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TRANSPORT OPTIMIZATION AND PERFORMANCE OF DISTRIBUTION FIRMS IN NAIROBI CITY COUNTY, KENYA

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ABSTRACT

Transport costs in Kenya are notably high, accounting for approximately 40% of the cost of goods, compared to the global average of 8-12%, as reported by the World Bank. These elevated costs are largely attributable to inefficiencies within transport operations The general objective of the study was to establish the influence of transport optimization on performance of distribution firms in Nairobi City County, Kenya. Specifically, the study sought to assess the influence of route optimization on performance of distribution firms in Nairobi City County, Kenya, to assess the effect of load optimization on performance of distribution firms in Nairobi City County, Kenya. The study adopted descriptive research design. The unit of analysis for this study was the distribution firms. The unit of observation of this study was management employees. The target population was 1061 distribution firms. The Yamane formula was adopted to calculate the study sample size. Therefore, the study sample size was 290 respondents. The stratified random sampling method was adopted to select the study sample size. Data was collected using a self-administered semi-structured questionnaire. Qualitative reports were analysed in content analysis and presented in form of essays. Descriptive statistical analysis included frequency, percentages, mean and standard deviation and used to analyze quantitative data. SPSS version 26 was used for analysis. Inferential statistical analysis to be used was multiple regression and correlation analysis and test the relationship between the study variables. The findings were displayed in tables and figures. The study concludes that route optimization has a positive and significant influence on performance of distribution firms in Nairobi City County, Kenya. In addition, the study concludes that load optimization has a positive and significant influence on performance of distribution firms in Nairobi City County, Kenya. Bases on the findings, the study therefore recommends that the management of distribution firms should implement real-time route monitoring and adjustment systems. By leveraging advanced technologies such as GPS tracking, predictive analytics, and machine learning algorithms.

Key Words: Transport Optimization, Performance of Distribution Firms, Route Optimization, Load Optimization

Background of the Study

Distribution firms play a crucial role in the economy by facilitating the efficient movement of goods from producers to consumers or intermediate users. These firms are integral components of the supply chain, linking various stages of production and consumption (Abuaisha & Abi-Eishe, 2023). Their efficiency directly impacts economic growth, market stability, and consumer welfare. Distribution firms are responsible for ensuring that products reach their intended destinations in a timely and cost-effective manner. This involves managing logistics operations such as warehousing, inventory management, transportation, and distribution network optimization. Efficient distribution operations contribute to reducing supply chain costs, which ultimately lowers the cost of goods for consumers and enhances overall market competitiveness. In addition to cost management, distribution firms play a pivotal role in enhancing market accessibility and reach (Adebayo, & Aworemi, 2021). By establishing efficient distribution networks, firms can expand their market presence both geographically and demographically. This expansion not only increases sales opportunities but also promotes economic inclusivity by making goods and services accessible to a broader population (Kenneth, Dwayne, & Inman, 2020).

Furthermore, the performance of distribution firms influences customer satisfaction and loyalty. Timely and reliable delivery of products is critical in meeting consumer expectations and maintaining competitive advantage in the market (Kiluu, & Moronge, 2021). Firms that excel in distribution management often leverage customer satisfaction as a strategic advantage, leading to repeat business and positive brand reputation. From an economic perspective, well-performing distribution firms contribute to overall productivity and efficiency gains across the economy (Kiwia, & Msemwa, 2023). By streamlining supply chain processes and reducing wastage, these firms enhance resource allocation and utilization efficiency. This efficiency translates into higher productivity levels throughout the economy, supporting sustainable economic growth and development (Kiptoo, & Osoro, 2024).

Transport optimization is a strategic approach to enhancing the efficiency and effectiveness of transportation systems and logistics operations. It encompasses a range of practices aimed at maximizing the utilization of transportation resources while minimizing costs and improving service quality. At its core, transport optimization involves meticulous planning and execution across various facets of transportation management (Musau, et al, 2020). One key aspect of transport optimization is route optimization. This involves identifying the most efficient routes for transporting goods based on factors such as distance, traffic conditions, and delivery schedules. Advanced routing algorithms and software enable companies to minimize travel times and fuel consumption, ultimately reducing operational costs and improving delivery efficiency. By optimizing routes, businesses can also enhance customer satisfaction by ensuring timely and reliable deliveries (Lütfi, 2020).

