) which has been enjoying limp frogging advantage of diffusion of industrial pattern from Lagos metropolis. Hence, most industries that could not be sited in Lagos are been located in the nearest settlement, which is in Ogun State. This no doubt has contributed to the enormous usage of this route.

In a similar vein, the descriptive statistics consisting of mean flows, minimum and maximum flows, standard deviation and coefficient of variation of the flows for all the commodity groups from these industrial areas are revealed in Table 3 Based on Table 3, the descriptive statistics for the industrial group revealed a high standard deviation for all the groups indicating that there are significant variations in the flows for these industrial groups from the industrial areas, during the period under study. The coefficient of variation is very high for all the groups (more than 270% of the mean) indicating a very high spread of the flows for the industrial groups from the individual areas. It is important to note that, the zero minimum values mean that, there has never been a time when there was no flow from or to these industrial areas, through these routes, to their various destinations. The implication of this is that the industrial areas are always active and the routes are busy, consequently, it requires

Table 2. 12 h traffic count on selected roads in metropolitan Lagos.

Roads		Nos. of vehicles in both direction (12 h traffic counts)	Nos. of vehicles in both direction p/hour	Average volume/capacity v/c ratio
1.	Third Mainland Bridge	220,190	15,075	7.5:1
2.	Carter Bridge	50,962	5,212	0.9:1
3	Eko Bridge	150,130	10,234	3.7:1
4.	Western Avenue	110,190	7,266	3.6:1
5.	Murtala Mohammed Way	21,302	4,234	0.5:1
6.	Herbert Macaulay Way	88,345	13,112	1.3:1
7.	Ojuelegba – Mushin	56,345	6,256	0.6:1
8.	Ikorodu Road.	300,238	24,175	4.8:1
9	Agege Motor Road	60,123	10,231	1.1:1

Sources: LAMATA (2008) and Author's field survey (2009).

Table 3. Descriptive statistics of flow of freight of industrial group in Lagos metropolis.

Statistics	Food	Energy	Others	Chemical	Food product
Mean	2486376	2100076	2033391	2411117	2000147
Min	0	0	0	0	0
Max	3.12e + 07	2.52e + 07	2.35e + 07	2.83e + 07	2.14e + 07
SD	7635161	6158210	5780361	6916889	5580271
CV	3.07	2.93	2.84	2.87	2.76

Sources: Computer output, based on author's survey (2009).

Table 4. Correlation of industrial groups across industrial areas.

Industrial area group	Apapa	Ikeja	Marina	Victoria Island	Ikoyi	Agege area
Food	0.814 (0.00)	0.7521	0.6613	0.6214	0.6112	0.7916
Energy	0.6771 (0.00)	0.6142	0.5314(0.00)	0.5612 (0.01)	0.5722	0.5866
Chemical	0.8617	0.8714(0.00)	0.8216	0.8811 (0.00)	0.8267	0.8624 (0.01)
Forest product	0.5643(0.00)	0.4122	-0.3661	- 0.4314 (0.01)	- 0.4421	0.6614
Others	0.5016	0.6610	0.4102	- 0.4134	- 0.4246(0.01)	0.6743(0.02)

(0.00): Significant levels.
Source: Computer output based in author's survey (2009).

adequate and appropriate planning such that this exercise will not run against effective and efficient logistics activities. This is later highlighted in the subsequent sectors of the write up.

Similarly, correlation coefficients of the industrial group across industrial area, is to investigate whether the individual flow have been systematic or vary across the industrial area (Table 4). These estimates indicate high positive correlation and low inverse correlation. For instance, food industrial group and Apapa industrial area is positive and significant. Ideally, food industrial group has a positive relationship with all the industrial areas and are significant. Similarly, engineering industrial group has a positive relationship with all these industrial areas with Apapa, Marina and Victorial Island are significant. (The significance levels are in the parenthesis in Table 4).

Surprisingly, chemical industrial group has high positive relationship with all these industrial zones. This might not be unconnected with the fact that chemical industrial group subsumed refined petroleum products that are necessary for the subsequent activities in these zones. Again, because of the nature of what the goods entails (essential products), consequently, the flow is very high towards these areas. Ironically, forest product and others industrial group have low but significant negative relationship with Marina, Victoria Island and Ikoyi industrial areas. The implication of this is that the higher the flow of these products, the lower the level of absorption into these areas. Perhaps, it might be interesting to reiterate that these industrial areas are more pronounced for service industries, hence need less of forest product for their relative activities. Moreover, for effective planning process

Table 5. Ranking of industrial zones according to paired t-test.

Industrial group	Apapa	Ikeja	Marina	Victoria Island	Ikoyi	Agege areas
Food	1	1	2	2	2	1
Engineering	1	1	2	2	2	1
Chemical	1	1	1	1	1	1
Forest product	2	2	3	3	3	1
Others	2	1	3	3	2	1

'I' indicates the highest mean flow, and "4" is the lower.
Source: Based on author's field survey (2009).

process, paired t-test was adopted for ranking of these industrial zones, such that it will be easier to know what, where and how logistics infrastructure will be provided. This is revealed in Table 5

Table 5 shows that Agege industrial zone has the highest rank, followed by Ikeja and Apapa, other Industrial zones take the rear. The implication of this is that all routes leading to Agege and Ikeja areas should be well catered for and planned for urgently such that congestion would be minimized and city logistics would be enhanced. Similarly, there must be integration of existing resources to solve the difficulties caused by the impact of increasing population and other logistics activities within these areas.

Conclusion, planning implication and recommendations

Logistics is timely positioning of resources, the paper to a considerable manner, has been able to identify some areas of attention within the metropolitan Lagos. Industrial areas need to be planned relatively to design, operations and maintenance of roads for instance, such that ultimate objectives of logistics can be achieved. In other words, there is need for provision of affordable opportunity for innovative solutions to be developed for improving the quality of life in urban areas (Taniguchi et al., 2001). This can only be done through several advance techniques such as geographic information system (GIS), global positioning system (GPS), logistics knowledge, intelligent transport system (ITS) and modeling to optimize the city environment, such that it assists in reducing both transport cost and negative environmental impact.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the contributions of Dr. Yetunde Adesanya, for her constructive and priceless suggestions and very helpful comments in correcting the manuscript. Also appreciated, is the contribution of Daniel Somuyiwa, Rapheal Aremu and Caleb Olasupo for there respective roles in collection of relevant data for this write-up.

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