

THE IMPACT OF TRAFFIC CONGESTION ON SUPPLY CHAIN PERFORMANCE (A CASE STUDY OF BISWAL COMPANY LIMITED, KANO STATE)

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ABSTRACT

This research investigated the impact of traffic congestion on supply chain performance. The primary purpose of the study is to examine the effect of road traffic congestion on the supply chain performance of Biswal Company Limited. Specifically, the study evaluated the causes of road traffic, assessed the effect of road traffic on supply chain performance, examined the effect of road traffic on customer service and assessed the effect of road traffic on productivity. The study adopted a case study survey research design. Findings from this study reveal that the correlation between road traffic congestion and supply chain performance is significant ($r = 0.567$), indicating a robust linear relationship. The R-squared value of 0.147 suggests that 14.7% of the variation in road traffic congestion can be explained by supply chain performance. The results indicated that road traffic congestion affected supply chain performance positively and significantly ($F = 8.465$, $p = 0.005$). There is also a significant correlation between the proxies. Based on these results, appropriate recommendations were made.

Keywords: Customer Service, Productivity, Supply chain performance, Traffic Congestion

Introduction

The transportation system is an integral part of modern-day society, designed to provide efficient and economical movement between the parts of a country and offer the maximum possible mobility to all citizens (Leshem & Ritov, 2020). Transport is central to all economic activity - moving raw materials to factories, labour to worksites, inputs and outputs along supply chains, consumers to services, and products to consumers (Andrew et al., 2020). Road transport is a catalyst for urban, rural, and national development. It is a catalyst by facilitating the movements associated with urban and national development and providing the means by which goods and services are made available to industry and consumers, creating opportunities for social and economic interaction and employment. Without transport, access to these facilities would not be possible, and the services they provide would not be consumable. Transport is what gives life to development (Gunnarson, 2021; Speathing, 2019; Oni, 2021; Atubi, 2016).

In the past few decades, African cities have been experiencing substantial population increases. This is mainly due to the fast urbanization and rural exodus (International Association of Public Transport and African Association of Public Transport 2020). Such fast-growing cities face enormous challenges in terms of infrastructure provision and the need to cope with the increasing demand for transport. This is significantly shortened as much of the existing road infrastructure in African cities needs to be more appropriate for the actual transport demand. Congestion is relatively easy to recognize when roads are noticeably filled with cars, trucks, buses and sidewalks filled with pedestrians.

Congestion, both in perception and reality, impacts the movement of people and freight in most urban areas and is deeply tied to our history of high levels of accessibility and mobility (Downs, 2024). Andrew et al. (2020) defined congestion as a process that slows the flow of people and goods, making trips take longer and arrival times more uncertain. Time spent in traffic is

often a time that could otherwise be spent doing something productive for drivers, passengers, and even goods. Indeed, traffic congestion is widely viewed as a growing problem in many urban areas across the world and particular megacities like Lagos; because the overall volume of vehicular traffic in many areas (as reflected by aggregate measures of vehicle kilometres of travel) continues to grow faster than the overall capacity of the transportation system.

The resulting traffic slowdowns can have a wide range of negative effects on people and on the business economy, including impacts on air quality due to additional vehicle emissions, quality of life due to personal time delays, and business activity due to the additional costs and reduced service areas for workforce, supplier, and customer markets (Ministry of Economic Planning and Budgeting, 2023). Congestion remains the main impediments for all activities whose attainment depends on transport being public, government or individual. The resultant effect in general are losses and in special way in all aspects pertaining to social and economic sector.

Congestion in Lagos is changing from bad to worse; more importantly worsened the economy of the State. This is due to poor urban planning implementation and obsolete cities policies. Therefore, the broad impacts of delays on local supply chains of manufacturing firms have not been adequately researched in transport and logistics literature in Nigeria. Despite recent efforts to upgrade transport infrastructure, both by Federal and state government, Lagos transport infrastructure is still inadequate to satisfy the huge demand generated by its booming economy. It has been predicted that, in the absence of any major transport policy initiatives, the level of congestion will rise by 40% above the 2020 level by 2020,

120% above it by 2020 and the total volume of traffic will grow by 28% by 2021 and 60% by 2031 (Department of Environment, Transport and the Regions 2020; Alan, 2021).

In the economic context, as traffic volumes and congestion grows on highways and urban roadways, freight and delivery service operators become increasingly challenged to maintain dependable and reliable schedules. This affects supply chains and truck-dependent businesses both of which are of increasing importance for both public policy and private sector operators. There are day-to-day cost implications of delay and reliability as it affects supply chain management, and well as a longer-range need to assess opportunities, risks and returns associated with location, production and distribution decisions. Both perspectives need to be recognized when considering the full range of impacts that traffic congestion can have on the economy (Glen and Stephen 2021).

This posit that the generalized growth of traffic congestion adds to total transport costs for delivered products, causing firms to shift location and shipment size configurations to re-optimize net revenues. Meller (2020) defined supply chain management as a broad range of activities require to plan, control and execute a product's flow from acquiring raw materials and production through distribution to the final customer in the most streamlined and cost effective way. This involves demand planning, sourcing, production, inventory management, storage and logistics. While there is also a separate line of research on bottlenecks at firms, the impacts of congestion can span different supply chain configurations - including not only the movement of material and parts to producers and then to distributors, but also local distribution and delivery of finished

goods to retail markets, and even local delivery of parts and repair services to businesses and households.

Since the movement of goods is done by supply chain management of the firms, it is reasonable premises that supply chain management command the profit of the firms. This implies that supply chain management is the heart of the manufacturing firms while logistics remains the flowing blood. Therefore, supply chain management is the groundwork that supports every manufacturing firm. Nowadays companies have to deal with a business environment that puts more accents on the concept of customer-driven manufacturing. To this end this study will examine the impact of traffic congestion on supply chain performance.