Load optimization maximizing the capacity of vehicles while maintaining compliance with weight restrictions and ensuring the safety and integrity of goods during transit. Efficient load planning reduces the number of trips required to transport goods, thereby lowering transportation costs per unit and improving resource utilization (Mwesigye, 2021). Additionally, transport optimization involves selecting the most appropriate mode of transportation for each shipment (Ngesa, & Namusonge, 2023). Factors considered include the distance to be traveled, time constraints, cost-effectiveness, and environmental impact. Companies may utilize a combination of road, rail, air, and sea transport modes, leveraging intermodal solutions to optimize logistics chains and meet varying customer requirements efficiently (Nangpiire, Salifu, & Beduwa, 2024).

Statement of the Problem

In Kenya, distribution firms grapple with significant challenges in optimizing their transport operations, which directly affect their overall performance and operational efficiency (Nguyai, & Ndeto, 2021). Efficient transport logistics are pivotal for ensuring timely delivery of goods

and services, enhancing customer satisfaction, and managing costs effectively. Despite global advancements in technology and logistics practices, the extent to which transport optimization strategies are implemented and their direct influence on the performance of distribution firms in Nairobi City County, Kenya remains inadequately explored (Ngesa, & Namusonge, 2023).

Transport costs in Kenya are notably high, accounting for approximately 40% of the cost of goods, compared to the global average of 8-12%, as reported by the World Bank. These elevated costs are largely attributable to inefficiencies within transport operations (Kiluu, & Moronge, 2021). Moreover, Nairobi, the capital city, faces severe traffic congestion, contributing to increased transport times and costs. Studies indicate that congestion costs businesses in Nairobi an estimated Ksh 50 billion annually in lost productivity and heightened fuel consumption (Musau, *et al*, 2020).

Economically, delays in transport logistics pose a significant impact, with inefficiencies estimated to cost the Kenyan economy approximately 2% of GDP annually, according to research by the Kenya Institute for Public Policy Research and Analysis (KIPPRA) (Kiptoo, & Osoro, 2024). Despite these challenges, the adoption of advanced logistics technologies such as GPS tracking and route optimization software among distribution firms in Kenya remains relatively low, with only about 30% of firms utilizing these technologies, compared to higher adoption rates globally (Ngesa, & Namusonge, 2023). Effective transport optimization strategies have been proven to enhance customer satisfaction levels by as much as 25% and increase market penetration by optimizing delivery times and reducing instances of stockouts (Kiptoo, & Osoro, 2024). Although various studies have been conducted on transport optimization and firm performance, none of these studies focused on the influence of transport optimization (route optimization, load optimization) on performance of distribution firms in Nairobi City County, Kenya. To fill the highlighted gaps, the current study seeks to establish the influence of transport optimization on performance of distribution firms in Nairobi City County, Kenya.

Objectives of the Study

The general objective of the study was to establish the influence of transport optimization on performance of distribution firms in Nairobi City County, Kenya.

Specific Objectives

i. To assess the influence of route optimization on performance of distribution firms in Nairobi City County, Kenya

ii. To assess the effect of load optimization on performance of distribution firms in Nairobi City County, Kenya

LITERATURE REVIEW

Theoretical Review

Theory of Constraints

The Theory of Constraints (TOC) is a management philosophy introduced by Eliyahu Goldratt in his book "The Goal" (1984). It revolves around the idea that any organization is limited in achieving its goals by a small number of constraints, or bottlenecks, rather than by its overall capabilities. TOC aims to identify these constraints and systematically improve them to enhance overall system performance. Central to TOC is the concept of identifying the "constraint," which is any factor that limits the organization from achieving its goals. This could be a physical bottleneck in a manufacturing process, a policy restricting efficiency, or a market demand outpacing supply capabilities. The goal is to focus resources and attention on improving or alleviating these constraints to maximize throughput and achieve organizational objectives effectively (Kirui & Maina, 2022). Once a constraint is identified, TOC advocates a process of exploiting, elevating, and subordinating other activities to it. Exploiting means fully utilizing the constraint's capacity to maximize output. Elevating involves taking actions to

increase the capacity of the constraint, whether through technological improvements, process redesign, or resource allocation. Subordinating non-constraints ensures that the entire system operates in alignment with the constraints' needs, preventing wasted effort and resources elsewhere (Ijirshar *et al*, 2023).

