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The Effects of Road Traffic Congestion on the Efficiency of Freight Logistics: A Survey of the Port of Mombasa

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Abstract:
Mombasais the second largest city in Kenya. Lying on the Indian Ocean, the city has a major port and an international airport which makes it the logistics hub of Eastern Africa. With a history spanning many centuries, including when dhows called on the north side of Mombasa Island, Mombasa is today the premier port of call in the East and Central Africa region handling about 24.87 million tons of cargo in 2014 including 5.262 million tons of transshipment. As Kenya's biggest and busiest seaport, Mombasa is the doorway to a vast hinterland where people depend on agriculture for their livelihood. It serves Kenya, Uganda, Rwanda, Burundi, the Democratic Republic of Congo, South Sudan, Ethiopia, Somalia and northern Tanzania. The upward trend in the use of road transport as a result of increase in trade volumes and passengers has put Mombasa's road infrastructure under pressure leading to road congestion. The existing logistics operations in Mombasa are strained by rising traffic levels, which slows down freight movement and business activity. Congestion on roads in particular is a frustration for business, as freight deliveries, commuters, and business travelers lose time stuck in traffic. The traffic jams have become a daily routine, delaying movement of goods and people leading to massive losses. The uncertainty brought by congestion impacts on the efficiency of freight logistics operations, which, along with tourism form the backbone of the city's main economy activities. This study examines the effects of road traffic congestion on freight logistics efficiency at the port of Mombasa and gives recommendations to help mitigate the negative effects.

1. Introduction

1.1. Background Information

The development and maintenance of physical infrastructure is key driver for both domestic and international trade which in effect leads to economic growth and poverty reduction. Markets accessibility and volume of trade are largely dependent on the quality of infrastructure and especially transport which facilitates the physical movement of people and goods. Traffic congestion occurs when a city's road network is unable to accommodate the volume of traffic that uses it. This situation is caused by rapid growth in motorization and with less than corresponding improvement in road network, traffic management techniques and related transport infrastructure. Road traffic congestion is a phenomenon that is associated with urban environment all over the world.

Road transport continues to be the dominant mode of goods transport in developing countries and offers the only real alternative worldwide for many localized final delivery operations. Road networks have not kept pace with growth in demand. Kilometre lengths are limited and construction standards are often low (Wasike, 2001). Traditionally in most African countries road building has been given a higher priority than road maintenance, with scant attention to the imperatives of recurrent costs of road management once the road has been constructed. Lack of maintenance has left over 50% of the paved roads in Africa in poor condition, and the condition of more than 80% of the unpaved main roads would be considered just fair. The road transport sector moves about 95% of the cargo in Kenya and along the Northern Corridor (ADB, 1999).

Logistics is concerned with the efficient transfer of goods and related information from the source of supply through the place of manufacture to the place of consumption in a cost effective way whilst providing an acceptable service to the customer (Rushton, Oxley &Croucher, 2000). The key elements of freight logistics include warehousing and materials handling; transport and distribution; inventory management; information and control; packaging and unitization. Freight logistics involves managing the physical flow of goods and related information from the port of origin, to the port of destination, and to the final delivery point (Hensher D. & Puckett, 2005). Transport plays a key role in freight logistics by facilitating the physical flow of goods through the various processes in distribution.

Mombasa is the second largest city in Kenya and the main logistics hub. Lying on the Indian Ocean, it has a major port and an international airport. With a population of 939,370, as per the 2009-census, the city is located on Mombasa Island and sprawls to the surrounding mainlands of Changamwe, Likoni, Nyali and Kisauni. Mombasa is the starting point of logistics along the Northern Economic Corridor leading to the landlocked countries of Uganda, Rwanda, Burundi and South Sudan (KSC, 2009). As Kenya's

biggest and busiest seaport, the Port of Mombasa is the doorway to a vast hinterland where people depend on agriculture for their livelihood. It serves Kenya, Uganda, Rwanda, Burundi, the Democratic Republic of Congo, southern Sudan, Ethiopia, Somalia and northern Tanzania. The port is a natural harbour with deep water berths for larger vessels such as bulk carriers, container ships, motor vehicle carriers and luxury cruise ships. The port's major markets encompass Western Europe, Asia, the Far East, America and the rest of Africa. It also provides anchorage and storage for regular feeder services between Mombasa and Dar es Salaam, Durban, Mogadishu, Djibouti and Dubai. It is the best connected port of call in the East Africa region after Durban, with about 35 shipping lines calling and having direct connectivity to over 80 seaports.

Container services at the port are provided entirely by liner vessels, while other types of cargo are carried by a mixture of liner and RORO vessels. The Port plays a strategic role in the regional economy as a gateway to the international markets and suppliers. As one of major seaport on Africa's east coast between Tanzania and the Red Sea, it has a huge responsibility to provide effective, reliable and efficient maritime services (KSC, 2009). The port is run by the KPA, which was established on 20th January 1978 through an Act of Parliament. The current port infrastructure is complemented by the presence of CFSs run by private sector investors and located within the port and around Changamwe area along the Mombasa-Nairobi Highway. KPA also runs ICDs in Nairobi, Kisumu and Eldoret which are underutilized due to the failure of the rail system (Fengler, 2012).

The port community in Mombasa comprises of other key players in addition to KPA which include KRA, KEBS, Shipping Agents, Clearing & Forwarding Companies, National Security Agents, Kenya Railways Corporation, Immigration and Port Health Departments, Rift Valley Railways, cargo owners, CFS, Dock workers Union, freight forwarders, among others. Each of these institutions has a role in the cargo clearance process and all of them must read from the same script for port efficiency to strive. The port recently started handling higher volumes after the completion of berth 19 at a USD 66.7 million to bring the total number of berths to 19 and stretching the total quay length of the container terminal to 840 meters up from 600 metres. The berth was operationalized in April 2013 expanding the port capacity after container traffic grew by 15% in the year 2012 to 903,463 TEUs (which is the standard measurememt of port activity) from 770,804 TEUs recorded the previous year (Akwiri, 2012). KPA also completed a port dredging exercise in the year 2013 that involved increasing depth of water way to enable access by bigger ships.

According to KPA Handbook (2015) the port recorded a container throughput of 1,012,002 TEUs and 24.87 million tons of cargo in the year ending 2014. This represents an 11.6% growth in throughput compared to the year 2013. The increased cargo traffic is seen as an indicator of economic activity in East Africa. Despite the strong import growth, the overall volumes handled in Mombasa are low by international standards. In 2012, Mombasa handled 21.92 million tons of cargo. This represents almost double the volume of Dar es Salaam, which recorded 13.7 million tons, but less than a quarter of Durban and only 2-2.5 percent of the volumes which go through the busiest ports in the world, Singapore and Hong Kong (see figure 1 below). A major impediment to cargo movement at the port is the relatively low volume of cargo carried by rail, with most goods being hauled by road. Around 95% of all the cargo coming in through the port is ferried to its final destination by road, with railway accounting for a paltry 5% (PREMUAR, 2010).This has contributed to congestion of roads around Mombasa whose network is largely underdeveloped.

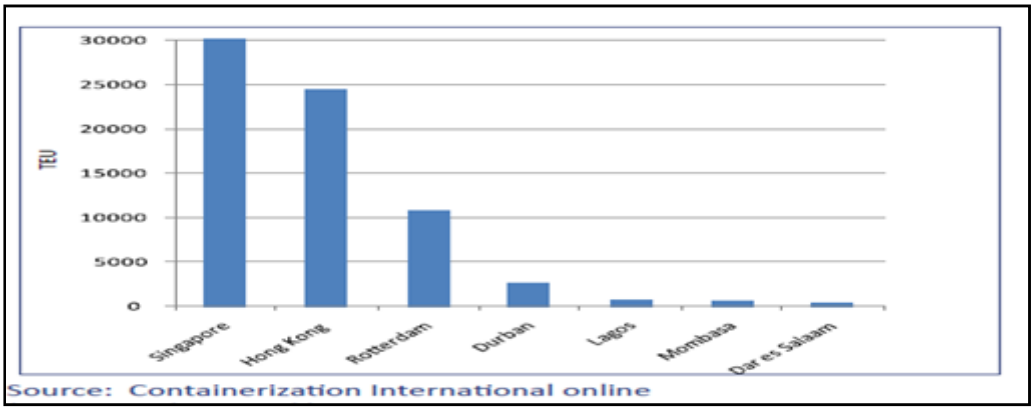

Figure 1: Singapore ships 50 times more goods than Mombasa in thousand TEUs

The steady growth in world economies and globalization has tremendously increased industry's demand for the rapid and timely delivery of goods. Kenya's industry has risen to the challenges and opportunities that have been occasioned by globalization in recent years. The country's transport infrastructure is under pressure from the rising levels of traffic both on rail and road. At the same time, limited maritime infrastructure and poor inland infrastructure are under immense pressure from the massive increase in imports and exports (Aworemi, *et al*., 2009). The efficiency of the existing logistics operations at the port of Mombasa are strained by the effects of road traffic congestion which include port congestion, falling delivery reliability levels, a challenged road transport capacity, the inability of railways to meet demand and the ever increasing user's demands for reliable and predictable services.

1.2. Statement of the Problem

The efficient flow of goods at the port of Mombasa is constrained by rising road traffic levels which slows down freight movement leading to time wastage, delays in delivery, low productivity and increased business costs. The upward trend in the use of road transport caused by increase in goods volumes and passengers has put Mombasa's road infrastructure under pressure leading to road

congestion (PREMUAR, 2010). The traffic jams in Mombasa have become a daily routine, delaying movement of goods and people leading to massive losses. The loss is felt by all sectors of the economy in the form of wasted man hours, travellers and tourists getting stuck in traffic, excessive fuel consumption, and prolonged transit times which leads to various logistical inefficiencies for KPA and freight companies. Mombasa's infrastructural environment for a long time has been characterized by poor road networks with limited capacity and poor maintenance, dilapidated railway, rural-urban migration, increased cargo flows and port congestion. These factors have collectively adversely affected the efficiency of Mombasa's transport system. Being a major gateway to the East African region, KPA and freight logistics providers are facing a series of problems posed by road traffic congestion leading to inefficiencies which can be summarized as follows:

i. Port congestion and container pile up due to the slow pace of cargo evacuation
ii. High cost of operation as a result of demurrage charges, increased fuel consumption, fleet maintence costs and vehicle downtime, and environmental pollution
iii. Prolonged transit lead times arising from delays caused by traffic congestion
iv. Reduced service levels and lost revenue leading to customer dissatisfaction
v. Reduced productivity levels due to wasted man-hours and drivers' stress
vi. Increased inventory holding and stock outs for downstream customers

Mombasa port currently has 19 berths comprising of 1 bulk grain terminal, 2 oil terminals/jetties, 4 container berths and 12 general cargo berths. Recent investments in modernising handling equipment, dredging of the main entrance channel and widening of the turning basin has enabled larger, modern post panamax vessels to call at the port. The port is currently ranked 117th of the top ranked container world ports and 5th in Africa. The container terminal capacity currently stands at 1,050,000 TEUs per year from the original design of 250,000 TEUs. The increase in cargo handled at the port of Mombasa has necessitated the port authority to focus on several other initiatives aimed at increasing efficiency and effectiveness of its services. The initiatives have been amongst others decreasing dwell times of consignments, increasing speed of discharge/loading by modernising equipment, increasing size of ships calling the port through dredging and widening of the turning basin. The construction of a second container terminal is also underway with Phase 1 set to be completed in 2016. This will raise the current capacity by an extra 450,000 TEUs. The second container terminal will create an additional space for 1.2 million TEUs once the other two phases are completed in 2019. This means that the port will be well positioned to accommodate the current volumes and cater for the projected increase in excess of 1,200,000 Units by 2015 (Fengler, 2012). Other developments plans include the construction of a Mombasa by-pass linking the northern corridor to the south coast region and northern Tanzania.

The major bottleneck to the port's expansion programme is the lack of an appropiate transport infrastructure composed of intermodal freight system to facilitate efficient cargo evacuation and freight logistics systems. Negative impacts of increased container traffic are already being experienced along the highways, and at transit towns including Nairobi. Mombasa city is now faced with road traffic gridlocks and the route to the Mombasa airport is constantly overwhelmed by traffic jams. This calls for work on the proposed by-pass and link road to be started immediately. If construction of the by-pass is not speeded up and synchronized with new planned capacity increases at the port and comphrehensive transport infrastructure development the efficiency of freight logistics will be severely compromised.

1.3. Objectives of the Study

1.3.1. General Objective

The purpose of this research is to identify the effects of road traffic congestion on the efficiency of freight logistics at the port of Mombasa.

1.3.2. Specific Objectives

The following are the specific objectives of the study:

i. To evaluate the effect of costs on the efficiency of freight logistics;
ii. To examine the effect of port congestion on the efficiency of freight logistics;
iii. To establish the effect of average transit time on the efficiency of freight logistics;
iv. To suggest appropriate strategies aimed at promoting efficiency of freight logistics at the port of Mombasa to overcome the problem of road traffic congestion.

1.4. Research Questions

The following questions are discussed to meet the above mentioned objectives: -

i. What are the effects of costs on the efficiency of freight logistics?
ii. To what extent does the effect of port congestion affect the efficiency of freight logistics?
iii. What are the effects of average transit time on the efficiency of freight logistics?
iv. What strategies or policies require to be undertaken to improve the efficiency of freight logistics operations at the port of Mombasa to help overcome road traffic congestion?

1.5. Justification for the Research

Road traffic congestion has a great effect on logistics costs in terms of direct transport costs, level of inventories held and ability of freight forwarders to effectively meet customers' expectations (Fadare&Ayantoyinbo, 2010). The efficiency of cargo evacuation at the port of Mombasa has also been compromised significantly by road congestion leading to an increase in freight charges and cost of goods. This study focuses on these issues, examining the relative extent to which traffic congestion in Mombasa city impairs port efficiency, the reliability of freight logistics operations and the measures which can be taken to minimize these effects.

1.6. Scope of the Research

The study has been confined to the port of Mombasa with special focus on freight logistics operations which includes the processes of ship dwelling time, offloading and storage of freight at the port and CFSs, customs procedures, warehousing, transportation and flow of information between these processes. The study covers major players at the port involved in freight logistics which included KPA, Shipping Agents, Freight Forwarders, CFSs and cargo owners. The research was carried out within a period of three months.

1.7. Limitations

Being a survey that is concerned with effects of road traffic congestion on freight logistics efficiency at the port of Mombasa, the information collected was restricted to port operations from which conclusions have be drawn. The limitation had to do with the problem of collecting enough and accurate data from the various respondents and government agencies without withholding relevant and sensitive information that would give insights to help make informed recommendations on how to deal with road traffic congestion and enhance the efficiency of freight logistics.

2. Literature Review

2.1. Introduction

This chapter examines the theoretical framework of the study and reviews previous empirical studies done on the effects of road traffic congestion on logistics processes in urban centres. A detailed description of the main variables and how they interrelate from previous research findings is given together with identified research gaps. Finally a dicussion of the conceptual framework for the study is done showing the interrelationship of the variables.