Statement of the Problem

Traffic congestion represents a critical challenge impacting supply chain performance globally (Tan & Gu, 2020). As urbanization accelerates and economic activities concentrate in urban areas, the volume of goods transported through road networks has surged, leading to increased traffic congestion (Ho, Yip, & Kwan, 2016). This congestion not only results in delays in the delivery of goods but also introduces uncertainties and disruptions into supply chain operations (Aronietis, Graham, & Harker, 2020). Moreover, the impacts of traffic congestion extend beyond delays in delivery times. Congestion-induced delays can lead to higher transportation costs, as firms are forced to invest in expedited shipping methods or alternative routes to mitigate the effects of congestion (Boyaci, Gallego, & Hu, 2019).

Additionally, congestion-related disruptions can disrupt production schedules,

inventory management, and customer satisfaction, ultimately affecting the overall performance of the supply chain (Wang, Zhang, & Lu, 2021). Furthermore, traffic congestion can exacerbate environmental concerns, as idling vehicles emit pollutants that contribute to air pollution and carbon emissions (Pan, Xu, & Pan, 2021). This not only poses risks to public health but also increases regulatory pressures on firms to adopt sustainable transportation practices (Tan & Gu, 2020). Consequently, there is a pressing need to investigate the impact of traffic congestion on supply chain performance and identify strategies to mitigate its adverse effects.

Nowadays companies have to deal with a business environment that puts more accents on the concept of customer-driven manufacturing. This creates an environment where there is more emphasis on differentiated product features, tight delivery performances and low costs (Hicks, Earl, Mc Govern, 2020). As of the customer-driven emphasis it is important for the manufacturing firm to consistently produce high quality products with competitive unit costs and high service levels (i.e. on time deliveries) (Ebadian, Rabbani, Torabi & Jolai, 2019). Revelle (2021) confirms this by stating that the three major features of the make-to-order (MTO) process are quality, cost and delivery. Delivery time is the fundamental order-winning criterion. Supply chain management has received substantial attention from both researchers and practitioners, yet in many companies' management is struggling to implement supply chain processes within their firms as well as across the supply chain. Order fulfillment is a key process in managing the supply chain. It is the customers' orders that

put the supply chain in motion, and filling them efficiently and effectively is the first step in providing customer service.

However, the order fulfillment process involves more than just filling orders. It is about designing a network and a process that permits a firm to meet customer requests while minimizing the total delivered cost (Keely, 2023). Hindrance to effective movement of goods and service in Kumasi to meet consumers need and order fulfillment at appropriate time by the logistics of supply chain management is road traffic congestion, which the World Bank (1999) stated that it constitutes about 54.5% of all noticeable urban transport externalities. Road traffic affect businesses in various ways including; productivity, customer service satisfaction and delivery, securing of raw materials timely among others. This study will observe the trend of traffic growth with a view to examine its effects on delivery of goods and services along supply chain performance of the Biswal Company Limited, Kano State. The questions arising from the for which this study intended to answers include What are the causes of road traffic? To what extent does road traffic congestion affect the supply chain performance Biswal Company Limited, Kano State? To what extent does road traffic congestion affect customer service of Biswal Company Limited, Kano State? And To what extent does road traffic congestion affect productivity of Biswal Company Limited, Kano State?

1.3 Research Objectives

The main purpose of the study is to examine the effect of road traffic congestion on supply chain performance of Biswal Company Limited. Specifically, the study seeks to:

- i. Identify the causes of road traffic;

- ii. Assess the effect of road traffic on supply chain performance:
- iii. Examine the effect of road traffic on customer service:
- iv. Assess the effect of road traffic on productivity:

1.4 Hypothesis

H01: Road traffic congestion does not affect the supply chain performance

H02: Road traffic does not have a significant effect on customer service

H03: Traffic congestion does not significantly affect the productivity

Scope and Significance of the Study

This research investigated the impact of traffic congestion on supply chain performance a case study of Biswal Company Limited The road traffic productivity, customer service. By advocating for policy interventions aimed at reducing congestion, such as investments in public transportation, implementation of congestion pricing schemes, and deployment of intelligent transportation systems, this study can contribute to the development of more efficient and sustainable urban transportation networks.

LITERATURE REVIEW

Concept Review

Transport Congestion

Traffic congestion has been defined as “a condition of traffic delay (i.e., when traffic flow is slowed below reasonable speeds) because the number of vehicles trying to use a road exceeds the design capacity of the traffic network to handle it.” (Weisbrod, Vary and Treyz 2021). Most transportation literature and transportation impact models treat congestion as a cost factor, comprised of time delay and operating expense (Cambridge Systematics,

2021; Short, Trego & White 2020). However, a premium is often added in recognition of the variability aspect of congestion delay that is masked by focusing just on average delay statistics. Indeed, there is also a growing base of research on freight logistics and time-sensitive delivery which attempts to estimate the magnitude of cost premium associated with travel time reliability and the avoidance of delay for this class of travel (Rao & Grenoble, 2021; Small, Chu & Noland 2020; Cohen & Southworth, 2019; Grant-Muller & Laird, 2016).

Another line of transportation research has highlighted the business productivity impact of growing traffic congestion. A US study laid out a framework for defining congestion and then viewing the ways in which it can affect regional economic competitiveness and growth by nullifying some of the agglomeration benefits (returns to scale) associated with operating a business in larger urban markets (Weisbrod et al, 2021, 2023). More recent work in the UK has shown how urban road traffic congestion, by constraining the benefits of agglomeration, can serve to reduce achievable levels of productivity in congested urban areas (Graham, 2020).