Furthermore, TOC emphasizes the importance of a holistic view of the system rather than optimizing individual parts in isolation. It encourages organizations to consider the impact of local decisions on the entire system's performance. These systems thinking approach helps in balancing capacity, inventory, and throughput across different parts of the organization to achieve overall efficiency and goal attainment. Another critical aspect of TOC is continuous improvement through a cycle of ongoing identification, improvement, and reassessment of constraints. This iterative process ensures that as constraints are alleviated or removed, new ones may emerge, requiring attention and optimization. By consistently refining and optimizing the constraints, organizations can achieve sustainable improvements in performance and maintain competitive advantage in dynamic environments (Vedaste & Muiruri, 2021).

The Theory of Constraints (TOC) operates on several key assumptions that underpin its approach to management and improvement within organizations. Firstly, TOC assumes that every complex system, whether it's a manufacturing process or a service delivery system, has inherent constraints that limit its ability to achieve its goals. These constraints can be physical, such as a machine's capacity, or non-physical, such as a policy or decision-making bottleneck. By identifying and addressing these constraints, TOC aims to unlock the system's potential and improve overall performance. Secondly, TOC assumes that focusing improvement efforts on alleviating or removing constraints will have the most significant impact on achieving organizational goals (Barbengi & Kibet, 2022). Rather than spreading resources thinly across various aspects of the organization, concentrating efforts on the critical constraints is believed to yield higher returns in terms of throughput, efficiency, and profitability. Thirdly, TOC assumes that organizations should adopt a holistic, systems-thinking approach. This means considering the interdependencies and interactions between different parts of the system when making decisions or implementing changes. By understanding how changes in one area affect the entire system, organizations can avoid sub-optimization and achieve more balanced and sustainable improvements (Abdul, *et al*, 2020).

Critiques of the Theory of Constraints often center around several points that challenge its applicability or effectiveness in certain contexts. Critiques of the Theory of Constraints often center around several points that challenge its applicability or effectiveness in certain contexts: One critique is that while TOC provides a structured methodology for identifying and improving constraints, it may oversimplify the complexities of real-world systems (Abdul, *et al*, 2020). In highly dynamic or unpredictable environments, constraints can shift rapidly, making it challenging to maintain a consistent focus on improvement. Another critique is related to the practicality of implementing TOC across different types of organizations and industries. What works well in manufacturing settings, where physical constraints are often more tangible, may not translate as effectively to service industries or knowledge-based work environments where constraints are less visible or harder to define (Barbengi & Kibet, 2022).

Additionally, critics argue that TOC's focus on constraints may lead to neglecting other important aspects of organizational performance, such as innovation, customer satisfaction, or employee engagement. By solely prioritizing throughput and efficiency improvements, organizations may miss opportunities for long-term growth and sustainability. Moreover, the rigid application of TOC principles without adaptation to specific organizational contexts or cultural factors can limit its effectiveness. Organizations may need to tailor TOC methodologies to fit their unique circumstances and challenges, which requires a more flexible and nuanced approach than what TOC often prescribes (Kirui & Maina, 2022). This theory was relevant in assessing the influence of route optimization on performance of distribution firms in Nairobi City County, Kenya.

Economic Order Quantity (EOQ) Model

The Economic Order Quantity (EOQ) model developed by Ford W. Harris (1913) is a fundamental tool in inventory management aimed at finding the optimal quantity of goods to be ordered so as to minimize total inventory costs. It balances the costs of holding inventory against the costs of ordering and replenishing it. At its core, the EOQ model calculates the ideal order quantity that minimizes the sum of two primary types of inventory costs: holding costs and ordering costs. Holding costs refer to expenses incurred by storing inventory, such as warehousing, insurance, and depreciation. These costs typically increase with the amount of inventory held over time. Ordering costs, on the other hand, include expenses associated with placing and receiving orders, such as administrative costs, shipping, and supplier management fees. These costs tend to decrease as order size increases due to economies of scale (Ologbon & Adesina, 2020).