2.2. Theoretical Framework

The theoretical framework for this study will be based on two interrelated theoretical areas, which are:

i. Systems theory
ii. Supply chain theory

2.2.1. Systems Theory

A systemis an integration of elements that function together for the purpose of achieving some objective. Systems theory, therefore, uses system structure as a means of explaining some class of phenomena. Systems can be classified in various ways. In their most elemental form, they can be open or closed. An open systemcommunicates with its environment, and a closed systemdoes not. Most systems are open. A closed system exists only in such artificial environments as settings for scientific experiments where outside interference is prohibited (Laszlo &Krippner, 1999). Systems can also be open-loop or closed-loop. An *open-loop system* does not have a feedback loop and control mechanism, and, for this reason, it has no way of adjusting its operation to perform as intended. A *closed loop system* has a feedback loop and control mechanism, and can adjust its operation. An organization of any type—profit or nonprofit, government or non-government—is an open, closed-loop system. Also, subdivisions of an organization are open/closed-loop systems. Therefore, a firm's supply chain operation can be regarded as an open/closed-loop system.

A system notion is considered in this study because it looks to the whole as property of inter-connected systems, and more importantly, it further explains the integration process, which aptly fits with supply chain theory. Freight movement cuts across two inter-related systems namely logistics and supply chain systems. Von Bertalanffy (1950; 1968) argued that the performance of a system is dependent upon the collaborative performance of individual firms in the system. The theory hypothesizes that performance optimization will be created through synergistic firm relationships in the form of network coordination that integrate business processes across firms (Lambert & Cooper, 2000). The theory offers the potential of providing a framework for organizing the various supply chain functions and providing a mechanism for a systematic approach to solving supply chain problems.

Logistics system consists of a network of inter-related sub-systems with the purpose of managing the orderly flow of material and personnel within the logistics channel (Stock & Lambert, 2001). Moreover, it is the functional silos within companies and also deals with the management of flows across supply chains (Lambert & Cooper, 2000). In general, logistics systems have been described in terms of operational characteristics, structural context and managerial context (Persson, 1995). Furthermore, Woxenius and Sjostedt (2003) worked out a combined model of transportation and logistics sub-systems for freight and passenger movement. In the freight model, four different entities or components are identified: goods, vehicles, facilities and infrastructure. The four entities are associated by relationships: sourcing and distribution, land use, transportation and finally traffic. Logistics activities take place in facilities located in relation to infrastructure – warehouses, terminals and production facilities. These facilities are supplied with products by means of transportation. The transportation sub-system is carried out by vehicles/vessels, which results in traffic. Transportation is the activity within logistics that achieves the movement of products along a supply chain between point-of-origin

and point-of-consumption. It creates time and place utility since a product produced at one point has very little value to the prospective customer unless it is available at the point where and at the time when it will be consumed (Stock & Lambert, 2001). These sub-systems are seen as complementary and necessary to reshape the landside logistics patterns, which are complex multimodal transports of networks linking the main gateway position with the correspondent network of nodes.

Robinson (2002) also noted that freight moves from supplier to buyer in a set of often complex sequential logistics sub-systems or activities – a linehaul shipping or trucking or rail operation, freight forwarding, customs agency operations, terminal and warehouse and depot operations and trucking end-dray operations. Traditionally, these separate sub-systems or functions are carried out by separate firms; costs are additive and a cost-plus-margin pricing environment may keep prices and rates high; and there is little or no integration of the separate elements to extract costs and inefficiency from operations but also to reposition themselves to deliver value to the end customer as well as to capture value and advantage for themselves. Modern paradigms advocate for a restructured freight handling and movement operations and to recreate the industry and the nature of competition within it. This requires an integrated freight logistics system that delivers value for the entire supply chain through operational efficiency (Almotairi, 2010).

2.2.2. Supply Chain Theory

A supply chain is defined by Mentzer*et al.*(2001, p. 4) as "a set of three or more entities (organizations or individuals) directly involvedin the upstream and downstream flows of products, services, finances, and/or information from a source to a customer." Supply chains can exist in both manufacturing and service organizations. They are principally concerned with the flow of products and information between supply chain member organizations from procurement of materials, transformation of materials into finished product, and distribution of that product to end customers. SCM is a proven business strategy that has gained wide acceptance in recent years due to increasing customer demands for quality, delivery, and speed. Increased speeds of communicating coupled with cost reduction and more interdependent supplier, provider, and customer relationships have accelerated the integration of supply chains on a wide-spread basis.

SCM engages the management of flows between and among stages in a supply chain to minimize total cost. It involves management of flows of products, information, and finance upstream and downstream in the supply chain. SCM is a concept whose primary objective is to integrate and manage the sourcing, flow, and control of materials using a total systems perspective across multiple functions and multiple tiers of supplier. Stevens (1989) stated the objective of SCM is to synchronize the customers' requirements with materials flow to strike a balance among conflicting goals of maximum customer service, minimum inventory management, and low unit costs. SCM also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. Supply chain collaboration, integration, or other similar endeavors rely heavily on information visibility to be successful. Information, shared across the supply chain, can eliminate uncertainty.

In essence, SCM integrates supply and demand management within and across companies (Ballou, 2007). According to Robison (2002) the common characteristics of logistics and SCM is the call for integration approach, cooperative efforts and corporate customer value. SCM aims at fulfilling customer demands through the most efficient and cost-effective use of resources. This is accomplished primarily by focusing on the whole SCM processes to deliver the right products or services, in the right quantity, to the right place, at the right time and with the maximum benefits. This delivers superior performance for the entire supply chain thus giving it a competitive advantage over other inefficient and fragmented supply chains.

2.2.3. Empirical Studies Review

According to the FHWA (2001) there is no single, broadly accepted definition of traffic congestion. One of the principal reasons for this lack of consensus is that congestion is both a physical phenomenon relating to the manner in which vehicles impede each others progression as demand for limited road space approaches full capacity and a relative phenomenon relating to user expectations *vis-à-vis* road system performance. The table 1 below summarizes the types of traffic congestion as outlined by Brownfield *et al* (2003).

Type	Nature of Congestion
Recurrent congestion	Occurs at regular times at a site. It can be anticipated by road users that normally use the route during those times. Examples of recurrent congestion are morning or evening peak hour congestion, or congestion due to a regular event such as a street market on a particular day each week.
Non-recurrent congestion	Occurs at non-regular times at a site. It is unexpected and unpredictable by the driver and is normally due to incidents such as accidents, vehicle breakdowns or other unforeseen loss of carriageway capacity.
Pre-congestion (Borderline congestion)	Occurs where free-flow conditions breakdown but full congestion has not yet occurred. This may occur either side of the time period when congestion occurs or upstream or downstream of congestion that is already occurring.

Table 1: Summary of types of congestion
Source: adapted from Brownfield, 2003

Several papers and reports have been published which shed new light on the links between road traffic congestion, reliability and logistical efficiency. The studies addresses the research questions for this study and are classified into five themes as follows:

a) Assessments of the impact of traffic congestion / disruptions on supply chain efficiency
b) Estimation of the value companies attach to the reliability of freight transport
c) Analyses of freight transport operators perceptions of congestion-mitigation policies
d) Surveys of company responses to declining freight transport reliability

a) Assessments of the impact of traffic congestion / disruptions on supply chains efficiency:
The wide-ranging review of the effects of traffic congestion on supply chains was based on case studies of three manufacturing / trading companies and several logistics operators in Auckland (Sankaran*et al.*, 2005). It sought to uncover the micro-level impact of traffic congestion from a supply chain perspective. The authors concluded that congestion has a variable impact on companies supply chain efficiency depending on the nature of the market, the nature of the products, location of premises and so forth. Congestion was found to be often an amplifier of delays and costs caused by other factors. As congestion increases, service levels are the first casualties, with the cost of congestion felt after some time lag. One reason for this lag effect is that much of freight transport is outsourced and rates agreed periodically. Carriers therefore have to absorb the congestion-induced time delays at least in the short-term. Successful management of congestion requires a collaborative effort by several organizations in the supply chain. Courier companies can "blunt the impact of road traffic congestion" by increasing the number of depots in their networks and shrinking service areas.

b) Estimation of the value companies attach to the reliability of freight transport.
Researchers in the Institute of Transport Studies at the University of Leeds (2008) employed their adaptive stated preference tool to assess, in computerized experiments, the trade-off that a sample of 40 logistics managers made between freight transport costs and delivery reliability (Fowkes*et al.*, 2004). Their analysis differentiated three types of delay: a schedule delay at departure time; a predictable time delay reflecting the regular amount of congestion on the road network; and an unpredictable spread of arrival times, representing the variance in transit times. By analyzing managers' responses they were able to attach average monetary values to the various forms of delay.

c) Analyses of freight transport operators' perceptions of congestion-mitigation policies:
In the course of an interview survey of a large sample of for-hire and private trucking companies in California in 1998, Golob and Regan (2000) examined around 1200 managers' views of a range of congestion relief policies. These policies were classified using an exploratory factor analysis. Some of the policies related to the internal management of logistics operations while others required intervention by governmental agencies. Six classes of congestion mitigation measures were identified which comprised of new dedicated truck facilities, improved operational efficiency, better traffic management on the road network, greater priority for trucks on urban arterial roads, increase in road capacity, and congestion tolling.

d) Surveys of company responses to declining freight transport reliability:
The 1998 Golob and Regan survey investigated the measures that companies were taking to reduce the impact of congestion on their freight transport operations. They were particularly interested in the application of advanced IT systems to ease the congestion problem, particularly mobile communication devices, EDI, AVI, an electronic clearance system as well as publicly available traffic information updates (Regan & Golob, 1999). In a subsequent computer-aided interview survey of 700 trucking companies in California in 2001 Golob and Regan (2003) assessed the extent to which they were using computerized vehicle routing and scheduling (R/S) software to minimize the impact of traffic congestion on their operations. They found that demand for R/S software is positively influenced directly by the need to re-route drivers, and indirectly by the need generated by customers' schedules to operate during congested period. The greatest application of R/S software to mitigate the effects of congestion was by for-hire carriers, companies working in the Los Angeles area, providers of flatbed and container services and those serving the ports. The main focus of the study by Kuipers and Rozemeijer (2006) in the Netherlands was the response of shippers and freight transport operators to worsening traffic congestion. In focus group discussions with these organizations they differentiated measures at the strategic, operational and tactical levels (see Table 2 below).

	Operational Measures	**Tactical Measures**	**Strategic Measures**
Road transport companies	• Earlier departure of trucks (and later return) • Delivery at an earlier time Use of more trucks • Use of back up trucks	• Make better agreements with shippers on delivery times • Broadening of planning horizon • Use of night distribution Use of planning software • Use of mobile telephone	• Consolidation of transport-networks with other transport companies • Strategic cooperation with other transport companies • Use of consolidation centers Increase the number of DCs Move DCs towards important customer locations • Design of new and innovative logistics concepts
Shippers	• Relax transport planning • Longer opening hours of facilities • Assign longer time windows per truck	• Make more use of ICT control tools • Adapt level of stocks Narrowing of planning horizon • Allow night distribution	• Increase the size of DCs to increase the level of flexibility in stock keeping practices • Increase the number of DCs Design of new and innovative logistics concepts

Table 2: Measures taken in response to the declining reliability of road transit times
Source: Kuipers and Rozemeijer, 2006

2.3. Conceptual Framework

This study focuses on analyzing the relationship between road traffic congestion and the efficiency of freight logistics at the port of Mombasa. Previous studies have identified the main factors contributing to road traffic congestion which include the capacity of the existing road network, quality of roads maintenance, scale of development of other infrastructure networks, level of economic activity and population density. The efficiency of freight logistics is highly dependent on the existing transport infrastructure and its capacity. Road traffic congestion adversely affects the efficiency of freight movement through increase in operating costs and transit times. This further compromises the quality of service offered by freight handlers and leads to losses caused by delayed deliveries (Rodrigue& Hessel, 1998). The efficiency of freight logistics is also affected by slow cargo evacuation from the port as a result of traffic congestion along the port's road links. This compromises port efficiency which is measured by freight throughput. Other factors that determine port efficiency include the number of terminals, inland depots, rail links and freight volume.

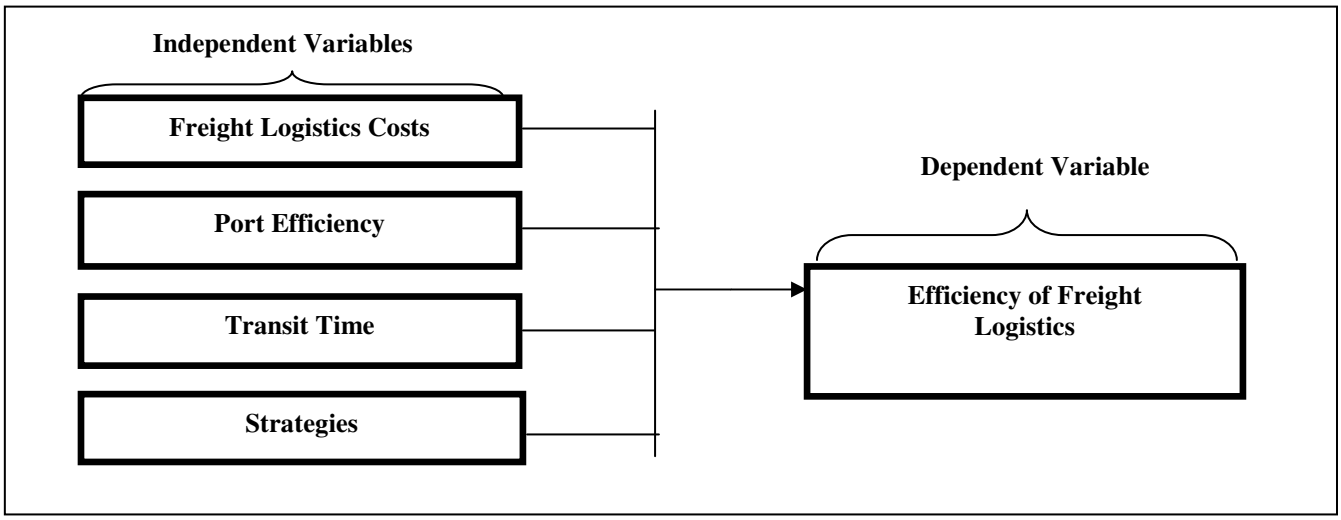

Figure 2: Conceptual framework model
Source: Researcher, 2015

Figure 2 above illustrates the conceptual framework model used for this study and depicts the relationship between on one hand the independent variables which comprise of port congestion, freight logistics costs, average transit time, and strategies and policies and on the other hand the dependent variables i.e. efficiency of freight logistics. The study determines if road traffic congestion affects the efficiency of freight logistics and how the variables interact. It also identifies appropriate strategies and policies that may be implemented by the government and KPA to enhance efficiency in freight logistics operations at the port of Mombasa.

2.3.1. Effects of Cost on Freight Logistics Operational Efficiency

According to Ronald Fischer (2011) traffic congestion for the freight industry and trucking companies diminishes productivity and increases the overall cost of transportation services. Increased costs may be due to higher costs of fleet operations, demurrage charges for unscheduled delays, decreased fleet and vehicle utilization, decreased fuel efficiency, increased emissions due to idling, and decreased hours of productive service for drivers. Because a supply chain is a "network of retailers, distributors, transporters, storage facilities, and suppliers that participate in the sale, delivery, and production of a particular product," as defined by "investorwords.com," congestion resulting in unreliable trip times and missed deliveries can have major business implications, causing a ripple effect that adds costs at every link of the supply chain. If the transportation function is reliable, manufacturing and retail firms can carry fewer inventories because they can rely on goods being delivered when and where they are needed. In addition, they can potentially expand their sourcing. However when the transportation system is congested and unreliable, a firm must carry more inventories to ensure production processes are uninterrupted and the availability of goods is maintained. Stock-out situations and interrupted manufacturing operations have a negative and growing impact on business operations that have been reengineered around a just-in-time lean inventory business model (Ilmer, 2009).