However, all of these studies focused at a general level when discussing productivity and accessibility, and none of them investigated the “micro-level” mechanisms by which businesses actually see their productivity eroded by traffic congestion. Increased congestion can require various adaptations for businesses. Although adaptations are made, they are not costless. Contributions to the literature on the business costs of congestion point to several components of these costs, including

(Weisbrod et al. 2021). Congestion interrupts the advantages that businesses obtain in urban centres from the ‘agglomeration’ of buyers and suppliers of goods and services (Ciccone and Hall 2016). The commercial response to excess congestion in the centre of a city for some businesses is to relocate to the periphery.

Those businesses reduce their costs, but they also break down networks of businesses that provided benefits to all of the participants in the network. Businesses will respond to congestion by adjusting their operations to minimise production costs. Businesses might adjust to congestion by moving away, or through adjusting their inventory management. In more severe cases, businesses might be unable to adjust and would go out of business. A recent survey of businesses in Portland in the US prepared by David (2020), 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; 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 specialised labour and materials.

The NCHRP report boils down a wide range of issues to three types of direct cost categories from traffic congestion for business: direct travel costs of all business-related travel, including vehicle operating expenses and the value of time for drivers (and passengers); logistics and scheduling costs, including effects on inventory costs such as stocking, perishability and just-in-time (JIT) processing; and reduction in

market areas for workers, customers and incoming/outgoing deliveries. Stank and Goldsby (2020) note that JIT production techniques have led to demand for faster, more frequent and more reliable supply of inputs. Extra transport costs are preferred to carrying inventory (Sankaran, Gore and Coldwell 2020).

A paper by Shirley and Winston (2024a) examined how highway infrastructure investment, which essentially decreases congestion costs, generate benefits by lowering firms' inventories. Shirley and Winston (2024b) also examine the cost of highway congestion on firms' inventories. They estimate the highway cost of congestion on inventory and logistic costs is US\$7 billion, with the costs of congestion to shippers accounting for nearly 25 per cent of total motorists and shippers congestion costs. Most of the existing research literature on economic costs of urban traffic congestion is at a very broad-brush level, demonstrating that increased congestion can affect business productivity by increasing operating costs and reducing the size of market areas served from any given business location. However, there is little information beyond that level to explain the ways in which congestion affects different types of freight movement, different types of businesses, or the ways in which businesses can respond to those conditions. These issues and their economic consequences can only be addressed through more detailed micro-level analysis of business processes and business decision-making (Glen and Stephen, 2021).

Causes of Congestion

The transport system, including the provision of urban land for transport infrastructure, operates with very special

characteristics, including in particular the following:

- The demand for transport is "derived": in other words, journeys are rarely made because of an intrinsic desire to travel but are generally due to the need to travel to the places where various kinds of activities are carried on, such as work, shopping, studies, recreation, relaxation, etc., all of which take place in different locations.
- The demand for transport is eminently variable and has very marked peak periods in which a large number of journeys are concentrated because of the desire to make the best use of the hours of the day to carry on the various types of activities and have an opportunity to make contact with other persons.
- Transport takes place in limited road spaces, which are fixed and invariable in the short term; as will readily be understood, it is not possible to store up unused road capacity for later use at times of greater demand.
- The forms of transport which have the most desirable characteristics - security, comfort, reliability, and autonomy, as in the case of private cars - are those which use the most road space per passenger, as will be explained below.
- Especially in urban areas, the provision of road infrastructure to satisfy rush hour demand is extremely costly.

- Because of the above factors, congestion occurs at various points, with all its negative consequences of pollution, heavy expenditure of private and social resources, and adverse effects on the quality of life.

A further aggravating factor is that, as noted in the previous section, the cost of congestion is not fully perceived by the users who help to generate it. Every time this happens, more of the good or service in question is consumed than is desirable for society as a whole. As users are not aware of the greater costs in terms of time and operation that they cause to others, their decisions on routes, forms of transport, points of origin and destination and time of execution of journeys are not taken on the basis of the social costs involved, but their own personal costs or, rather, an often partial perception of those costs. The natural result is the over-exploitation of the existing road system, at least in certain areas and at certain times.

The state of the roads and driving habits

Faulty design or maintenance of road systems causes unnecessary congestion. In many cities there are frequent cases of failure to mark traffic lanes, unexpected changes in the number of lanes, bus stops located precisely where the road width becomes narrower, and other shortcomings which disturb a smooth traffic flow. Likewise, road surfaces in bad condition, and especially the presence of potholes, give rise to increasing constraints on road capacity and increase congestion. In many Latin American cities, such as Caracas, the accumulation of rainwater on roads reduces

their traffic capacity and hence increases congestion.

Some driving habits cause more congestion than others

There are drivers who show little respect for other road users. In some cities, such as Lima, many drivers try to cut a few seconds off their journey times by forcing their way into intersections and blocking the passage of other motorists, thus causing economic losses to others which are much greater than their own gains. In other cities, such as Santiago, it is a tradition for buses to stop immediately before an intersection, thereby causing congestion (and accidents). In those same cities, as in others that have an excessive number of taxis that do not habitually operate from fixed taxi ranks, these vehicles crawl along looking for passengers, and this also gives rise to congestion.

In addition to these practices, the traffic flows also often include old and poorly maintained vehicles, as well as some drawn by animals. It must be borne in mind that when the traffic flow resumes after being stopped at a traffic light, a form of congestion ensues because vehicles with a normal rate of acceleration are held up by slower vehicles located in front of them. Furthermore, a vehicle which is stopped or moving sluggishly seriously affects the smooth flow of traffic, since in effect it blocks a traffic lane.

Insufficient information availability on traffic conditions

Another factor which increases congestion is ignorance of the prevailing traffic conditions. If a motorist with two possible routes, A and B, for reaching his destination knew that traffic conditions were

bad on route A, he could use route B, where his own contribution to congestion would be less. A study of a hypothetical city made in the University of Texas in the United States indicates that the fact of being well informed about traffic conditions in different parts of the road network can reduce congestion much more than such drastic measures as levying charges for using congested streets (IMT, 2020). Basic unfamiliarity with the road system can also increase the average distance of each journey and thereby contribute to congestion.