One primary assumption of the EOQ model is that demand for the inventory item is constant and known with certainty over the planning horizon. This assumption implies that fluctuations in demand due to seasonality, market trends, or unpredictable customer behavior are not considered. In practice, such variability can lead to either excess inventory (increasing holding costs) or stockouts (resulting in lost sales and potentially higher costs to expedite orders). Another assumption is that both ordering costs and holding costs per unit remain constant. Ordering costs typically decrease with larger order quantities due to economies of scale in procurement and transportation. Conversely, holding costs, which include storage, insurance, and obsolescence, can vary based on factors such as storage space availability and interest rates. Failure to account for these variations can lead to suboptimal inventory decisions and increased overall costs (Njuwasasira, 2022).

Furthermore, the EOQ model assumes instantaneous replenishment, where inventory is restocked immediately upon ordering. In reality, lead times can vary due to supplier constraints, shipping delays, or unforeseen disruptions in the supply chain. Such uncertainties can impact inventory levels and necessitate adjustments to the EOQ calculation to maintain adequate stock levels. Critiques of the EOQ model also extend to its static nature and lack of flexibility in adapting to dynamic business environments. It does not consider strategic factors such as market demand changes, competitive pressures, or shifts in customer preferences. Consequently, reliance solely on EOQ may overlook opportunities to enhance customer service levels or adjust inventory strategies to align with broader business goals (Nyang'au & Muturi, 2021). This theory was relevant in assessing the effect of load optimization on performance of distribution firms in Nairobi City County, Kenya.

Conceptual Framework

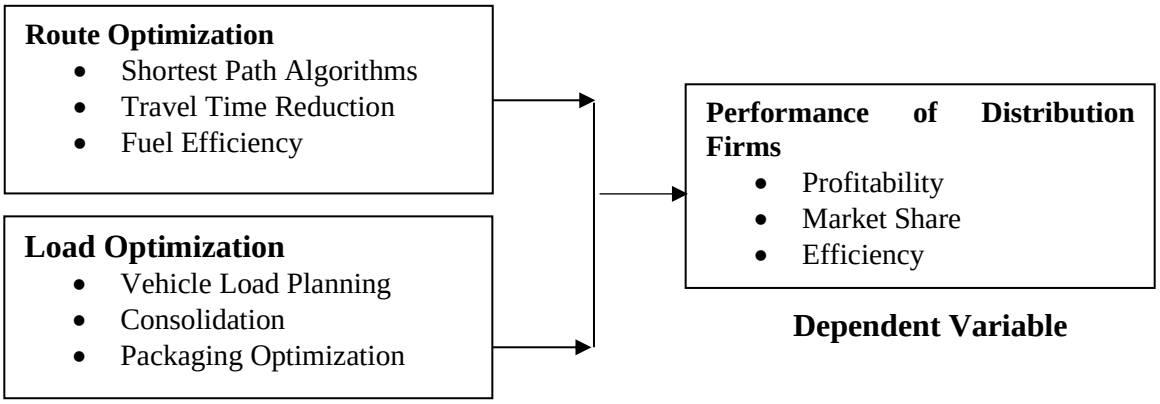

Figure 2. 1: Conceptual Framework

Route Optimization

Route optimization refers to the process of determining the most efficient and cost-effective route for vehicles or goods in transportation and logistics operations (Ijirshar *et al*, 2023). It involves utilizing mathematical algorithms, computational models, or software solutions to calculate optimal routes based on various factors such as distance, travel time, traffic conditions, vehicle capacity, fuel efficiency, and other logistical constraints (Vedaste & Muiruri, 2021).

Shortest path algorithms are fundamental tools in route optimization, essential for determining the most efficient routes between locations. These algorithms, such as Dijkstra's algorithm and A* algorithm, calculate the shortest distance or path based on various criteria, such as road networks, traffic conditions, and geographical obstacles. By leveraging graph theory and computational methods, these algorithms help logistics companies, transportation services, and even everyday commuters find the quickest routes for deliveries, commutes, or travel plans. Implementing shortest path algorithms ensures that resources, such as time and fuel, are utilized optimally, reducing operational costs and improving overall efficiency. Real-time updates and integration with GPS data further enhance their effectiveness, allowing for dynamic adjustments in route planning based on current traffic conditions (Abdul, *et al*, 2020).