Carrying inventory is a major cost to a firm. Not only is a firm's capital tied up in inventory, precluding its use for more productive activity, but inventory must be stored and insured, and the capital invested is at risk should the inventory lose its shelf life (Fadare, 2010). This model of businesses carrying more inventories to buffer transportation unreliability has negative cost implications and also affects customer service. According to CSCMP's report of (2006), inventories have slowly crept up, reversing the trend toward leaner logistics. The report notes that the 17 percent increase in inventory carrying costs in 2005 is in part a response to longer and sometimes unpredictable delivery times. According to the report, during the same period, trucking costs increased by $74 billion due in part to factors such as worsening congestion and higher fuel expenditures.

a) Direct costs

There are different views about what constitutes a direct cost to business from traffic congestion. These are generalised and direct business production cost according to Centre for International Economic (CIE), 2006. A traditional approach is to identify the share of

the generalised cost of transport congestion that is borne by business. The generalised cost of travel is an extension of the concept of cost to include items which influence travel behaviour, but which are not always thought of in monetary terms (CIE, 2006). Key items are set out in conventional manuals for the economic analysis of roads and traffic and include; Travel time — the additional time absorbed in delays caused by congestion; and vehicle operating costs — additional running costs (fixed and variable) such as depreciation, fuel, repairs and maintenance. Another direct cost concept is to identify the costs of congestion that directly apply to the cost of production for business. That is, the costs that alters the ability of a business to make and deliver goods and/or services. Authors and analysts in this area generally take into account what happens to the business as well as what happens in vehicles. Economic Development Research Group, 2005 in a recent survey of businesses in Portland in the US highlighted a number of impacts of congestion on business production costs. These include costs of additional drivers and trucks due to longer travel times; costly 'rescue drivers' to avoid missed deliveries due to unexpected delays.

b) Indirect Costs

This includes indirect costs such as loss of productivity due to missed deliveries; shift changes to allow earlier production cut off; increased inventories; and reduced market accessibility and scale, including loss of market-scale and reduced access to specialisedlabour and materials. Figure 3 below shows the breakdown of logistics costs.

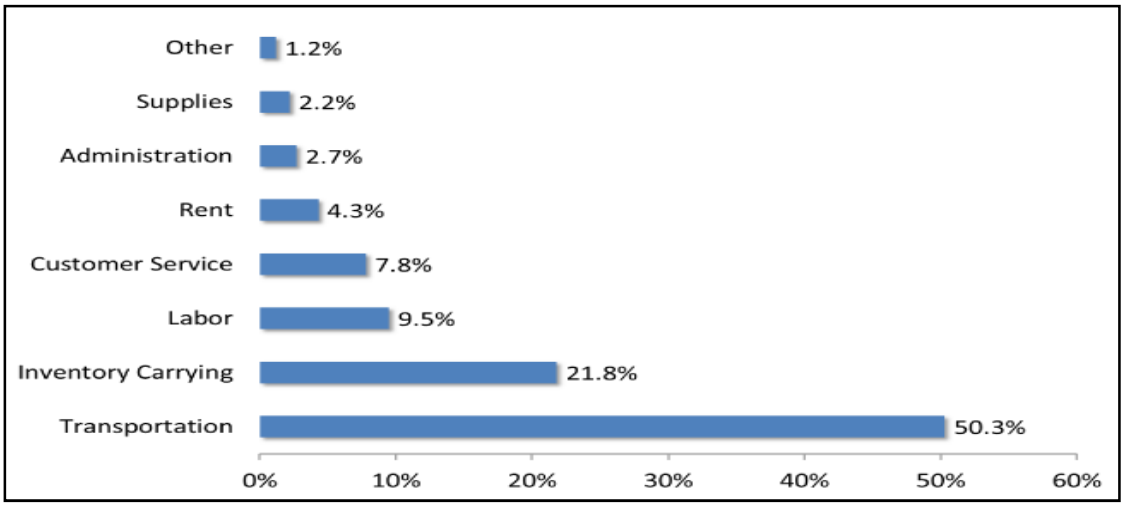

Figure 3: Logistics costs breakdown
Source: International Transportation and Geopolitics

2.3.2. Effect of Port Congestion on the Efficiency of Freight Logistics

In a paper by Trevor D.H (2011) road traffic congestion has an adverse effect on port efficiency especially in developing countries where there is the lack of appropiate transport infrastructure composed of intermodal freight system to facilitate efficient cargo evacuation and integrated freight logistics systems. The efficiency of trucking services to and from container terminals, generally dominated by drayage, is a local problem found globally. The common features are the occurrence of congestion on the roads and at the terminal gates. The challenges outside the terminals are less tractable as many shippers with their preferred service hours are involved, many trucking enterprises offer services, often owner operators, and the vehicles operate on city streets and highways. The problems have existed for many years but have generally become chronic before port authorities have taken ownership of initiatives to improve conditions. Measures taken to reduce the problems include reservation systems for trucks at terminals, designated truck routes and improvements in rail links, most notably in Los Angeles. However, trucking services continue to be sources of port inefficiency. Collaboration is an important part of most improvement initiatives but is difficult because of the number of businesses involved, generally in different supply chains (Maguire A. *et al*).

According to the Kenya Economic Update report of June 2010, Mombasa Port remains poorly equipped to handle containers and other goods. Increased imports volumes have placed increased stress on land transport, and have generated the need for faster and more efficient intermodal connections. Progress in this area has been poor. The failure of the railway system has resulted in a large number of new truck movements in and around the port contributing to the growing problem of road traffic congestion and road deterioration. Rail transport carried around 80 percent of goods transiting Mombasa in the early 1970s. Today only 5 per cent of Mombasa's freight moves on rails, a decline that has been due to the absence of sustained government investment in the railways and, most recently, the lack of investment by Rift Valley Railways, the company that operates the Mombasa to Uganda rail line.

The current exit from Mombasa port through the traffic congested Changamwe is choking the port. A newly proposed new terminal will only work well with the construction of the bypass. The Government has already secured Sh29 billion loan from Japan for construction of the 26 km bypass that is aimed at decongesting the city of Mombasa by providing an alternative to the Likoni ferry by linking the main land with south Coast. To import a container from Singapore, your goods would spend 19 days on the sea (over 7,500 kilometers), but they would need 20 more days just to make it from Mombasa, by road, to Nairobi (see figure 4 below).

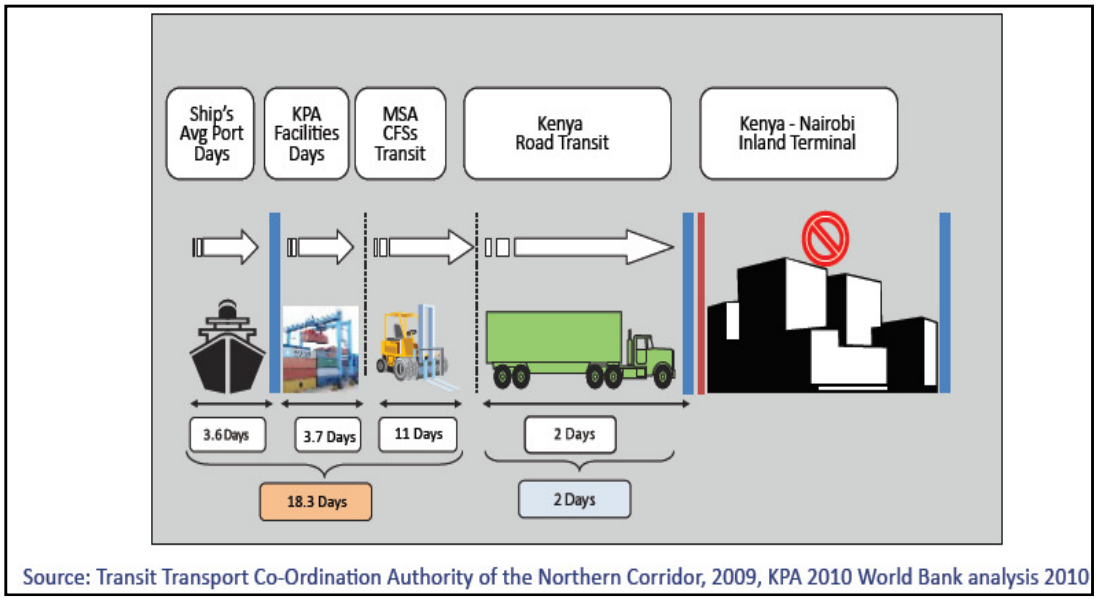

Figure 4: Transit time for a container to go through the port and by road to Nairobi

In contrast to Canada, rail intermodal and bulk transport is major component of Canadian maritime logistics chain and forms the major mode of inland transport serving the Pacific gateway. Currently, 65 percent of inbound containers leave the port by rail (Heaver, 2011). Modern rail systems are more efficient with better logistics than road transportation. Any expansion of a port that leaves behind the upgrade of the railway systems capacity may not achieve the desired benefits.An efficient port and a railway system complement each other. The rail system clears cargo as fast as it arrives, and transports exports at the same rate without competition (KSC, 2009).

2.3.3. Effect of Average Transit Time on the Efficiency of Freight Logistics

Traffic congestion prolongs average transit time and affects reliability of delivery schedules which leads to indirect costs. According to Alan McKinnon *et al* (2007) the cost of congestion is not confined to the road network. The late arrival of supplies at factories, warehouses and shops can also impair their operating efficiency and sales performance. Missed deliveries to manufacturing plants and retail outlets can halt production, hinder sales, and potentially severe business relationships. Efficient and reliable freight transportation enables businesses to respond rapidly to changes in customer and consumer demand, shorten product cycle times, and reduce inventory. Transportation always has been integral to the ability of businesses to capitalize on economic and competitive advantages. Shippers, particularly those employing just-in-time management techniques, expect freight carriers to deliver goods on time, in the right amount, and in undamaged condition.

In the UK, congestion was found to be by far the most important of six types of impediment to road freight movement, congestion-related delays accounting for approximately 5% of total transit time. The total cost of these delays was evaluated in terms 'lost revenue, including missed opportunities, due to the forced inactivity of vehicles and transport staff'.Previous research by HCG in 1998 established 'value-of-time' measures for freight traffic which comprised estimates not only of vehicle operating costs but also of the value of inventory in transit. The total cost of congestion related delays was found to be 2.2 times higher than the previously estimated value-of-time figures.The indirect costs of traffic congestion are largely associated with unreliability, in contrast to the direct, 'on-the-road' costs which are essentially a function of average transit time (Adenle, 1981). By asking firms to attach a monetary value to reliability, it should be possible to gain an indication of the indirect costs of congestion. However in practice very few firms can account for costs associated with delayed in inbound deliveries as most of them focus on outbound delieveries (McKinnon *et a1*, 2007). In general delays in delivery lead times leads to customer dissatisfaction, lost revenue as a result of stock outs and missed orders, disruptions accomodated with normal operating procedures, temporary redeployment of resources such as extension of warehouse working hours and associted staff overtime, and departure of the outbound vehicle without late deliveries leading to lost sales downstream.

2.4. Critique of the Existing Literature

The paper by S.O. Fadare*et al* (2010) titled "effects of traffic congestion on freight movement in Lagos", found that the effect of congestion to a shipper means longer travel times, decrease in vehicle utilization, decreased in fuel efficiency, higher cost of fleet operation, shrink in market coverage, higher cost of shipment, less reliable pick-up and delivery times for truck operators. A sample size of 85 truck drivers, 91 shippers and 108 suppliers were selected using stratified sampling techniques with the aid of well-structured questionnaires. The result of the findings revealed that congestion decreased vehicle utilization, decreased fuel efficiency, increased cost of fleet operation, shrinked market coverage and increased cost of shipment.

According to a paper by Alan Mckinnon (2004) titled "the impact of road congestion on logistical efficiency", the researcher made the following recommendation to ease congestion: Scheduling vehicle movements to avoid peak hours; overhauling goods reception operations; and exploiting new information technology. The reseacher noted the irony by logistics managers to reduce inventory levels

and instead focus on material flow while disregarding the fact that 90% of all surface freight movement in the UK were done by road thereby increasing road congestion. The study highlighted the difficulty of isolating the indirect costs of congestion and comparing them on a consistent basis between companies. The sample of seven distribution centres was however too small to permit wider generalisation. The study also relied on interviews alone which should have been supplement by direct observations and measurements.

In his thesis on port efficiency (2012), BadiAlmotairi developed a framework for the concept of integrated logistics platform. The researcher argued that the capability of integrating different forms of interfaces relies on the port organization so as to support supply chain coordination in which all member-firms work closely as if one single domain, adopt key business process integration by identifying links to logistics activities (like combined transport carrying capacity and other linking activities); and enhance system optimization by bridging interfaces through the proprietary information system, allowing supply chain visibility for the entire system. However an application of the concept and its effectiveness has not been tested.

A study by Heaver (2011) titled "improving efficiency in port and maritime logistics in the U.S" observed that the efficiency of trucking services to and from container terminals, generally dominated by drayage, is a local problem found globally. Heaver noted that collaboration is an important part of most improvement initiatives but is difficult because of the number of businesses involved, generally in different supply chains. Increased efficiency at intermodal port terminals affect the overall transportation community and all other types of intermodal transportation by allowing more containers to be shipped, and moved more quickly away from the ports, onto the other forms of transportation, and to their final destinations. The paper was however unclear on the methodology used to inform his recommendations.

2.5. Summary

Road Traffic congestion is a significant problem that is growing in many modern urban societes. To address this problem requires concerted effort from all stakeholders. The effect of congestion to a shipper means longer travel times, decrease in vehicle utilization, decreased in fuel efficiency, higher cost of fleet operation, shrink in market coverage, higher cost of shipment, less reliable pick-up and delivery times for truck operators. The uncertainty brought by congestion impacts the efficiency of freight logistics operations and port operations. Direct and indirect costs incurred due to congestion have been widely studied and reported, mostly in relation to passengers' value of travel time, carriers' value of travel time, shippers' market access costs, logistics costs, production costs, and productivity costs (Weisbroad, Donald &Treyz, 2001). However, the specific effects of road traffic congestion on the efficiency of freight logistics at the port of Mombasa have not been researched. This study attempts to further the already existing body of knowledge on the effects of road traffic congestion by specifically highlighting the port of Mombasa and how the efficiency of freight logistics is affected.

2.6. Research gaps

The cost of road traffic congestion is not confined to the road network. The late arrival of supplies at factories, warehouses and shops can also impair their operating efficiency and sales performance. Very little research has so far been done on these 'indirect' or 'consequential' costs of traffic congestion (McKinnon, 2004). These costs are inversely related to the reliability of the transport operation which diminishes as the density of traffic increases leading to decline in the quality of service. This will therefore require an indepth analysis in future research to identify the actual indirect costs incurred by companies and nationally due to traffic congestion.