Types of Congestion

The three types of congestion are outlined by Brownfield et al (2023) as recurrent congestion, non-recurrent congestion and the pre-congestion state, as shown in Table 1 below. These types are based upon the frequency and predictability of the congestion - factors which will impact on driver behaviour. The costs associated

with each type of congestion are likely to be different. Non-recurrent congestion costs may be more difficult to quantify due to the inherent sparseness of adequate amounts of data needed - it may be argued that the costs could be higher as drivers have not been able to take the possibility of congestion into account in planning their journey or alternatively the costs may be less dramatic as drivers pre-developed strategies for coping with congestion will not have come into play.

Some routes are increasingly subject to non-recurrent congestion however, for example with accident black spots. In these cases drivers may 'learn' an expected cost in terms of likely delay and successful contingency routes. The Pre-congestion state will carry some costs similar to those of congestion, including loss of control over drivers' environment, deterioration in the environment and other impacts.

Table 1: Type of Congestion

Congestion Type	Definition
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 events 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.

Source; Adapted from Brownfield, (2023)

The increase in traffic congestion is more than a time-wasting nuisance to freight movers. High levels of traffic congestion have been found to reduce the number of trip a truck driver can make in a day and therefore increase shipment costs, which

impacts the competitiveness of metropolitan manufacturers and other businesses.

Supply Chain

A separate line of research studies on supply chain behavior have used systems dynamics models to show how traffic

congestion can change the optimal decisions of producers, distributors and retailers along a supply chain. The most basic impact is that congestion delay and uncertainty increases requirements for (and hence costs of) product inventory (Disney, Naim and Towill 2020; Mason-Jones, Namim, & Towill 2020). That, in turn, can affect supply chain behavior by encouraging shipment of smaller lot sizes to reduce cost risk (Moinzadeh, Klastorin, & Emre., 2020). More recent research has extended this beyond delivery lot size, to also affect delivery frequency, spread of deliveries over time of day, and also total trips made per day (Sankaran & Wood, 2020).

Surveys of corporate managers confirm that there is a range of ways in which traffic congestion can affect delivery decisions for retail (Ferne, Pfab, & Regan, 2020) and trucking industries (Golob & Regan, 2023). Simulation modeling has also been used to show how traffic congestion can lead to fluctuations along a supply chain, as retailers adjust their inventory which in turn “reverberates upstream” via a “bullwhip” effect on inventory requirements for distributors and suppliers (Lee, Padmanabhan & Whang, 2020). However, since significant congestion delays may occur on a non-predictable basis, the optimal responses of affected parties may critically depend on both where they are in the supply chain and the probability of occurrence (Wilson, 2021).

In the longer run, firms may also change their location decisions to minimize congestion impacts (Geunes & Konur, 2019). Yet most of these studies are based on simulations, and there has been relatively little attention to the question of how business decisions regarding location,

scheduling, and deployment of vehicles and labor resources can also contribute to congestion or be used to minimize the effects of rising traffic congestion. Supply chain management has received substantial attention from both researchers and practitioners, yet in many companies’ management is struggling to implement supply chain processes within their firms as well as across the supply chain. Supply Chain Management is the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders (Lambert, Douglas, Martha and Janus 2021).

The order fulfillment process needs to be designed around the customer, but within the limits of the firm’s business and marketing strategy. At the operational level, order fulfillment is very transactional. It is focused on managing the customer order cycle and the specific activities are executed primarily within the logistics function. In fact, a customer order is said to serve “as the communications message that sets the logistics process in motion” (Stock and Douglas 2021). Order fulfilment cycle (OFC) comprises the process in receiving, processing and delivering a customer order. It refers to all the steps companies must take from the moment they receive an order until the goods land in customers’ hands.

There are many types of order fulfilment options such as Engineer- to-Order where the product is completely build and designed to customer specifications, or Assemble-to-Order where the product is built to customer specifications from an inventory of existing materials, and finally to Make-to-Stock (MTS) where the product is built against a sales forecast, and sold to the

customer from an inventory of finished goods (Orrigo, 2020). Production must be aware what needs to be produced and when, and distribution needs to know when the goods must be transported from the production to the warehouse or distribution centre. When there is lack of communication within the supply chain, the replenishing of stock is likely to fail. Production can produce products in wrong order or distribution could transport wrong goods.

This again will cause out of stock situations and the customers' orders cannot be fully fulfilled in time (Meller, 2020). If the company is able to provide order fulfilment cycle in a way that satisfies the customer, it will create value for the customer. When a satisfactory OFC is combined with good product(s) and/or service(s), company's market position will be strong. Fast fulfilment will help the company to retain their current customers, and even open doors for new customers who are speed sensitive. Faster order processing and later order cut-off times also gives more time for the company to transport the goods. By using more time on transportation, company will be able to realize even larger geographic reach (Muzumdar and Zinzuwadia, 2020).

When company is able to process the orders quickly, they do not need to keep high levels of inventory as a safety stock. Goods needed for the order will stay shorter time in their distribution center since the order processing requires less time. This again will reduce the total inventory and create significant savings within the supply chain. Company is able to utilize the space better as there is no need to store the goods in shelves like before.

This free space can be used for other needs or even totally new products. (Meller, 2020). There are many different processes within the supply chain such as

manufacturing, warehousing, transportation, planning etc. which can be optimized organization of all sizes and across all industries can achieve significant by making their supply chain cost efficient (O'Byrne, 2021). For the organization to be able to gain the best possible knowledge and really utilize business intelligence for its benefits, it needs to pay attention and analyze each the logistics part of the firms supply chain in the study area, there is need to study the nature of congestion in Lagos state and possible way to meet consumer's demand.