Reducing travel time is a critical objective in route optimization, particularly for distribution firms, transportation services, and logistics providers. Efficient route planning aims to minimize the time required to reach destinations, thereby enhancing operational efficiency and customer satisfaction. Strategies for travel time reduction include optimizing routes based on traffic patterns, historical data, and predictive analytics. By leveraging technology like GPS navigation systems and traffic monitoring tools, businesses can mitigate delays, avoid congested routes, and ensure timely deliveries. Improved travel time not only reduces operational costs associated with fuel and vehicle wear but also supports sustainable practices by minimizing carbon emissions and environmental impact. This focus on travel time reduction is essential for maintaining competitiveness in a fast-paced market while meeting increasing customer expectations for prompt and reliable service (Barbengi & Kibet, 2022).

Fuel efficiency plays a crucial role in route optimization, impacting both operational costs and environmental sustainability. Efficient route planning and vehicle scheduling can significantly reduce fuel consumption by minimizing unnecessary detours, idling time, and inefficient driving practices. Advanced algorithms and telematics systems provide insights into optimal routes that prioritize fuel-efficient pathways and driving behaviors. For fleet managers and logistics companies, integrating fuel-efficient strategies into route planning not only lowers fuel expenses but also extends the lifespan of vehicles and reduces maintenance costs. Embracing eco-driving techniques, vehicle maintenance schedules, and adopting alternative fuels are additional measures that support long-term sustainability goals. By prioritizing fuel efficiency in route optimization strategies, organizations can achieve significant cost savings while contributing to environmental conservation efforts (Kirui & Maina, 2022).

Load Optimization

Load optimization refers to the strategic process of maximizing the efficiency and capacity utilization of vehicles, containers, or transport units while ensuring safe and secure transport of goods (Okumu & Bett, 2020). It involves systematically arranging and organizing cargo or items within a given space to minimize wasted space, reduce transportation costs, and improve overall logistics performance. Load optimization aims to achieve balanced distribution of weight, proper stacking of goods, and efficient use of available volume, taking into account factors such as product characteristics, transportation regulations, and delivery schedules (Mogoi & Osoro, 2022).

Vehicle load planning is the systematic process of efficiently arranging goods within vehicles to maximize capacity utilization while ensuring safe and balanced loading. This process is crucial for transportation and logistics companies aiming to optimize resources and minimize costs. Effective load planning considers factors such as weight distribution, size of goods, and

vehicle capacity constraints. By utilizing load planning software or manual calculations, logistics managers can determine the optimal placement of items to prevent overloading, reduce fuel consumption, and enhance vehicle stability. Proper load planning not only improves operational efficiency by minimizing empty space and maximizing the number of deliveries per trip but also ensures compliance with regulatory standards and safety protocols (Ologbon & Adesina, 2020).

Consolidation in logistics refers to the practice of combining multiple smaller shipments into fewer, larger shipments for more efficient transportation and delivery. This strategy helps to optimize transportation resources, reduce transportation costs per unit, and improve overall supply chain efficiency. Consolidation can occur at various stages of the supply chain, including at distribution centers or through third-party logistics providers. By consolidating shipments, businesses can achieve economies of scale, streamline inventory management, and reduce the environmental impact associated with transportation. Moreover, consolidation enhances flexibility in responding to customer demands and improves delivery reliability by reducing the frequency of shipments and associated handling (Njuwasasira, 2022).

Packaging optimization involves designing and selecting packaging materials and configurations that maximize space utilization, protect goods during transit, and minimize packaging waste. Efficient packaging not only ensures the safe and secure transport of goods but also contributes to cost savings and environmental sustainability. Strategies for packaging optimization include using standardized packaging sizes to maximize container or pallet utilization, employing lightweight yet durable materials to reduce transportation weight and fuel consumption, and implementing innovative packaging designs that minimize material usage without compromising product protection. By optimizing packaging, businesses can enhance logistics efficiency, reduce shipping costs, and improve overall supply chain sustainability metrics (Nyang'au & Muturi, 2021).