Further studies with regard to interface collaboration which enables an integrated logistics platform by different stakeholders involved in freight movement at the port should be done. This requires network structures at the port and key business process elements to be aligned by an appropriate network-interdependence and technology-enabled coordination strategies. This concept has not exhaustively researched especilly with applicability to developing countries and should be made the focus of future research. Under a network structure opportunities arise for all member-firms to coordinate and integrate to achieve synergies in delivering corporate customer value. The identified gap in this scenario remains what level/degree of network interdependency and interface collaboration are required for the organizations to perform their functions efficiently.

3. Research Methodology

3.1. Introduction

This chapter describes the methodology components that have been employed in the study so as to achieve the objectives stated in chapter one. Contained in the chapter are the following sections; the research design, target population, sample size and sampling procedures. The last sections cover instrumentation, data collection procedures, data analysis and ethical considerations guiding the research.

3.2. Research Design

According to Kothari (2003) research design constitutes a blue print for the collection, measurement and analysis of data. It is therefore a plan and structure of investigation that assists the researcher to obtain answers to the research questions. The study employed the descriptive survey design which gives a description of the state of affairs as they exist to assist in achieving the objectives stated in chapter one. A cross-sectional survey design method was used to collect data for this research. According to Cooper and Schindler (2003), this type of survey is suitable where data is collected from a given sample in a particular period of time. Nachmias (1996) argued that the cross-sectional survey allows the researcher to assess the relation between traffic

congestion and firm performance but we can not conclude that theses two variables are causally related. By using the correlation coefficient analysis technique, we are able to determine the direction as well as the magnitude of the relationship between the two variables.

3.3. Population of the Study

The target population comprised of organizations operating at the port of Mombasa that handle freight namely KPA, CFSs, freight forwarders, shipping agents, and cargo owners.

3.4. Sampling Frame

The sampling frame represents the actual set of units which the sample was drawn from the target population. The sampling frame for this study was composed of personnel from those organizations that are directly involved with freight movement at the port of Mombasa. This comprises of KPA, CFSs, freight forwarders, shipping agents, and cargo owners.

3.5. Sample Size

The sample size was drawn from four organizations and individual cargo owners representing five target groups as shown in table 3 here below. This is because of the large population that exists under the target population study comprising of different players that perform different roles affecting freight movement.

Organization	Estimated number of Employees	Sample Size	%
Freight Forwarders	1,100	50	4.54%
KPA	7,300	50	0.68%
CFS	1,200	20	1.67%
Cargo owners	N/A	20	N/A
Shipping agents	750	10	0.59%
TOTAL	**10,450**	**150**	**1.08%**

Table 3: Population study and sample size distribution
Source: Researcher, 2015

3.6. Sampling Techniques

This refers to the process of selecting a number of individuals or objects from a population such that the selected group contains elemnsts representative of the characteristics found in the entire group. It was not logistically possible to include all the accessible population in the study therefore a sample that is representative of the population was used. Stratified random sampling was used to divide the target population into homogenous groups. This ensures that all the groups from the population are represented in the sample (Kombo & Tromp, 2006). Simple random sampling was then used to select subjects from each group.

3.7. Data Collection Instruments

The researcher used the following instruments to collect data for the study:

a) Questionnaires: This is a set of structured questions used to query the respondents in the sample in order to obtain information for the purposes of analysis.
b) Personal interview: The researcher sought answers to a set of pre-conceived questions through personal interviews. This method of collecting data was carried out in a structured way whereby the output will depend upon the ability of the interviewers.

3.8. Data Collection Procedure

The researcher sought permission to conduct the study from the Jomo Kenyatta University Graduate School once the proposal was accepted. The researcher then visited the target study population at the Port to explain to the sampled populations the purpose of the study and request for their consent to proceed with research.

a) Questionnaires: A day for administering the questionnaire was set. On the appointed day, the researcher distributed the questionnaires to the subjects who were given two days to fill the questionnaires on their own. Thereafter the researcher collected the filled questionnaires.
b) Personal interview: The personal interview was conducted on the material day of collecting the questionnaires with the consent of the subjects. This was done so as to avoid inconveniencing the subjects by making unnecessary visit and interfering with their work. The interview guide was used to guide the process.

3.9 Pilot Test

Upon receiving permission from the university to conduct the study, the researcher conducted a pilot test on a few independent respondents. This pilot test was used to evaluate the competence of the data collection instruments in providing relevant information to the research objectives. This included assessing the effcetiveness of the questionnaire and interview in terms of; if the respondents understood the objective of the survey; if the respondents felt comfortable answering the questions; if the wording of the survey was

clear; if the time reference was clear to the respondents; if the questions were compatible with the respondents' experience in the matter; and if the questions were clearly understood by the respondents.

3.10. Data Analysis Techniques

Qualitative and quantitative techniques were employed to help demonstrate the relationship between the independent and dependent variables. The findings were analyzed for purposes of making interpetations. The analysed data was in the form of frequencies, percentages, means and standard deviations.

3.11. Ethical Issues

Ethics are essential in research since researchers are people genuinely concerned about other peoples' quality of life. As a result they should be people who will not carry out research that will have a negative impact on others (Mugenda & Mugenda, 1999). This study was built on ethical considerations of anonymity, confidentiality, intellectual honesty, respect for intellectual property rights, and non-fabricated findings.

4. Research Findings & Discussion

4.1. Introduction

The chapter represents the empirical findings and results of the research. The data presented includes response rate, background information of the respondents and the presentation of research findings against each question. Descriptive statistics was also employed in analyzing the findings.

4.2. Response Rate

The total number of respondents targeted for the study was 150. A total of 150 questionnaires were distributed as shown in Table 4 here below whereby 120 were duly filled and received back giving a response rate of 80%. Therefore, among the targeted sample of 150, 120 (80%) proceed to data analysis.

Organization	Sample	Respondents	% Response
Ballore Africa Logistics	30	25	83.3
KPA	40	35	87.5
Interpel Investment Ltd	30	20	66.6
Express Shipping & Logistics (EA) Ltd	20	12	60
Cargo owners	30	28	93.3
Total	**150**	**120**	**80**

Table 4: Summary of Key Respondents
Source: Researcher, 2015

4.3. Data Presentation and Findings

4.3.1. Background Information

The study sought to establish the background information of the respondents by using thefollowing parameters: name of respondent, gender, age, level of education, and the current position held.

Gender	Frequency.	%
Male	82	68.33
Female	38	31.67
Total	120	100

Table 5: Gender distribution:
Source: Researcher, 2015

The descriptive statistics of the study indicates that 82 (68.33%) of the respondents were male, while the remaining 38 (31.67%) were female as shown in Table 5. This implies that male respondents participated more in answering the questionnaires.

Gender	Frequency.	%
18-30	9	7.5
31-40	54	45.0
41-50	43	35.83
51-60	14	11.67
Total	**120**	**100**

Table 6: Age of respondents
Source: Researcher, 2015

The finding shows that 45% of the respondents are aged between 31-40 years, 35.8% are aged between 41-50 years, 11.67% aged between 51-60 years and only 7.5% are aged between 18-30 years. This implies that majority of the respondents are aged between 31-40 years.

Level	Frequency.	%
Post-graduate	2	1.67
Graduate/Higher Diploma	24	20
Diploma	37	30.83
Certificate	45	37.5
'O' Level	12	10
Total	**120**	**100**

Table 7: Level of Education
Source: Researcher, 2015

Out of the 120 respondents only 1.67% were post-graduates, 20% were graduates, 30.83% were diploma holders, 37.5% were certificate holders while 10% were "O" Level certificate holders.

Level	Frequency.	%
Management	31	25.83
Clerical / Unionisable	67	55.83
Drivers / Operators	22	18.33
Total	**120**	**100**

Table 8: Position in organization
Source: Researcher, 2015

55.83% of the respondents were clerical and unionisable staff while 25% were holding management positions. Drivers and machine operators accounted for 18.33% of the respondents.

The questions were designed to evaluate the effects that road traffic congestion has on the freight logistics efficiency at the Port of Mombasa. Response was sought for twenty five questions whereby the findings are as analysed and discussed here below:

- What areas are most important to improve in Freight Logistics? (Ranked on a scale of 1-4 with 1 being the most important)

Rank	1	2	3	4
Reliability	50	35	15	20
Transit time	80	30	5	5
On-time delivery	75	25	10	10
Transportation cost	100	15	5	0

Table 9: Most important areas to improve in Freight Logistics
Source: Researcher, 2015

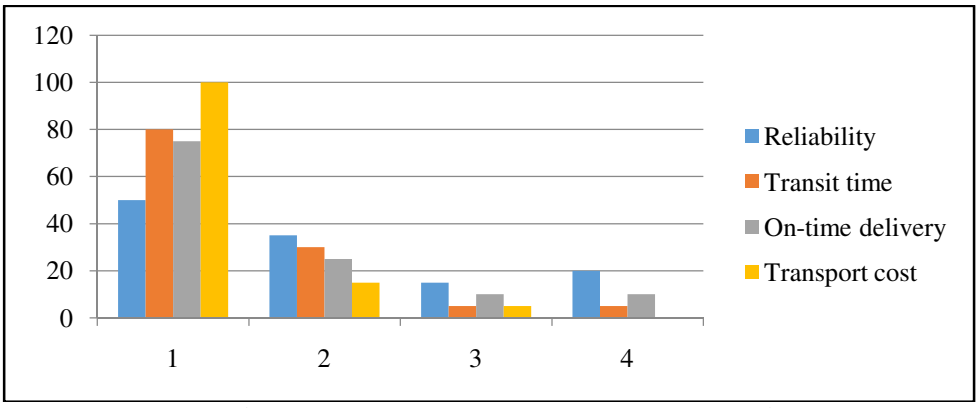

Figure 5: Ranking of most important areas to improve in Freight Logistics
Source: Researcher 2015

This question sought to establish the key freight logistics variables in order of importance with respect to their contribution to the overall efficiency. Respondents gave their internal views by ranking on a scale of 1 to 4 the element that requires improvement to enhance freight transportation. The most important element was ranked number one while the least important was ranked number four. The findings were as shown in Table 9 and Figure 5. Responses to the question suggest that transportation cost is the most important factor that needs focus to improve freight logistics efficiency as cited by the respondents. Transit time was ranked second after transportation cost. This was attributed to the close relationship between transit time and transport cost given that longer transit time escalate transportation cost. On-time delivery was ranked third and finally the reliability factor with respondents arguing that if transportation cost is low and transit times reduced then deliveries will be on-time and reliable. This implies that transport cost and transit times are the key drivers in determining freight logistics efficiency.

- How many carriers do you currently manage?

	Frequency.	**%**
1-3	0	0
4-9	0	0
10-20	0	0
21 or more	120	100

Table 10: Number of carriers managed currently
Source: Researcher, 2015

All the respondents were from firms that operated a fleet of 21 carriers or more giving a frequency of 100%. This implies that respondents were well conversant with challenges encountered in freight logistics.

- How often are your delivery schedules missed because of road congestion?

The researcher sought to know the frequency of missed delivery schedules experienced by the freight logistics firms as a result of traffic congestion to evaluate business loss resulting from delays in traffic and the findings were as shown here below.

	Frequency	**%**
Never	0	0
Sometimes	0	0
Often	15	12.5
Very often	105	87.5

Table 11: Missed Delivery Schedules due to road congestion
Source: Researcher, 2015

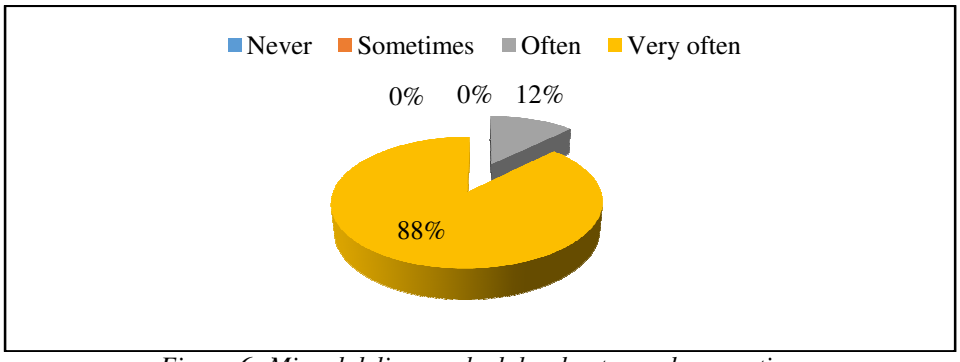

Figure 6: Missed delivery schedules due to road congestion
Source: Researcher 2015

Majority of the respondents agreed that missed delivery schedules is a very often occurrence with 87.5% on the affirmative and only 12.5 % responding as often. There were zero responses on never and sometimes. This concludes that road traffic congestion had rendered delivery schedules from the port of Mombasa to be highly unreliable.

- Does road traffic congestion contribute to port congestion?

	Frequency	**%**
Yes	120	100
No	0	0

Table 12: Whether road traffic congestion contribute to port congestion
Source: Researcher, 2015

All respondents cited road congestion as one of the key factors that leads to congestion at the port of Mombasa. The study revealed that entry to the port was heavily congested with huge volumes of truck traffic entering and leaving the port area. Respondents indicated that on average trucks were taking 6 hours on average to enter and exit the port against a global standard of one hour with some ports like Malasyia doing a port turnaround time of 0.8 hours (SCEA, 2013). The poor truck turnaround time from the Port to CFS storage yards slowed down port evacuation process which negatively affected port efficiency. Also noted was the poor traffic flow within the port area occasioned by poor gate operations had resulted in an increase in truck turnaround within the port area. Based on these findings Table 13 and Figure 7 illustrate the effect of poor turnaround times occasioned by traffic congestion on port efficiency and freight logistics performance revealing that 20 hours are lost for every five trucks going through the port. This infers that traffic congestion negatively affects port efficiency and freight logistics.

No. of trucks	Total Truck turnaround time in port (Hrs)	Container throughput	Global Standard Port Turnaround time (Hrs)	Time lost due to congestion (Hrs)
1	6	1	1	5
2	12	2	2	10
3	18	3	3	15
4	24	4	4	20
5	30	5	5	25

Table 13: Effect of traffic congestion on vehicle turnaround time and port efficiency
Source: Researcher 2015

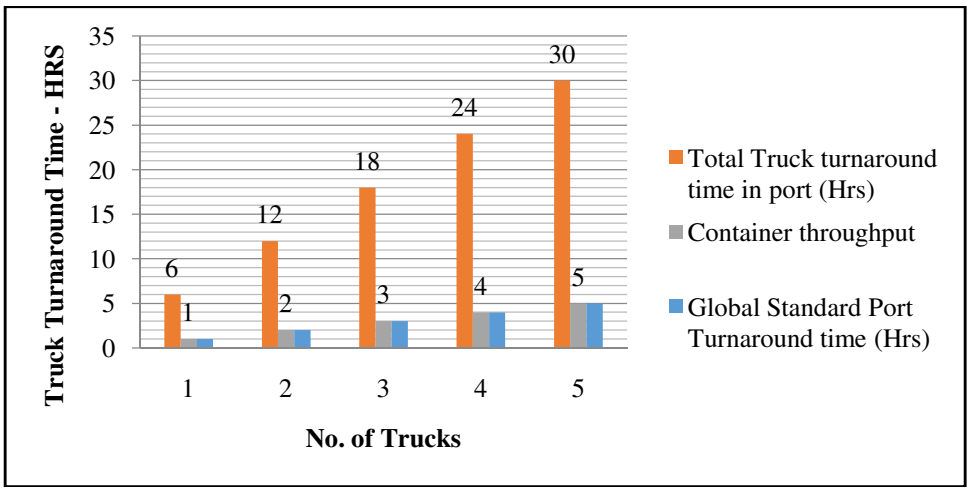

Figure 7: Effect of traffic congestion on vehicle turnaround time and port efficiency
Source: Researcher, 2015

- Does road traffic congestion affect freight clearance process?