Theoretical Review

Several theories explain the impact of traffic congestion on supply chain performance. One prominent theory is the Theory of Constraints (TOC), originally proposed by Eliyahu M. Goldratt. TOC emphasizes identifying and managing constraints within a system to improve overall performance. In the context of traffic congestion and supply chains, TOC provide valuable insights:

- **Identification of Bottlenecks:** Traffic congestion acts as a bottleneck within the transportation network, limiting the flow of goods between supply chain nodes such as suppliers, manufacturers, warehouses, and customers. TOC advocates for identifying and addressing these bottlenecks to optimize the flow of materials and products through the supply chain.
- **Buffer Management:** TOC suggests the use of buffers to protect against variability and uncertainty. In the case of traffic congestion, buffers can take various forms, such as safety stock, flexible production capacity, or alternative transportation routes. By strategically managing buffers, supply

chain managers can mitigate the negative impact of congestion on lead times and customer service levels.

- **Exploiting and Subordinating to the Constraint:** TOC encourages organizations to exploit the constraint by maximizing its throughput and subordinating all other activities to the constraint's rhythm. In the context of traffic congestion, this could involve optimizing transportation schedules, prioritizing high-value shipments, or leveraging real-time traffic data to adapt delivery routes dynamically.
- **Elevating the Constraint:** TOC suggests that if the constraint cannot be sufficiently mitigated, efforts should be made to elevate or remove it altogether. In the context of traffic congestion, this may involve lobbying for infrastructure improvements, advocating for better urban planning, or investing in alternative transportation modes that are less susceptible to congestion.
- **System Thinking:** TOC promotes a holistic view of systems, recognizing that changes in one part of the system can have ripple effects throughout the entire supply chain. Therefore, addressing traffic congestion requires considering its systemic impact on inventory levels, production schedules, distribution networks, and customer service.

By applying the principles of TOC, supply chain managers can develop strategies to

Table 1: Population definition

better manage the impact of traffic congestion on supply chain performance, ultimately improving efficiency, reducing costs, and enhancing customer satisfaction. Additionally, TOC provides a framework for prioritizing investments and interventions to address congestion-related challenges systematically.

Methodology

Research Design

The research design adopted in this study is correlational in order to ascertain the extent of the relationship among the dependent and independent variable. Regression is employed in the study to forecast relationship between variables and estimate the influence of each explanatory variable to the dependent variable. The use of existing documents of data (secondary sources of data) also provides opportunities for comparing of independent views on the subject matter so as to come out with objectives and realistic conclusions. The use of existing documents becomes imperative in this research work because of the vast areas it covers. In the view of Chandra (2024), research design brings out the features of a population in full. The study will adopt a descriptive survey method of research design. Questionnaires will be distributed to the staffs of the Bayero University Kano.

Population of the Study

Population can be defined as a group of individuals or items that share one or more characteristics from which data can be gathered and analysed. The population for this study is Biswal Limited. Biswal Limited has a total population of One hundred and sixteen (116) staff members in Kano region.

S/N	Attributes	Numbers
1	Regional Manager	1
2	Regional Maintenance Planner	1
3	Regional Mechatronics	1
4	Regional Supervisor	2
5	Regional Human Resource Supervisor	1
6	Regional Accountant	1
8	Regional Warehouse Supervisor	1
9	Regional Community Relations & Security Officer	1
10	Team leads	26
11	Team Supports	31
12	Driver and janitor	39
13	AC Technicians	2
14	NOC	2
15	Riggers	4
16	RMS installers	3

Source: Researcher's Field Survey (2024)

Sample Size and Sampling Techniques

A sample is a subset of a population that is used to represent the entire group as a whole. The sample size will be Thirty-three persons who make up the main team that handle asset in Kano region. Thirty-three (33) questionnaires will be administered to various staff in Kano region who deal directly with supplies of goods to customers. Probability sampling is based on the fact that every member of a **population** has a known and equal chance of being selected. The appropriate sampling technique that will be adopted for this study will be the stratified

random sample under the probability sampling. This technique is adopted because the respondents are all in maintenance department of the company and they all maintain and manage asset on site.

Sources of Data

The content analysis technique here serves as the basic secondary method of data collection which will be used to supplement information obtainable through survey methods. This is otherwise known as documentary analysis in which relevant literature such as published articles,

Newsletters, Newspapers, Books, Magazines, and Journals etc will be reviewed. The advantage of this method is that the data collected are usually available in designated places. On the other hand, the primary source within the context of this research refers to the data generated from survey using the instrumentality of questionnaire administration and interviews where applicable.

Method of Data Collection

The data collection methods that will be used for this research work is mainly primary and secondary data. The primary data for this study will be collected from Biswal Limited, Kano. The primary source will involve the use of questionnaires and personal interviews. The Human Resource Personnel of Biswal Limited will be consulted and an official letter presented to seek permission to administer questions and conduct personal interviews. The secondary data will involve the use of various literary works on road traffic congestion and telecommunication industry and also from the internet.

Method of Data Analysis

The collected questionnaires will be comprehensively examined, checked for completeness. The questionnaires will be then coded and entered into the Statistical Package for Social Sciences (SPSS), because it helps in organizing and summarizing the data to provide important parameters, which will be useful for the data analysis. Several statistical tools were employed in analyzing the results, including tables,

percentages, Pearson correlation and regression analysis. The calculated p-value (significant value) is compared with the level of significance which is usually at 10%, 5% and 1%. Where the p-value is higher than 10% it means that they are not significant; meaning that there is no difference between the variables compared. Therefore, the null hypothesis is accepted and the alternative hypothesis is rejected. But where the p-value is at 10% or lower, it means they are significant and the null hypothesis is rejected while the alternate hypothesis is accepted.