	Frequency	%
Yes	10	8.4
No	110	91.6

Table 14: Whether road traffic congestion affect freight clearance process
Source: Researcher, 2015

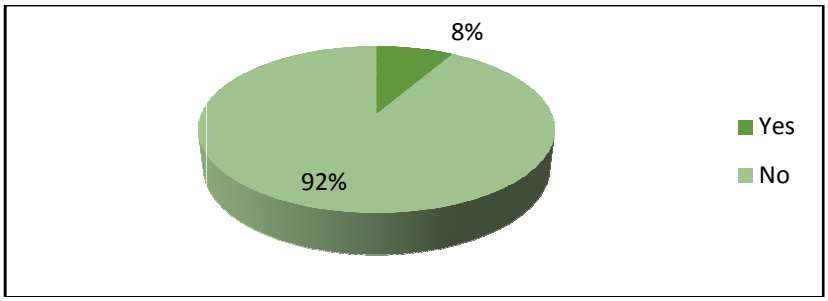

Figure 8: Whether road traffic congestion affects freight clearance process
Source: Researcher, 2015

Only 8.4% of respondents held the view that road traffic congestion affect the freight clearance process while 91.4% of the respondents cited it was, in fact, the other way round due to excessive customs procedures. The respondents revealed that the slow and inefficient freight clearance process is one of the contributers to the heavy traffic build up at the port area as volumes of trucks queue to collect or deliver cargo to or from the port. The current period taken to clear one container was averaging 5 days below the global standard of 3 days. This implies that inefficiencies in freight clearance negatively affected freight logistics efficiency.

- Do customers complain about late deliveries caused by road traffic congestion?

	Frequency	%
Never	0	0
Sometimes	0	0
Often	30	25
Very often	90	75

Table 15: Customers complaints about late deliveries due to road traffic congestion
Source: Researcher, 2015

Majority of the respondents totaling 75% cited that complains by customers are very often given that the delay impacts negatively on the customers business. Only 25% of the respondents cited that complains by customers are often indicating that complains of delays was very common. This was evidenced by the long traffic queues dominated by haulage trucks on both lanes to and from the enrty to the container terminals at the port. None of the respondents cited that complains of late deliveries by customers occurs sometimes or are never received. This concludes that traffic congestion leads to customer dissatisfaction and complains.

- Have you incurred demurrage charges from shipping companies as a result of road congestion?

	Frequency	**%**
Never	0	0
Sometimes	0	0
Often	25	20.8
Very often	95	79.2

Table 16: Whether firms incur damurrage charges due to road congestion
Source: Researcher, 2015

The response obtained for this question is very similar to the previous question. Demurrage charges were incurred very often according to 79.2% of the respondents and oftenly by 20.8%. None of the respondents cited that demurrages are incurred at sometimes or are never incurred. The high frequency of demurrage charges has a direct impact on freight costs which affects the price competitiveness for commodities. The study revealed that shippers charge a standard re-marshalling fee USD 100 per 20ft container and USD 150 per 40ft container on expiry of the 4 free days for domestic cargo and 9 days for transit cargo accorded to importers. Respondents cited the poor truck turnaround which was affected by delays in traffic outside the port and within the port area. It emerged that a truck was spending on average 6 hours within the port and 4 hours were wasted in traffic within a radius of 10 kilometers giving an average vehicle turn around of 10 hours to pick and drop one container from the port. This infers that an increase in vehicle turnaround had a negative impact on time taken to clear freight from the port and thus increased the risk of demurrage charges as illustrated in Table 17 and Figure 9 here below.

Days taken to clear container	**Demurrage charges - USD**	**Total turnaround time - Hours**
4	0	96
5	100	120
7	200	168
8	300	192

Table 17: Effect of turnaround time on days taken to clear freight and demurrage charges
Source: Researcher, 2015

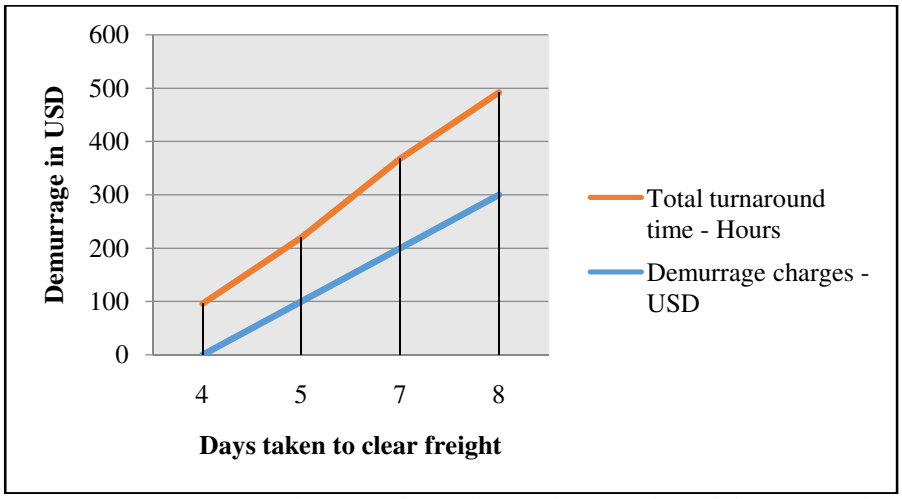

Figure 9: Effect of turnaround time on days taken to clear freight and demurrage charges
Source: Researcher, 2015

- What is your annual demurrage spend as a percentage of total freight costs?

	Frequency	%
Below 5%	10	8.4
5-10%	80	66.6
Above 10%	30	25

Table 18: Percentage of annual demurrage spend against total freight cost
Source: Researcher, 2015

66.6% of respondents cited that demurrage costs accounted for 5-10% of total freight cost. 25% cited above 10% of total freight cost while 8% of the respondents incurred demurrage charges of below 5% of total freight cost. Respondents cited that the high cost of demurrage charges was a factor of inefficiencies in the clearance process and port efficiency at container terminals which was constrained by the heavy traffic entering and leaving the port area. None of the respondents encountered or operated under a demurrage free environment. This implies that traffic congestion increases the risk of demurrage charges which negatively affects the cost of freight.

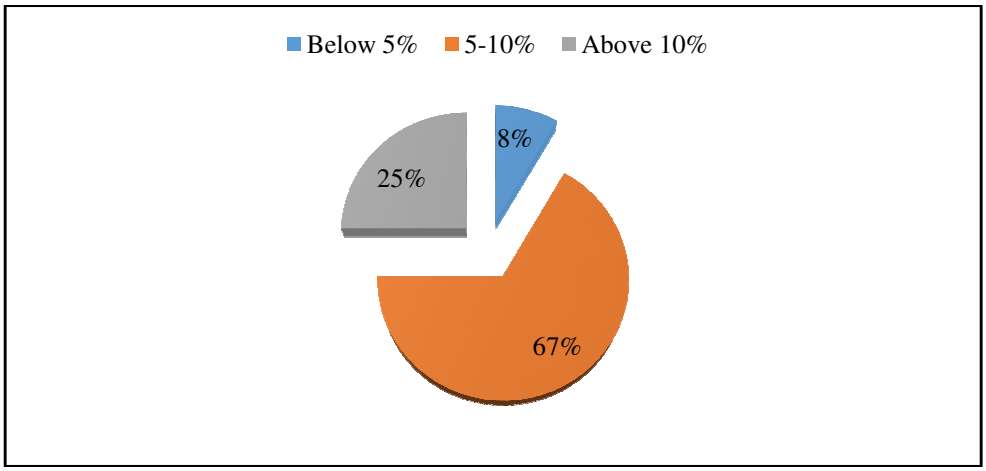

Figure 10:Percentage of demurrage in total freight cost
Source: Researcher, 2015

- Overall, is traffic congestion a problem in your business?

	Frequency	%
Yes	120	100
No	0	0

Table 19: Traffic congestion as a problem in business (Yes/No)
Source : Researcher, 2015

All the respondents were unanimous that traffic congestion was a problem to their business. All respondents mentioned increased cost of doing business as a major problem caused by traffic congestion. Delayed deliveries and loss of business was also cited as other problems encountered by freight companies. With 95% of the cargo relying on road transport traffic congestion posed various logistical inefficiencies for KPA and freight companies. This was worsened by the limited capacity of the main highway leading in and out of Port of Mombasa. Failure to upgrade the road to dual carriage was cited as a major bottleneck and contributed to heavy traffic snarl ups experienced on the road leading to the entry to the Port area. This concludes that traffic congestion impacted negatively on freight logistics performance.

- Does road traffic congestion lead to low productivity?

	Frequency	%
Yes	120	100
No	0	0

Table 20: Whether traffic congestion affects productivity (Yes/No)
Source: Researcher, 2015

The respondents were unanimous that traffic congestion negatively affects productivity. This was in the form of wasted man hours, vehicle downtime, prolonged transit times, reduced vehicle trips and container turnaround times leading to delays in arrivals and unreliable delivery schedules. It was noted that it takes 6 hours to collect one container from the Port to the CFS stations due to lengthy documentation process. On average drivers were making a maximum of two trips to and from the Port instead a minimum of 4 trips within the 24 hours of operation. This translates to reduced man hours and trips which has a direct negative bearing on productivity. This infers that traffic congestion lowered productivity as depicted in Table 21 which shows the effect of traffic congestion on productivity and revenue based on the findings and taking into consideration the current port transfer charges to CFS at the rate of USD 120 per 20ft container.

No. of trucks	Expected Trips per day (Free flow traffic)	Actual Trips per day (Due to Traffic Congestion)	Expected Income (free flow) $120 per trip	Actual Income (free flow) $120 per trip	Lost Revenue
4	16	8	1920	960	960
6	24	12	2880	1440	1440
8	32	16	3840	1920	1920
10	40	20	4800	2400	2400
12	48	24	5760	2880	2880

Table 21: Effect of traffic congestion on productivity for freight operators
Source: Researcher, 2015

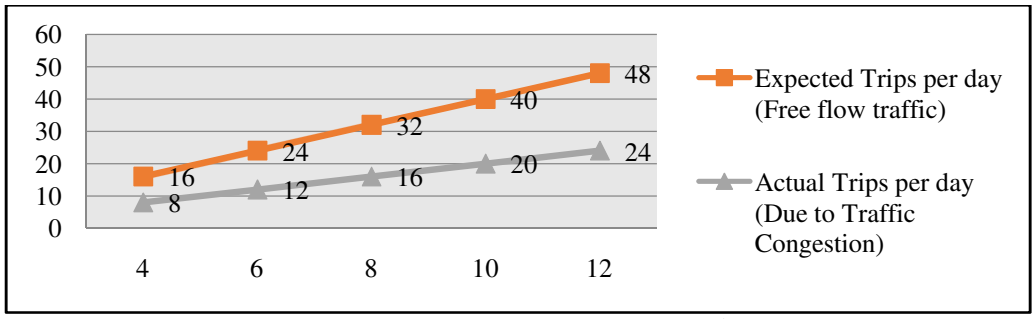

Figure 11:Effect of traffic congestion on productivity
Source: Researcher, 2015

The findings reveal a reduction in the actual number of trips per day by half due to wasted time in traffic. This is despite the fact that majority of CFS operators are located within 10 kilometers from the Port. However it also emerged that a lot of time is consumed in the Port as vehicles wait for documentations to be cleared by Port authorities. Vehicles were spending an average of 6 hours from entry to exit. This implies that traffic congestion lowers productivity.

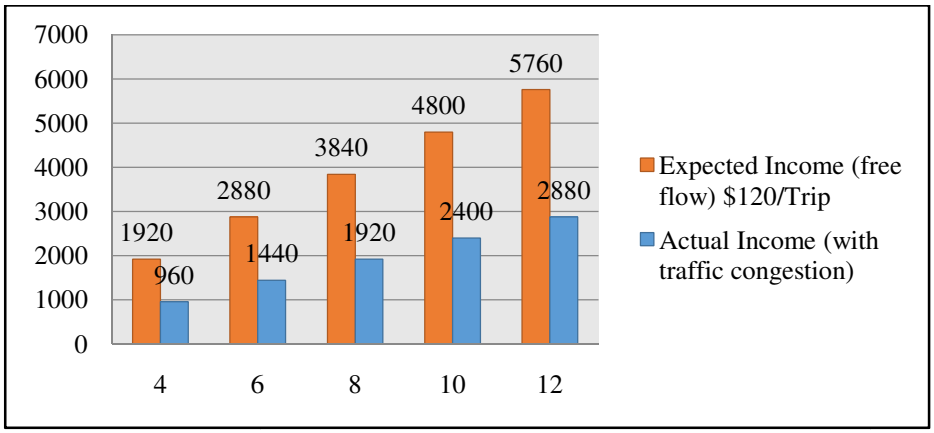

Figure 12: Effect of traffic congestion on revenue for freight operators
Source: Researcher, 2015

The findings also reveal that the expected revenue for service providers ferrying containers from the Port to CFS stations was reduced by at least half per day due to traffic congestion. The drastic reduction in expected revenue infers that traffic congestion had a negative effect on profitability for companies involved in freight logistics.

- In your opinion what are the factors contributing to road traffic congestion?

	Frequency	%
Increased number of vehicles	100	83.3
Poor capacity of roads	120	100
Poor railway infrastructure	100	83.3
Clearing Inefficiencies	111	92.5
Weigh bridge	86	71.7

Table 22: Factors contributing to road traffic congestion
Source: Researcher, 2015

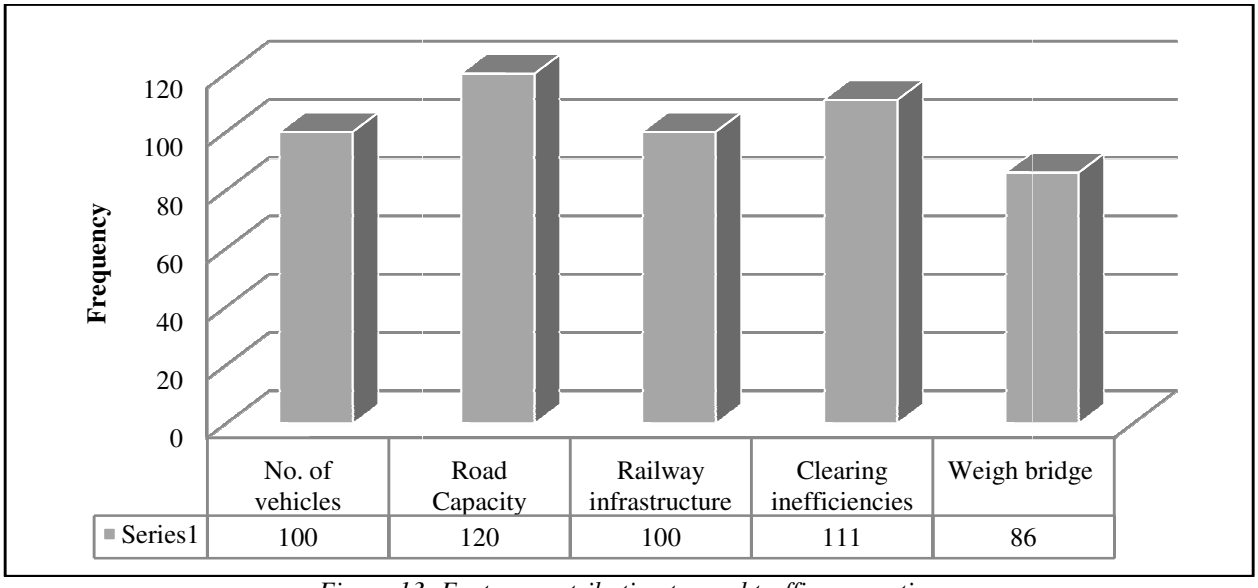

Figure 13: Factors contributing to road traffic congestion
Source: Researcher, 2015

All the respondents cited the limited road capacity as major cause of traffic congestion which hindered the free flow of traffic in and out of the Port. Respondents pointed out that the main road leading to the Port which is also linked to the Mombasa – Nairobi highway has limited capacity and required expansion of more lanes to accommodate more vehicles. Other roads leading to the Port have remained the same over the years as observed by respondents despite the increase in vehicles. Freight clearing emerged as the second major cause of traffic congestion according to 92.5% of the respondents who cited that this was occasioned by inefficient procedures which were bureaucratic and riddled with corruption. This was despite the advent of the Simba on-line clearance system installed by

KPA. The poor use of railway due to undeveloped infrastructure and increased number of vehicles using the main access roads to the Port were cited third according to 83.3% of the respondents. The respondents argued that the number of private, public, and commercial vehicle had increased greatly over the years yet the infrastructure growth had stagnated. Improvement in railway infrastructure had been neglected for long with only 5% usage as opposed to 95% reliance on road transport. This hindered use of intermodal freight system can facilitate efficient cargo evacuation and freight logistics system as well as reduce the pressure on road use. Inefficiencies at the weigh-bridge in Mariakani were also cited by 71.7% of the respondents as another bottleneck causing traffic congestion. It was noted that corruption was rampant at the weigh-bridge causing traffic snarl ups which negatively affected transit times. This implies that the key drivers of traffic congestion were poor roads and railway infrastructure followed by inefficiencies in both freight clearance and weigh-bridge.

- Which roads in Mombasa affect freight movement from the Port due to traffic congestion?

	Frequency	%
KPA – Changamwe (Kipevu) Road	40	33.3
Kipevu – Magongo – Jomvu – Nairobi	15	12.5
Changamwe – Kibarani – Makupa	25	20.8
Changamwe – Jomvu – Mariakani	29	24.1
Nairobi- Mombasa Highway	11	9.1

Table 23: Roads affecting freight movement from the Port due to traffic congestion
Source: Researcher, 2015

33.3% of the respondents cited the KPA – Kipevu Road as the main road contributing to traffic congestion. This is the main access road for entering and exiting the port of Mombasa. 24.1% of the respondents cited the Changamwe – Jomvu – Mariakani while Changamwe – Kibarani – Makupa Road section came third as cited by 20.8% of the respondents. Kipevu – Magongo – Jomvu – Nairobi road was cited fourth by 12.5% of the respondents and lastly Nairobi -Mombasa Highway was cited by 9.1% of respondents with regard to contributing to traffic congestion at the port. This implies that the five access roads were the key contributors of the traffic congestion at the Port of Mombasa.

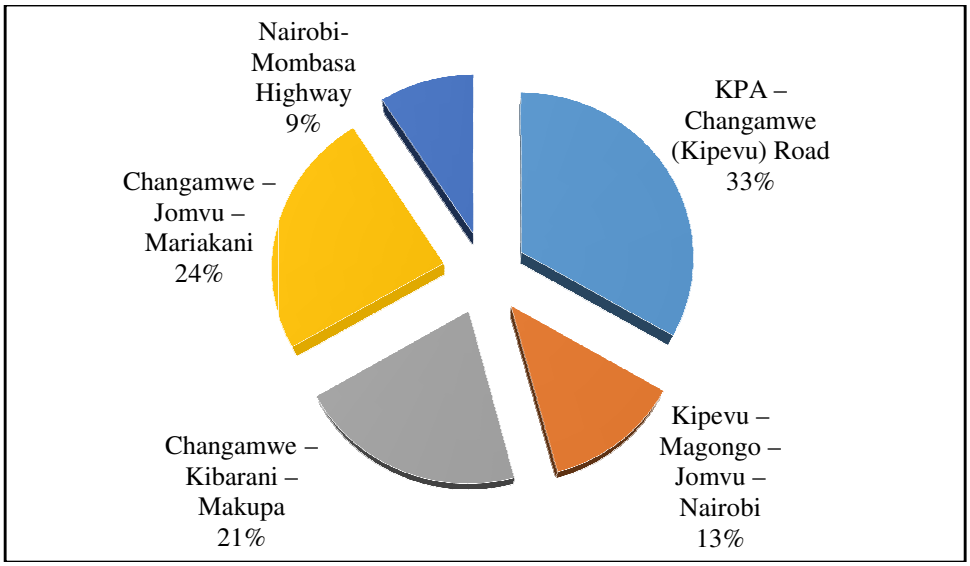

Figure 14: Roads affecting freight movement from the Port due to traffic congestion

- How much additional time per day per truck is absorbed between the Port/CFS to the weigh-bridge at Mariakani as a result of delays caused by traffic congestion?

The survey sought to measure effect on transit time efficiency by ascertaining the truck turnaround time for a truck to reach Mariakani weigh-bridge.

Average delay per truck	Frequency	%
Less than 5Hrs	9	7.5
5-10 hrs	92	76.7
More than 10 hrs	19	15.8

Table 24: Additional time per day per truck absorbed between CFS/ Port to the weighbridge at Mariakani due to delays by traffic congestion
Source: Researcher, 2015

76.7% of the respondents experienced an average delay per truck of between 5-10 hours while 15.8% cited a delay of more than 10 hours especially for transit cargo. Only 7.5% experienced delays of less than 5 hours per truck. The survey revealed that the heavy traffic between the port exit gates and Mariakani means that trucks were spending as much as 6 hours to navigate through a 30 kms stretch, which ordinarily would take 30 minutes. The situation was compounded by narrow roads and single lane roads between Changamwe and Miritini. Respondents attributed this problem to the encroachment on road reserves by Container Freight Stations. Key findings of the survey are that one truck was losing 150 hours per month in transit time absorbed between the port and Mariakani. This is equivalent to 6.25 days per month or 75 days in a year which translates to productivity loss due to reduced mileage coverage and poor return on investment for freight logistics operators. This infers that traffic congestion negatively affects transit time efficiency, vehicle productivity and the overall freight logistics performance. Table 25 and Figure 15 shows the effect of prolonged transit time on freight logistics efficiency.

No. of Trucks	Cumulative Traffic Free Flow Time Taken (Hours)	Actual cumulative Time Taken with Congestion	Total Transit Time Loss (Hours)
1	0.5	6	5.5
2	1.0	12	11.0
3	1.5	18	16.5
4	2.0	24	22.0
5	2.5	30	27.5

Table 25: Effect of traffic congestion on transit time efficiciency
Source: Researcher, 2015

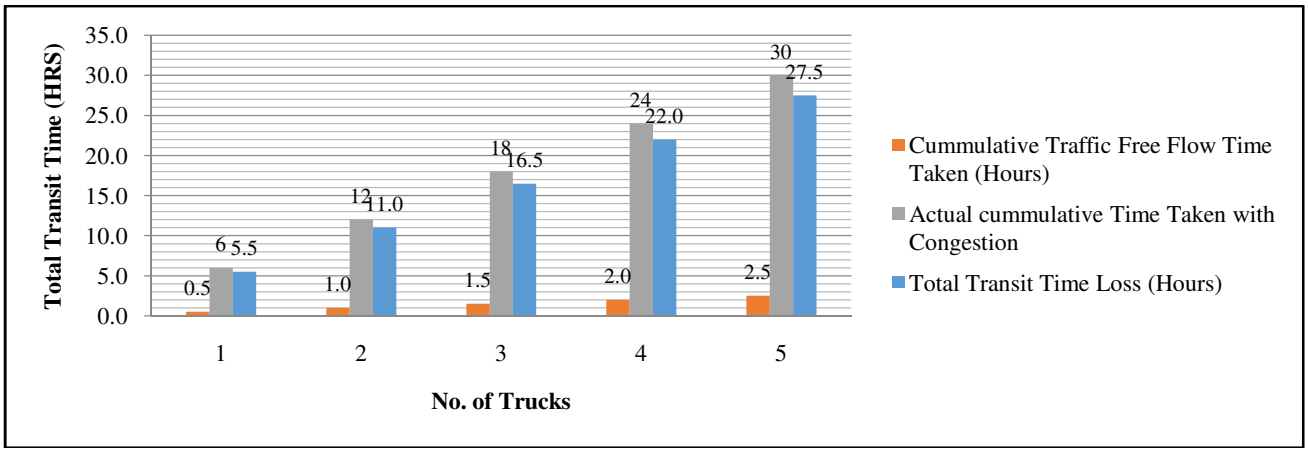

Figure 15: Effect of traffic congestion on transit time efficiency
Source: Researcher, 2015

- Does traffic congestion increase your average fuel consumption rate (Kms/Ltr)?

	Frequency	%
Yes	120	100
No	0	0

Table 26: Whether traffic congestion increases average fuel consumption
Source: Researcher, 2015

All the respondents agreed unanimously that traffic congestion increases the average fuel consumption mainly because of longer vehicle running time. This concludes that traffic congestion has a negative effect on freight logistics efficiency since it increases transport costs.

- If your answer is yes above, what is the percentage increase in fuel consumption rate?

	Frequency	%
Less than 5%	0	0
5-10 %	64	53.3
10-15%	35	29.2
Over 15%	21	17.5

Table 27: Percentage increase in fuel consumption rate/month
Source: Researcher, 2015

53.3% of the respondents cited an average monthly increase of 5-10% in the fuel consumption rate. 29.2% of the respondents cited an increase of between 10-15% while 17.5% of the respondents cited over 15% increase in fuel consumption. Drivers interviewed said they cover a mileage of approximately 5,000 to 10,000kms depending on business demand but noted that the consumption rate varies depending on traffic congestion. Ideally the acceptable rate was noted to be 40 litres per 100 kms but this is erratic due to traffic congestion which affects the volume of fuel consumed in any given specific month and the fuel cost as illustrated by Table 28 here below. This implies that the fuel efficiency was dependent on traffic congestion.

Normal Rate (Ltrs/100 kms)	% increase Fuel Consumption Rate	Congestion Rate (Ltrs/100 kms)	Mileage	Litres Consumed Normal Rate	Litres Consumed Congestion Rate	Fuel Price	Fuel Cost Normal Rate	Fuel Cost Congestion Rate	Fuel Cost Change
40	5	42	5,000	2,000	2,100	76.71	153,420	161,091	7,671
40	10	44	5,000	2,000	2,200	76.71	153,420	168,762	15,342
40	15	46	5,000	2,000	2,300	76.71	153,420	176,433	23,013
40	20	48	5,000	2,000	2,400	76.71	153,420	184,104	30,684

Table 28: Effect of traffic congestion on fuel efficiency in freight logistics
Source: Researcher, 2015

Assuming the average monthly mileage given by respondents of 5,000kms the survey reveals that an increase in 5% in fuel consumption rate as a result of traffic congestion increases the amount of fuel consumed to 2,100 litres per month while an increase of 20% increases the fuel consumed to 2,400 litres. This has corresponding effect in fuel cost with an increase of 5% increasing the cost of fuel to Kshs 161,091 while an increase of 20% increases the fuel cost to Kshs 184,104 as illustrated in figures 16 and Figure 17 here below. This concludes that traffic congestion increases the cost of fuel and causes a negative effect on fuel efficiency which negatively affect freight logistics efficiency.

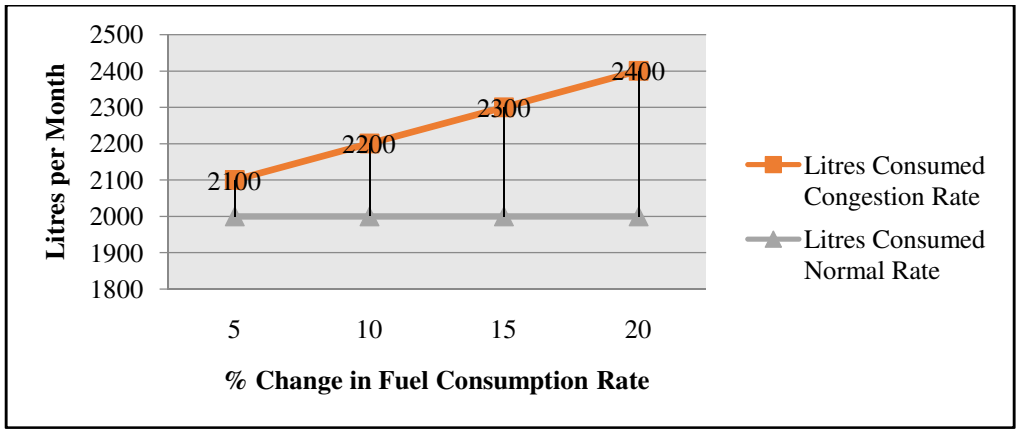

Figure 16: Effect of traffic congestion on fuel consumption efficiency
Source: Researcher, 2015

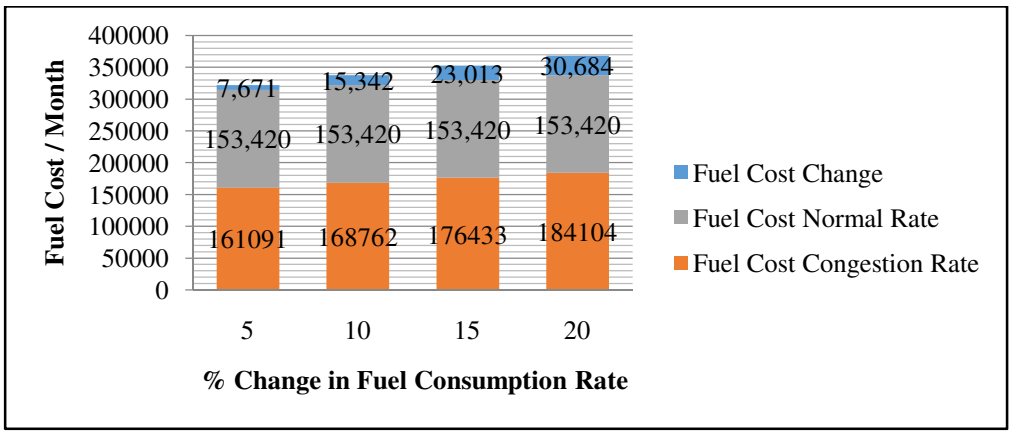

Figure 17: Effect of traffic congestion on fuel cost efficiency
Source: Researcher, 2015

- Does traffic congestion affect your vehicle running cost?

The study sought to establish the effect of traffic congestion on the overall vehicle running cost.