Model Specification and Variable Measurements

In trying to assess the impact of traffic congestion on supply chain performance, the following model has been used:

$$SCP = \theta_0 + \theta_1 CA + \theta_2 CE + \theta_3 CX + \mu \quad (1)$$

where

SCP = chain performance

θ_0 = Constant parameter

$\theta_1 \theta_3$ = Coefficients of independent variables

CA = the cost of Causes of road congestion

CE = the cost of effect of road traffic

μ = Error term

RESULTS AND DISCUSSION

Presentation of Data

A total of 33 copies of the questionnaire were distributed, 27 copies of the questionnaire were returned. This indicates 82% response rate.

Table 2: Analysis of Response Rate

Questionnaire	Respondents	Percentage (%)
Returned	27	82

Not Returned	6	
Total Distributed	33	100

Source: Researcher's Field Survey (2024)

Return Rate

$$\frac{\text{Number of question got back}}{\text{Number of question sent out}} \times 100$$

$$\frac{27}{33} \times 100 = 82\%$$

Demographic Characteristics

The table above represents the gender of respondents of BISWAL Limited. The above table shows that 27 respondents representing 100% are males, this implies that all the respondents are males. The age range of the staff at Biswal Limited. 4

respondents representing 14.8% of staff are between the ages of 20 to 30 years. 10 respondents, representing 37% of staff belong to the age range of 31 to 40. 11 respondents representing 40.7% of staff are between the ages of 41 to 50 years. 2 respondents, representing 7.5% of staffs belong to the age range of 51 and above. The educational qualification of the staff shows that, 18.5% of the respondents are primary school holders, 25% of the staffs are secondary school holders, 29.6% are diploma holders, 14.9% of the respondents are degree holder and lastly 11.1% of the respondents are post graduates.

Table: Respondent profile

Gender	Frequency	Percentage	Cumulative Percent
Male	27	100.0	100.0
Female	0	0.0	100.0
Total	27	100.0	
Age			
20 – 30	4	14.8	14.8
31 – 40	10	37.0	51.8
41 – 50	11	40.7	92.5
51+	2	7.5	100
Total	27	100.0	
Educational quafications			
Primary	5	18.5	18.5
Secondary	7	25.9	44.4
Diploma	8	29.6	74.0

Degree	4	14.9	88.9
Post graduate	3	11.1	100
Total	27	100	

Source: Researcher's Field Survey (2024)

Section B

Table 3: Effect of road traffic congestion affect the supply chain performance

Supply Chain Performance

Questions	Road Traffic Congestion				
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Inventory levels need to be adjusted frequently to account for delays caused by traffic congestion.	.969**	.373**	.913**	.919**	.984**
Traffic congestion affects the overall efficiency of our supply chain processes.	.759**	.312**	.683**	.717**	.782**
Customer satisfaction is negatively impacted by delays in product deliveries due to traffic congestion.	.773**	.309**	.697**	.219**	.793**
Our company has implemented effective measures to mitigate the impact of traffic congestion on supply chain performance.	.327**	.855**	.866**		.930**

**** Statistically Significant (P < 0.05)**

Source: Researcher's Field Survey (2024)

The table provided outlines the perceived impact of road traffic congestion on the supply chain performance of Biswal Company Limited in Kano State. There is a strong positive correlation (all above .9) across all responses, indicating that respondents overwhelmingly believe inventory levels need frequent adjustments due to traffic congestion. Even those who

disagree still show a strong correlation, suggesting that traffic congestion's impact on inventory management is a widely acknowledged issue. The correlations indicate that a majority of respondents (Strongly Agree and Agree) perceive that traffic congestion significantly affects supply chain efficiency. The lower correlation for Agree (.312**) suggests some variability in

perception, but overall, the impact is recognized as significant. There is a strong agreement (Strongly Agree and Strongly Disagree) that traffic congestion negatively impacts customer satisfaction.

The lower correlations for Agree and Disagree suggest some differing opinions, but the overall trend supports the negative impact. The high correlations (especially Strongly Agree and Strongly Disagree) indicate that respondents believe the company has implemented effective measures to mitigate traffic congestion's

impact on the supply chain. Even those who disagree or are undecided still show strong correlations, suggesting recognition of these efforts. Overall, traffic congestion is a critical issue affecting the supply chain performance of Biswal Company Limited, with strong evidence of its impact on inventory management, operational efficiency, and customer satisfaction. The company has implemented measures to mitigate these effects, which are generally recognized as effective by the respondents.

Table 4: Effect of Road traffic congestion on customer service

Questions	Road Traffic Congestion				
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Road traffic congestion leads to delays in product deliveries, negatively impacting customer satisfaction.	.708**	.241**	.614**	.656**	.212**
Frequent traffic congestion hampers our ability to meet customer delivery time expectations.	.457**	.402**	.578**	.468**	.442**
Customer complaints regarding late deliveries have increased due to road traffic congestion.	.603**	.310**	.595**	.573**	.631**
Traffic congestion affects our ability to provide timely customer support and service.	.815**	.491**	.879**	.705**	.773**
The reliability of our customer service operations is compromised due to unpredictable traffic conditions.	.455**	.385**	.831**	.742**	.813**

**** Statistically Significant ($P < 0.05$)**

Source: Researcher's Field Survey (2024)

The table above provided outlines the perceived impact of road traffic congestion on customer service at Biswal Company

Limited in Kano State. The strongest correlation (.708**) is among those who strongly agree that traffic congestion leads

to delays in product deliveries, negatively impacting customer satisfaction. The correlations for Agree and Strongly Disagree are lower, suggesting that while most see a negative impact, some variability exists in the perception of its severity. The correlations indicate that frequent traffic congestion hampers the company's ability to meet customer delivery time expectations. The agreement is moderate across all categories, reflecting a consistent but not overwhelming recognition of this issue. The correlation coefficients suggest that most respondents agree that customer complaints regarding late deliveries have increased due to traffic congestion, with a relatively strong

agreement among those who strongly disagree (.631**), indicating this issue is widely acknowledged. The highest correlations (.815** for Strongly Agree and .879** for Undecided) suggest a strong consensus that traffic congestion affects the ability to provide timely customer support and service. This is a significant concern, as indicated by high agreement levels across all categories. There is a notable agreement that the reliability of customer service operations is compromised due to unpredictable traffic conditions, with strong correlations particularly for Undecided (.831**), Disagree (.742**), and Strongly Disagree (.813**).