	Frequency	%
Yes	120	100
No	0	0

Table 29: Whether traffic congestion affect vehicle running cost
Source: Researcher, 2015

All the respondents indicated that traffic congestion affect running costs. None of the respondents had a different view. This was evidenced by decreased fuel efficiency for delivery trucks, increased emissions due to idling, low turn around time and vehicle utilization leading to higher costs of fleet operation. This implies that traffic congestion has a negative effect on vehicle running cost which leads to freight logistics inefficiencies.

- If yes above, give the additional costs for the following categories of costs in comparison to the optimal/ideal monthly estimate.

The respondents cited an optimal vehicle consumption rate of 40 litres per 100 kilometers which was highly erratic due to traffic congestion and could increase up to 50 litres per 100 kiometres depending on the volume of traffic. This implies that traffic congestion has a negative effect on fuel efficiency which a direct impact on vehicle running costs. However the study could not ascertain other additional vehicle maintenance costs associated with traffic congestion since these are indirect costs that could not be accurately measured.

- Does traffic congestion affect the inventory/cargo holding in your warehouse?

	Frequency	%
Yes	120	100
No	0	0

Table 30: Whether traffic congestion affect the inventory/cargo holding in warehouses / storageyard
Source: Researcher, 2015

All the respondents observed that traffic congestion affect inventory/cargo holding in the warehouse/storage. Respondents interviewed indicated that traffic congestion resulted in delayed deliveries, prolonged transit times and unreliable deliveries schedules leading to congestion of container terminals and storage yards as well as increased stock holding in the warehouses. This implies that traffic congestion has a negative effect on optimal stock holding which directly affects freight logistics efficiency.

- Do you often experience the following situations as a result of traffic congestion?

	Overstocking		Stock-outs	
	Respondents	%	Respondents	%
Never	0	0	0	0
Sometimes	68	56.67	88	73.33
Often	39	32.5	17	14.16
Very Often	13	10.83	15	12.5

Table 31: Instances of overstocking and stock outs due to traffic congestion
Source: Researcher, 2015

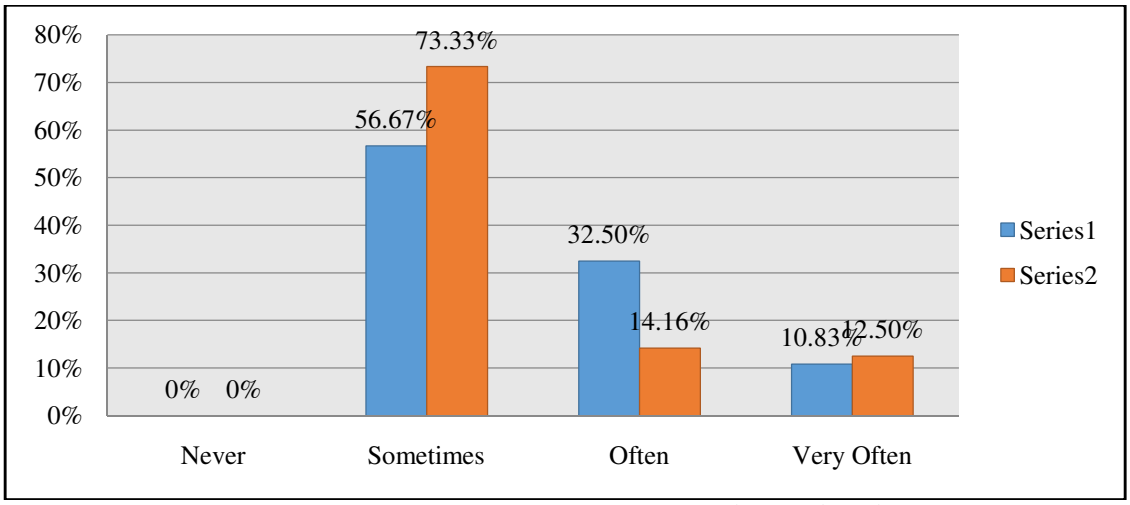

Figure 18: Effect of traffic congestion on overstocking and stock outs
Source: Researcher, 2015

All the respondents had experienced instances of overstocking and stock outs although at varying degrees arising from traffic congestion. Majority of respondents cited the instances as occurring not very often or often but sometimes. It was noted from the findings that overstocking was more common than stock outs. This is because most importers preferred to carry more stocks to ensure production process are uninterrupted and the availability of goods is maintained. Stock-out situations had a negative impact leading to loss of revenue and customer dissatisfaction. The prevalence of overtsocking was evident in storage yards and warehouses indicating inefficiency in the supply chain processes. This infers that traffic congestion has a negative effect on the optimum stock holding which leads freight logistics inefficiencies.

- Do you incur overtime expense as a result of traffic related delays?

	Frequency	**%**
Yes	120	100
No	0	0

Table 32: Whether firms incurred overtime expenses due to traffic related delays
Source: Researcher, 2015

All the respondents concurred that overtime work was inevitable due to the traffic related delays. Traffic congestion resulted in unrealiable trip times and delayed deliveries. Most firms were therefore required to work over the weekends and evenings to compensate for the lost time and avoid incurring demurrage charges from shipping companies. This concludes that overtime expenses increased with an increase in traffic volumes thereby increasing freight logistics costs.

- If yes, what is the estimated increase in staff cost due to overtime caused by late deliveries and traffic congetion?

	Frequency	**%**
Less than 5%	10	8.4
5-10 %	73	60.8
Above 10%	37	30.8

Table 33: Estimated increase in staff cost due to overtime caused by traffic congestion
Source: Researcher, 2015

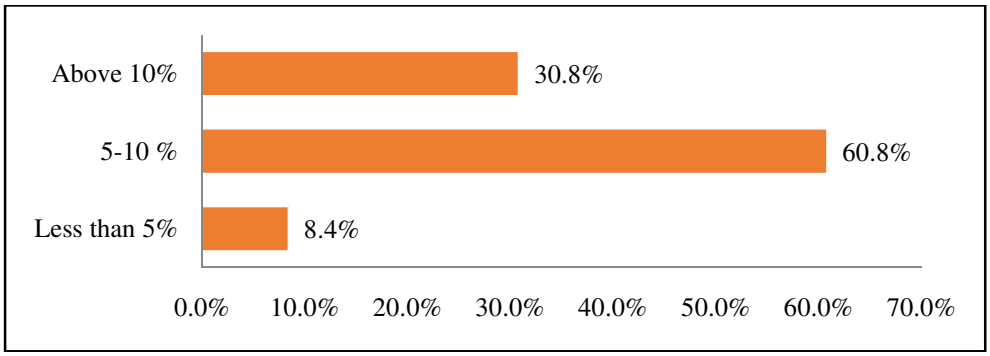

Figure 19: Estimated increase in staff cost due to overtime caused by traffic congestion
Source: Researcher, 2015

60.8% % of the respondents cited an increase in staff overtime of between 5 - 10% due to traffic related delays while 30.8% of the respondents cited over 10% rise in wage bill. Only 8.4% of the respondents cited less than 5% increase in wage bill. It was noted that freight logistics companies were working under tight delivery schedules which faced severe constraints from delays in vehicle turnaround times caused by traffic queues leading to and from the Port. Consequently, the staff were engaged to work overtime to help meet delivery timelines for clients and shipping companies. This infers that staff costs were affected negatively by traffic congestion.

- Does traffic congestion affect your daily average vehicle/container turnaround?

	Frequency	**%**
Yes	120	100
No	0	0

Table 34: Effect on daily average vehicle turnaround time to and from the port
Source: Researcher, 2015

The study sought to establish the effect of traffic congestion on the daily average vehicle turnaround time for trucks going through the port to make deliveries within Mombasa to a radius of 30 kms. All respondents agreed that the daily vehicle turnaround time to and from the port was prolonged by traffic congestion. One of the key reasons cited for this situation was the limited access road to the port entry causing long queues of traffic. This in effect prolonged the average turnaround time for carriers and flat beds ferrying containers to and from the port. The other reason given was port efficiency that determines the daily container throughput. The survey revealed an average delay of 4 hours daily per truck for deliveries and pick up within a radius of 10 kms from the port. Another evident reason was the lack of efficient railway line to provide an alternative transport mode to help in cargo evacuation and port decongestion. Trucks were spending an average of 6 hours to enter and exit the port. This translates to a loss of 10 hours per truck per day as illustrated in Table 35 and Figure 20 here below. This implies that traffic congestion was a major cause of inefficiencies in vehicle turnaround times at the port due to the time lost queueing at the entry and exit points to the port.

No. of Trucks	**Cumulative turnaround time outside port (Free flow traffic) - Hours**	**Cumulative standard turnaround time within port - Hours**	**Total actual cumulative Time Taken without Congestion**	**Actual cumulative turnaround time with congestion (Hrs)**	**Total Transit Time Loss (Hours)**
1	0.5	1.0	1.5	10	8.5
2	1.0	2.0	3	20	17.0
3	1.5	3.0	4.5	30	25.5

Table 35: Effect of traffic congestion on vehicle turnaround efficiency
Source: Researcher, 2015

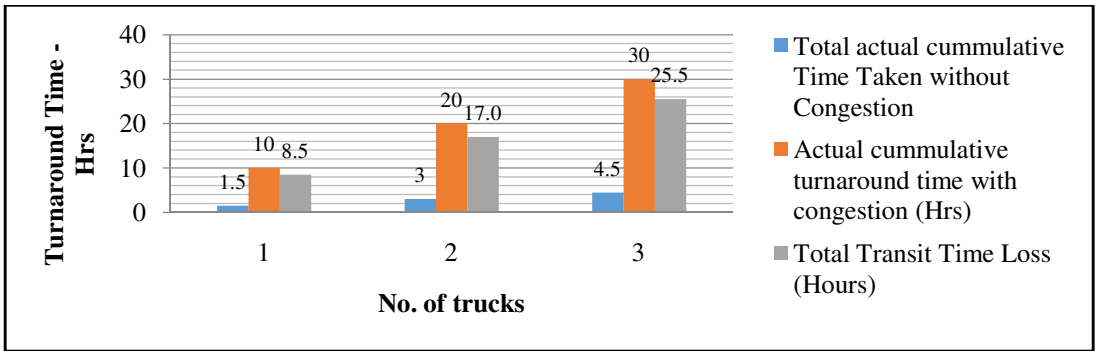

Figure 20: Effect of traffic congestion on vehicle turnaround efficiency
Source: Researcher, 2015

- If yes, what is the decline in the daily average vehicle/container turnaround time?

Average Delay per day	Frequency	%
Less than 1 HR	15	12.5%
1-3 HRS	89	59.3%
Above 3 HRS	16	13.3%

Table 36: Approximate decline in average vehicle turnaround time per day
Source: Researcher, 2015

59.3% of the respondents cited an approximate daily delay of 1 to 3 hours in the average vehicle turnaround time while while 13.3 % of the respondents reported an approximate delay of above 3 hours per day. 12.5 % of the respondents cited a delay of less than one hour on the average daily vehicle turnaround time. The additional time absorbed in delays caused by congestion amounts to lost time. From the above feedback we can infer that an average of 2 hours per day are lost in traffic which amounts to 10 hours per week taking into account that ordinarily there are five working days. These amounts to 40 hours per month which implies that approximately 3 working days per month are lost due to road traffic congestion leading to logistics inefficiency.

- In your opinion does road traffic congestion affect the following factors?

	Frequency	%
Timeliness of delivery	120	100
Customers satisfaction	108	90
Port efficiency/cargo evacuation	120	100
Quality of freight logistics services	101	84.2

Table 37: Opinion on aspects that road traffic congestion affects
Source: Researcher, 2015

All respondents agreed that timeliness of deliveries and ports efficiency are the key aspects that are negatively affected by road traffic congestion with each aspect obtaining 100% respondents' confirmation. Customer's satifaction was next which 90% of respondents cited as negatively affected by traffic congestion. Quality of freight logistics services was cited by 84.2% respondents as being negatively affected by traffic congestion. This implies that traffic congestion has a negative effect on the above variables which are key performance indicators freight logistics efficiency.

- Suggested measures to mitigate road traffic congestion problem at the port of Mombasa

The study sought to obtain suggested measures from respondents that can be employed to mitigate the negative effects of traffic congestion on freight logistics efficiency at the port of Mombasa. This was for purposes of suggesting appropriate strategies that can be adopted by the relavant players involved in freights logistics. The suggestions were given as tabulated in Table 38 here below.

	Frequency	%
Fixing road transport infrastructure	120	100
Raise the level of usage of railway transport	120	100
Streamlining the clearance procedure	113	94.2
Review of weigh bridge policy	105	87.5
Fixing Port Inefficiencies	120	100

Table 38: Suggested measures to mitigate the effects of traffic congestion at the port
Source : Researcher, 2015

Fixing the road transport infrastructure through redesigning and expanding the road network was cited by all respondents as a key solution to dealing with traffic congestion at the port of Mombasa. Equally important was raising the level of usage for railway transport as both an alternative and to complement road transport which currently caters for 95% of freight transport. Port inefficiencies with regard to extremely slow documentation processes leading to delays of up to 6 hours per truck was noted as another bottleneck which affected vehicle turnaround times and contributed to long queues at the entry to the port. Adoption of new technology and embracing best practices was cited by the respondent as key in dealing with port congestion. Streamlining the clearance process by removing bureaucracies, investing in new technologies and wiping out corruption was another step that 94.2% of the respondents suggested as key to fixing the traffic congestion. Review of weighbridge policy by the government to minimize the weighbridge points was cited by 87.5% of the respondents as vital in fixing the traffic congestion especially reducing the ports o weighbridge.

4.4. Correlation Coefficient Analysis

The researcher conducted correlation coefficient analysis so as to establish relationship between traffic congestion and freight logistics efficiency in terms of strength and direction. Correlation coefficients are used in statistics to measure how strong a relationship is between two variables. The Pearson's correlation coefficient was used in the study by taking findings from the study on cost of demurrage charges (see Table 17 above) as an indicator of freight logistics efficiency compared to port vehicle turnaround time as an indicator of port efficiency. The findings will help to establish the direction and relationship between the two variables.

No.	Total turnaround time - Hours (x)	Demurrage charges - USD (y)	(xy)	x^2	y^2
1	96	0	0	9,216	0
2	120	100	12,000	14,400	10,000
3	168	200	33,600	28,224	40,000
4	192	300	57,600	36,864	90,000
∑	576	600	103,200	88,704	140,000

Table 39: Correlation coefficient between demurrage cost and port turnaround time
Source: Researcher, 2015

The correlation coefficient formula:

$$r_{xy} = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n\sum x_i^2 - (\sum x_i)^2}\ \sqrt{n\sum y_i^2 - (\sum y_i)^2}}$$

Where: y = Demurrage charge in USD (dependent variable)
x = Port vehicle turnaround time in hours
n = 4

The correlation coefficient =
$4(103,200) - (576 \times 600) / [\sqrt{[[4(88,704) - (576^2)] \times [4(140,000) - 600^2]]}$
=0.9899

The range of the correlation coefficient is from -1 to 1. Our result is 0.9899 or 98.99%, which means that the variables have a strong positive correlation. We therefore conclude that

4.5. Discussion of Findings

4.5.1. What are the effects of costs on the efficiency of freight logistics?

Traffic congestion increases transport costs affecting the efficiency of freight logistics through three major factors: Demurrage charges, staff overtime, and fuel consumption. According to the findings, 79.2% of the respondents in Table 17 cited that demurrage charges were incurred very often. The study revealed that an increase in total truck turnaround time, which is an indicator of freight logistics efficiency, led to an increase in demurrage charges after the expiry of the 4 days free period. Subsequently an increase in total turnaround time by 24 hours had a negative effect on demurrage charges which increased by approximately USD100 as illustrated in Table 17. According to 59.3% traffic congestion increased vehicle turnaround time by up to 3 hours daily as shown in Table 36. This increased the risk of incurring demurrage charges at the port due to delays occasion by prolonged vehicle turnaround times. 66.6% of the respondents show that demurrage charges accounted for 5-10% of total freight costs. In addition, road congestion also contributed to an increase in fuel cost by reducing fuel efficiency. All respondents as shown in Table 26 were affirmative that traffic congestion increases fuel consumption. Drivers interviewed revealed that the fuel consumed increased from 40 litres per 100 kms to 50 litres per 100 kms due to traffic congestion. All respondents cited increase in overtime occasioned by traffic congestion with 60.8% citing an estimated increase of 5-10% as shown in Table 33.

4.5.2. How does the effect of reduced port congestion affect efficiency of freight logistics?

Port congestion plays a major role in determining the efficiency of freight logistics. The survey revealed that port congestion had a negative impact on freight logistics through missed deliveries as shown in Table 11, demurrage charges as shown in Table in 16, overstocking as shown in Table 32 and customer complaints as shown in Table 15. Inefficiencies at the port through poor container evacuation, prolonged vehicle turnaround time, lengthy documentation at the port entry and poor storage contributed to port congestion. 87.5% of the respondents in Table 11 cited that missed delivery schedules occurred very often. All respondents were of the opinion that traffic congestion contributed to port congestion by slowing down the container evacuation process as a result of prolonged transit times. The survey revealed that on average 5 hours were lost per truck through poor vehicle turnaround time at the port area as shown in Table 13. Trucks were spending an average of 6 hours as opposed to the global standard of 1 hour per truck (SCEA, 2013). This in effect reduced the container throughput at the port leading to port congestion. A reduction in port congestion through improved vehicle turnaround time will increase container throughput leading to timely deliveries, optimal stockholing, eliminate demurrage charges, reduce customer complains, and lost business opportunities arising from missed delivery schedules thus improving freight logistics efficiency.

4.5.3. What are the effects of average transit time on the efficiency of freight logistics?

The study revealed that transit time efficiency is paramount in determining the performance freight logistics and was key driver of productivity and return on investment. Inefficiencies in transit arising from traffic congestion contributed to missed delivery schedules as observed by all respondents in Table 11 which also led to customer dissatisfaction and loss of business. Table 15 shows that all respondents experienced customer complains due to late deliveries with a score often and very often. With regard to productivity, drivers were making 2 trips in 24 hours to pick and drop containers from the port instead a minimum of 4 trips due to time lost in traffic as shown in Table 21. This translates to loss of revenue of USD 240 per truck per day measuring by the current CFS transfer charge of USD 120 per day. Additional time absorbed in traffic between the port and Mariakani weighbridge amounted to 5 ½ hours per truck which negatively affected transit time efficiency as shown in Table 25 leading to reduced productivity and lowering the return on investment due to poor truck utilization.

4.5.4. What strategies require to be undertaken to improve the efficiency of freight logistics operations at the port of Mombasa to help overcome road traffic congestion?

The study sought the opinion of respondents on the suggested strategies that can be employed to mitigate the negative effects of traffic congestion on freight logistics efficiency at the port of Mombasa. Respondents cited improvement of road transport infrastructure through redesigning and expanding the current road network to accommodate more vehicles as one of the key solutions to dealing with traffic congestion at the port of Mombasa. Improving the railway infrastructure and usage was also mentioned as being equally important both as an alternative and to complement road transport which currently caters for 95% of freight transport. This would reduce the demand for road transport and facilitate the use of multi-modal freight logistics thus improving the overall efficiency. Port inefficiencies with regard to extremely slow documentation processes causing a delay of up to 6 hours per truck was noted as another bottleneck which affected vehicle turnaround times and contributed to long queues at the entry to the port. Adoption of new technology, enhancing storage capacity including ICDs and embracing best practices was cited by the respondent as key in dealing with port congestion. Streamlining the clearance process by removing bureaucracies, investing in new technologies and wiping out corruption was another step that 94.2% of the respondents suggested as key to fixing the traffic congestion. Respondents also pointed out the encroachment of several CFS operators next to the Mombasa-Nairobi highway increasing traffic congestion during offloading as truck queue to offloading. There was need to relocate the affected CFS operators to more suitable locations. Review of weighbridge policy by the government to minimize the weighbridge points was cited by 87.5% of the respondents as being vital in fixing the traffic congestion which was responsible for increasing transit times due to lost time absorbed in queues at the weighbridge. On average 5 ½ hours were lost per truck which negatively affected productivity and the return on investment.

5. Summary, Conclusions and Recommendations

5.1. Introduction

This chapter presents the summary, conclusion and recommendations based on the findings of the survey. It provides the summary of the study from the objectives, research methodology and results of the study. The conclusions are derived from the research findings. It also highlights the recommendations and areas for further research.

5.2. Summary of Findings

The objective of the study was to identify the effects of road traffic congestion on the efficiency of freight logistics: A survey of the port of Mombasa. The specific objectives were: To evaluate the effect of costs on the efficiency of freight logistics; to examine the effect of reduced port congestion on the efficiency of average transit time on the efficiency of freight logistics; and to suggest appropriate strategies aimed at promoting efficiency of freight logistics at the port of Mombasa to overcome the problem of road traffic congestion. To accomplish the research objectives, a questionnaire and interview survey was conducted from the 30th of July – the 14th August, 2015 using quantitative survey. The study assessed these factors and discussed the extent to which they influence freight logistics efficiency at the port. The study also looked at two major theories: Systems theory and Supply Chain theory as well as other empirical studies relating to the topic. The study targeted population comprised of respondents from KPA, CFS operators,

freight forwarders, shipping agenst and cargo owners. A questionnaire was used as a major instrument to obtain primary data and supplemented with personal interview conducted during the collection of the questionnaires. A sample size of 150 respondents was used for the research of which 120 of the respondents participated in the survey. The data were analyzed in the form of frequencies, percentages, and Microsoft Excel 2013.

The findings revealed that freight logistics efficiency at the port of Mombasa is measured by freight logistics costs, vehicle turnaround time, and transit time efficiency. The results indicated that traffic congestion increases freight transport costs affecting the efficiency of freight logistics through increase in demurrage charges, staff overtime, and fuel consumption. The study also revealed that traffic congestion led to increased total truck turnaround time, which contributed to further freight logistics cost being incurred through demurrage charges after the expiry of the 4 days free period. An increase in total turnaround time by 24 hours had a negative effect on demurrage charges which increased by approximately USD100 per container. The study further revealed that the port turnaround time per truck was 6 hours to collect one container and deliver to the CFS stations. This is a loss of 5 hours in comparison to globally accepted standard of 1 hour (SCEA, 2013). This translates to loss of revenue, reduced man hours and trips which has a direct negative bearing on productivity. The findings reveal a reduction in the actual number of trips per day by half due to wasted time in traffic. This is despite the fact that majority of CFS operators are located within 10 kilometers from the Port.

Key findings also revealed that the performance of container throughput was affected by poor turnaround time reducing port efficiency through slow cargo evacuation which has a negative on freight logistics efficiency. The poor truck turnaround time from the Port to CFS storage yards slowed down port evacuation process which negatively affected port efficiency. Moreover, the effect on port vehicle turnaround time negatively affected port efficiency and freight logistics performance revealing that 20 hours are lost for every five trucks going through the port. This has a direct impact on container throughput which impaired port efficiency through reduced productivity leading to inefficiencies in freight logistics.

Other findings revealed that transit time efficiency was negatively affected by traffic congestion leading to missed delivery schedules and late deliveries. This led to customer complaints due to business loss from downstream customers. The study also revealed that additional time was absorbed in traffic between the port and Mariakani weighbridge amounted to 5 ½ hours per truck which negatively affected transit time efficiency. This reduced the number of trips that a driver was able to make per day effectively reducing productivity and return of investment due to poor vehicle utilization. Additionally, the findings revealed that traffic congestion resulted in delayed deliveries, prolonged transit times and unreliable deliveries schedules leading to congestion of container terminals and storage yards as well as increased stock holding in the warehouses which is an indicator of inefficiency in supply chains. Other findings revealed that traffic congestion increased staff costs through overtime expenditure and reduced fuel efficiency by increasing the cost of fuel thereby reducing freight logistics efficiency through increased cost of operations. Findings on the key roads contributing to traffic congestion identified five access roads that require focus in order to reduce traffic congestion.

Key findings of study on the strength and direction of the relationship between the variables established a strong positive correlation which was done using Pearsons correlation coefficient. Finally, the findings revealed suggested strategies that can be undertaken to mitigate the traffic congestion problem affecting freight efficiency at the Port of Mombasa. These are: Road capacity and infrastructure improvement, improvement of railway infrastructure and usage to facilitate multi-modal freight systems, streamlining of the clearance process, weigh-bridge policy review and adoption of new technology to modernize port and enhance port efficiency.

5.3. Conclusions

This study aims to establish the effects of road traffic congestion on the efficiency of freight logistics: A survey of the Port of Mombasa. The study tries to answer the following questions:

1) What are the effects of costs on the efficiency of freight logistics?
2) How does the effect of reduced port congestion affect the efficiency of freight logistics?
3) What are the effects of average transit time on the efficiency of freight logistics?
4) What strategies require to be undertaken to improve the efficiency of freight logistics operations at the port of Mombasa to help overcome raod traffic congestion?

All the research questions of the study were answered in chapter 4. From the survey conducted, findings revealed that freight logistics efficiency is measured freight costs, transit times, vehicle turnaround time, and transit time efficiency.

Pursuant to the research question; “What are the effects of costs on the efficiency of freight logistics?” the study found out that costs affect freight logistics efficiency at the Port in three through three major factors: Demurrage charges, staff overtime, fuel consumption performance. The study concludes that traffic congestion increases demurrage charges, staff overtime and fuel consumption which negatively affects freight logistics efficiency.

Pursuant to research question; “How does the effect of reduced port congestion affect the efficiency of freight logistics?”The study found out that a reduction in port congestion through improved vehicle turnaround time will increase container throughput leading to timely deliveries, optimal stockholing, eliminate demurrage charges, reduce customer complains, and lost business opportunities arising from missed delivery schedules thus improving freight logistics efficiency.

From the last research question: “What are the effects of average transit time on the efficiency of freight logistics?” Thestudy revealed that transit time efficiency affects productivity, timely delivery and reliability, customer satisfaction, and vehicle turnaround time. The study concludes that traffic congestion negatively affects transit time efficiency which affects freight logistics performance.

From the research question; “What strategies require to be undertaken to improve the efficiency of freight logistics operations at the port of Mombasa to help overcome road traffic congestion?” the study found adopted the proposed strategies as recommendations to

help overcome traffic congestion. Therefore, the findings from this study have practical applications to help enhance freight logistics efficiency in the global supply chain.

5.4. Recommendations

The causes of road congestion at the port of Mombasa have been identified by the respondents who pointed out five key aspects namely: Road capacity and infrastructure improvement; modernization of railway infrastructure and usage to facilitate multi-modal freight systems; streamlining of the clearance process; weigh-bridge policy review and adoption of new technology to modernize the port and enhance port efficiency.

5.4.1. Road Capacity and Infrastructure Improvement

Road transport caters for 95% of freight in Kenya along the Northern Corridor (ADB, 2010). The Northern Corridor route links the port of Mombasa to the landlocked EAC countries of Uganda, Rwanda, Burundi, DR Congo and South Sudan. In 2010, this route accounted for 75% of 12 the total EAC trade volume (SCEA, 2013). This figure may have changed in recent times based on the independence of South Sudan and infrastructure improvements in the region. There is urgent to upscale road infrastructure development within Mombasa city targeted at easing traffic congestion and building road capacity. Construction of the DogoKundu by – pass will ease congestion at Likoni Ferry. A super highway should be constructed on the section between Changamwe and Miritini in addition to the ongoing dualing of Changamwe toMiritini initiative of decongesting the city of Mombasa.

5.4.2. Railway Transport and Use of Multi-Modal Freight System

The failure of the railway system has resulted in a large number of new truck movements in and around the port contributing to the growing problem of road traffic congestion and road deterioration. Only 5 per cent of Mombasa's freight moves on rails, a decline that has been due to the absence of sustained government investment in railways infrastructure. The Standard Gauge railway project should be expanded to link ICDs within the northern corridor. In many advanced economies, the railway is the most dependable means of evacuating cargo from the port largely due it its reliability and cost. Rail intermodal and bulk transport is major component of maritime logistics chain and forms the major mode of inland transport in countries Canada where 65% of inbound containers leave the port by rail (Heaver, 2011). Modern rail systems are more efficient with better logistics than road transportation. Any port expansion plans by KPA and RVR that leaves behind the upgrade of the railway freight systems capacity may not achieve the desired benefits for efficient freight system which is critical in any supply chain.An efficient port and a railway system complement each other. The rail system linked to ICDs clears cargo as fast as it arrives and transports exports at the same rate without competition (KSC, 2009).

5.4.3. Streamlining Freight Clearance Processes

There is need to improve the goods clearance process by implementing measures that will establish an elaborate risk management system that will remove bureaucracies, allow faster clearance for shippers and eliminate the need for physical inspection. Respondents indicated that implementation of the proposed Electronic Single Window System will improve efficiency in documentation, if embraced by all stakeholders, since documents will be lodged online and eliminate human interaction thereby minimizing corruption and reduce the process from the current 5-7 days to 2- 3 days on ship arrival.

5.4.4. Port Efficiency Improvement

Efficient port operations are critical to improving the movement of freight in and out of countries. The major factor identified in the survey affecting freight logistics efficiency was the lengthy documentation procedures which affected vehicle turnaround time. Trucks are delayed in the port by an average of 6 hours instead of spending 1 hour as per the global standard. Implementation of an integrated port system that will eliminate unnecessary procedures required at pick – up and delivery points within port should be considered. Automation of handling equipment should be complemented by targeted efforts to improve labor productivity. The poorly located Container Freight Stations along the Mombasa – Nairobi highway should be relocated to areas with vast land like Mariakani whereby they can also be linked by an efficicient railway network from the port.

5.4.5. Weighbridge Policy

The survey revealed that transit time efficiency was highly affected by the Mariakani weighbridge whereby trucks were losing 5 ½ hours daily to cover the 30 kms stretch from Mombasa. The relevant authorities should consider the option of managing axle weight limits by implementing a standards system to be complied with at the port of loading to ensure all cargo arriving at the port is within the regulated weight limits. This will eliminate the need for multiple weighbridges along the northern corridor and improve transit time efficiency.

5.5. Areas for Further Research

Further research should be undertaken in the areas of multi-modal freight logistics and interface collaboration which enables an integrated platform by different stakeholders involved in freight movement at the port. Research should also be conducted in the area of indirect and consequential costs of traffic congestion. This will require an in-depth analysis to identify the actual indirect costs incurred by freight companies and the effect to the national economy.

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