Table 5: Effect of road traffic congestion on productivity

Productivity	Road Traffic Congestion				
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Road traffic congestion leads to significant delays in employee arrival times, reducing overall productivity.	.963**	.336**	.885**	.917**	.977**
Frequent traffic congestion results in extended travel times for deliveries, affecting operational efficiency.	.961**	.324**	.877**	.916**	.978**
Traffic congestion increases operational costs due to lost time and fuel expenses, impacting productivity.	.969**	.373**	.913**	.919**	.984**
The unpredictability of traffic conditions leads to inconsistent workflow and productivity disruptions.	.824**	.345**	.945**	.925**	.932**
Employee stress and fatigue caused by long commutes due to traffic congestion negatively affect productivity.	.918**	.352**	.817**	.756**	.843**

**** Statistically Significant ($P < 0.05$)**

Source: Researcher's Field Survey (2024)

The table highlights the impact of road traffic congestion on the productivity of Biswal Company Limited in Kano State. There is a very strong consensus, especially among those who strongly agree (.963**) and strongly disagree (.977**), that road traffic congestion leads to significant delays in employee arrival times, thereby reducing overall productivity. This suggests that most respondents recognize the negative impact of traffic congestion on employee punctuality and productivity. The high correlations for strongly agree (.961**) and strongly disagree (.978**) indicate a strong belief that frequent traffic congestion results in extended travel times for deliveries, affecting operational efficiency. The relatively lower correlation for agree (.324**) suggests some variability in perception, but the overall agreement is strong.

The high correlations across all categories, especially strongly agree (.969**) and strongly disagree (.984**), suggest that respondents widely recognize that traffic congestion increases operational costs due to lost time and fuel expenses, impacting productivity. The high correlations for undecided (.945**), disagree (.925**), and strongly disagree (.932**) indicate a broad

acknowledgment that the unpredictability of traffic conditions leads to inconsistent workflow and productivity disruptions. This suggests that traffic congestion is a significant source of operational inconsistency. The high correlations for strongly agree (.918**) and strongly disagree (.843**) indicate a strong consensus that employee stress and fatigue caused by long commutes due to traffic congestion negatively affect productivity. Even the undecided group shows a relatively high correlation (.817**), indicating that this issue is widely acknowledged. The analysis of Table 4.8 reveals that road traffic congestion poses a substantial challenge to productivity at Biswal Company Limited. It affects employee punctuality, delivery times, operational costs, workflow consistency, and employee well-being. The data underscores the need for effective strategies to mitigate the impact of traffic congestion, ensuring that productivity levels are maintained and operational efficiency is optimized.

4.3 Test of Hypotheses

Hypothesis 1

H₀: Road traffic congestion does not affect the supply chain performance Biswal Company Limited, Kano State.

Table 6: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.384 ^a	.147	.130	.80050

a. Predictors: (Constant), Supply chain performance

The correlation between Supply chain performance and Road traffic congestion is (0.567), meaning that supply chain performance and road traffic congestion are

strongly and linearly correlated. While R squared is (0.147) meaning that (14.7%) of road traffic congestion could be explained by supply chain performance, by the

respondent. The significance level below 0.01 implies a statistical confidence of above 99%. This implies that supply chain performance affects road traffic congestion of Biswal Limited. Thus, the decision would be to reject the null hypothesis (H_0), and accept the alternative hypothesis (H_A). Reject the null hypothesis (H_0) and accept the

alternative hypothesis (H_A) that road traffic congestion affects the supply chain performance of Biswal Company Limited.

Hypotheses 2

H_0 – Road traffic does not have a significant effect on customer service of Biswal Company Limited.

Table 7: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.644 ^a	.414	.402	.68131

a. Predictors: (Constant), Road traffic congestion

The correlation between customer service and road traffic congestion is 0.644, meaning road traffic congestion and customer service are strongly and linearly correlated. While R squared is 0.414 meaning that 41.4% of road traffic congestion could be explained by customer service by the respondent. The significance level below 0.01 implies a statistical confidence of above 99%. This

implies that greater proportion of road traffic congestion is as a result of effective customer service. Thus, the decision would be to reject the null hypothesis (H_0), and accept the alternative hypothesis (H_A).

Hypothesis 3

H_0 – Traffic congestion does not significantly affect the productivity of Biswal

Table 8: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.437 ^a	.191	.174	.90255

a. Predictors: (Constant), Road traffic congestion

The correlation between road traffic congestion and productivity is 0.437, meaning that traffic congestion and productivity is not strongly and linearly correlated. The significance level below 0.01 implies a statistical confidence of above 99%. This implies that road traffic congestion on productivity have significant relationship. Reject the null hypothesis (H_0) and accept the alternative hypothesis (H_A) that road traffic has a significant effect on customer service.

4.5 Discussion of Findings

The mean for road traffic congestion is 4.1961 with a standard deviation of 0.82510, and the mean for supply chain performance is 3.9412 with a standard deviation of 0.85818. This indicates a high level of agreement among respondents about the impact of traffic congestion. The correlation (R) between supply chain performance and road traffic congestion is 0.384, and the R-squared value is 0.147, meaning that 14.7% of the variance in road

traffic congestion can be explained by supply chain performance. Although this is a modest proportion, it is statistically significant. The F-calculated value is 8.465 with a significance level of 0.005, indicating that supply chain performance significantly contributes to road traffic congestion. The significant statistical evidence ($F = 8.465$, $p < 0.01$) indicates that road traffic congestion does affect the supply chain performance of Biswal Company Limited. Therefore, the null hypothesis is rejected in favor of the alternative hypothesis.

The mean for customer service is 4.1176 with a standard deviation of 0.68256, and the mean for road traffic congestion is 3.9412 with a standard deviation of 0.88118. This suggests a high level of agreement among respondents regarding the impact of traffic congestion on customer service. The correlation (R) between customer service and road traffic congestion is 0.644, and the R-squared value is 0.414, meaning that 41.4% of the variance in customer service can be explained by road traffic congestion. The F-calculated value is 34.638 with a significance level of 0.0001, indicating that road traffic congestion significantly affects customer service. The statistical evidence ($F = 34.638$, $p < 0.01$) shows that road traffic congestion has a significant effect on customer service at Biswal Company Limited. Hence, the null hypothesis is rejected in favor of the alternative hypothesis.

The mean for road traffic congestion is 3.6667 with a standard deviation of 0.99331, and the mean for productivity is 4.0784 with a standard deviation of 0.89091. This shows a moderate level of agreement among respondents regarding the impact of traffic congestion on productivity. The correlation (R) between road traffic congestion and productivity is 0.437, and the R-squared value is 0.191, meaning that

19.1% of the variance in productivity can be explained by road traffic congestion. The F-calculated value is 11.562 with a significance level of 0.0001, indicating that road traffic congestion significantly affects productivity. The statistical evidence ($F = 11.562$, $p < 0.01$) suggests that traffic congestion significantly affects the productivity of Biswal Company Limited. Therefore, the null hypothesis is rejected in favor of the alternative hypothesis.

Impact on Supply Chain Performance: Road traffic congestion has a statistically significant impact on the supply chain performance of Biswal Company Limited. The correlation indicates a moderate relationship, but the significance implies that traffic congestion is a notable factor affecting supply chain efficiency and reliability. **Impact on Customer Service:** Traffic congestion significantly affects customer service, with a strong correlation indicating that congestion leads to delays and increased customer complaints. This relationship suggests that effective management of traffic-related issues is crucial for maintaining high levels of customer satisfaction. **Impact on Productivity:** Traffic congestion significantly impacts productivity, affecting employee punctuality, operational efficiency, and overall workflow.

The correlation is moderate but statistically significant, emphasizing the need for strategies to mitigate congestion-related disruptions to maintain productivity. The hypotheses testing reveals that road traffic congestion significantly impacts supply chain performance, customer service, and productivity at Biswal Company Limited in Kano State. These findings underscore the critical need for effective traffic management and operational strategies to mitigate the adverse effects of congestion on

business performance. Addressing these issues can lead to improved efficiency, better customer satisfaction, and enhanced productivity, contributing to the overall success of the company.

Conclusion and Recommendations

Summary of Findings

This chapter of this research gives an overview of the whole research work as this starts with the summary of the work from the first chapter to the last chapter, the findings that are to be looked at from the theoretical and the empirical point of view, the conclusion of this research work, recommendations that were proffered by the researcher as a way by which more research have a benchmark or point of reference after this research work as to what is expected from them. The study examined road traffic congestion amongst supply chain in Nigeria, using Biswal Limited as the case study.

Conclusion

Based on the analysis, the researcher draws the following conclusions about the impact of road traffic congestion on various aspects of Biswal Company Limited's performance: The correlation between road traffic congestion and supply chain performance is significant ($r = 0.567$), indicating a strong linear relationship. The R-squared value of 0.147 suggests that 14.7% of the variation in road traffic congestion can be explained by supply chain performance. The ANOVA results ($F = 8.465$, $p = 0.005$) indicate that the model is statistically significant, leading to the rejection of the null hypothesis (H_0). Therefore, road traffic congestion significantly affects supply chain performance. There is a significant correlation between road traffic congestion

and customer service ($r = 0.644$), indicating a strong linear relationship.

The R-squared value of 0.414 implies that 41.4% of the variation in road traffic congestion can be explained by customer service. The ANOVA results ($F = 34.638$, $p < 0.001$) show that the model is statistically significant. This leads to the rejection of the null hypothesis (H_0), indicating that road traffic congestion significantly affects customer service. The correlation between road traffic congestion and productivity is moderate ($r = 0.437$), indicating a moderate linear relationship. The R-squared value of 0.191 suggests that 19.1% of the variation in road traffic congestion can be explained by productivity. The ANOVA results ($F = 11.562$, $p < 0.001$) indicate that the model is statistically significant. Therefore, the null hypothesis (H_0) is rejected, and we conclude that road traffic congestion significantly affects productivity.

Recommendation

Based on the findings, the following recommendations can be made to improve the performance of Biswal Company Limited in the context of road traffic congestion:

- i. Work with local authorities to develop and implement better traffic management strategies, including optimizing traffic light timing, creating dedicated lanes for freight transport, and improving road infrastructure.
- ii. Implement flexible working hours or remote working options to reduce the impact of peak traffic congestion times on employees and supply chain activities.
- iii. Utilize route optimization software to identify the most efficient routes for

delivery and transportation, minimizing delays caused by traffic congestion.

- iv. Invest in advanced supply chain management and logistics technologies that can help predict and mitigate the impact of traffic congestion on operations.
- v. Improve communication with customers regarding expected delivery times and potential delays due to traffic, which can enhance customer satisfaction and service quality.
- vi. Provide training for employees on efficient time and resource management to mitigate the effects of traffic congestion on productivity.

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