Empirical Review

Route Optimization and Performance of Distribution Firms

Ijirshar *et al* (2023) conducted a study on evaluating the impact of route optimization on organizational performance of Jumia Company in Nigeria. The current study employed a survey research design. The study elicited primary data from 768 respondents with the help of online Google Forms. Moreover, the research also surveyed two distinct categories of participants, comprising 384 Jumia customers and 384 Jumia staff members. The study found that route optimization significantly impacts organizational performance. The study concluded that route optimization enhanced the company's organizational performance.

Vedaste and Muiruri (2021) researched on the route optimization and operational performance of clearing and forwarding companies in Rwanda: a case of Gorrila Logistics Ltd. The study adopted in this research descriptive research designs. The targeted population was all 240 staff of Gorrilla logistics ltd which where sample size of 150 respondents was calculated using Yamane's formula. The study found that route optimization affects operational performance of Gorrilla logistics ltd in Rwanda. The study concluded that there is a strong positive significant effect of route optimization on operational performance of clearing and forwarding companies.

Abdul, *et al* (2020) assessed on the impact of route optimization on organizational performance (a case study of Dangote Flour Mills PLC, Nigeria). Descriptive survey research design was used to sample 115 employees of Dangote Flour Mills Ilorin. The study found that route optimization affects organizational effectiveness. The study concluded that route optimization has a significant effect on organizational effectiveness.

Barbengi and Kibet (2022) examined on the effect of route optimization on firm performance of Eldoret Dola Manufacturers. This study adopted descriptive research design. The target population for this study was 155 employees from Dola Manufacturer Company. Sample size for this was obtained using Israel formulae to get a sample size of 111 respondents. The study found that route optimization has a positive and statistically significant effect on firm

performance of Eldoret Dola Manufacturers. The study concluded that there is a statistical significant effect of route optimization on firm performance.

Kirui and Maina (2022) investigated on the effect of route optimization on operational performance of construction industry in Uasin Gishu County, Kenya. The research adopted the descriptive research design. The target population was the construction contractors in Kenya and the accessible population was the construction contractors in Uasin Gishu County, Kenya. The sample size was 34 building contractors and 30 road contractors. The study found that route optimization increases operational performance of construction industry in Uasin Gishu County, Kenya. The study concluded that route optimization has a significant influence relationship with operational performance of construction industry in Uasin Gishu County, Kenya.

Load Optimization and Performance of Distribution Firms

Ologbon and Adesina (2020) examined on the production optimization and corporate productivity in the Nigerian Manufacturing Industry. Primary and secondary source of data collection were used. Study population for this study comprise of all manufacturing company in Lagos State, Nigeria, that is all the staff of the organization. The study found that production optimization has significant impact on organizational performances and that production optimization practices has help management to achieve organization goals and responding to threats and opportunities in the industry. The study concluded that production optimization practices have a relationship with product quality.

Njuwasasira (2022) conducted a study on the the contribution of load optimization on organizational performance in automotive sector in Rwanda; a case of Toyota Rwanda. Both qualitative and quantitative methods were used in the study. The target population in this study involved eighty-four staff working in corporate department at Toyota Rwanda. The study found that there was a strong, positive monotonic correlation between load optimization and organizational performance of Toyota Rwanda. The study concluded that there is a positive and significant contribution of load optimization on the organizational performance of Toyota Rwanda.

Nyang'au and Muturi (2021) investigated on the influence of load optimization on organizational performance in retail sector in Kenya: a survey of large retail stores in Kisii Town. The survey design methodology was adopted for the study with a target population of 810 large retail stores drawn from different segments of the retail sector. Sample selection used stratified random sampling based on the size of the retail stores. The study found that there was a significant positive influence of load optimization on organizational performance in retail sector in Kenya. The study concluded that load optimization influences performance of retail outlets in Kenya positively.

Okumu and Bett (2020) assessed on load optimization and organization performance of steel industries in Nairobi County, Kenya. Descriptive research design was used in the study. The target population for this study was employees in the three steel companies in Nairobi County Kenya and a sample size of 45 respondents was utilized. The study found that there is a positive and significant correlation between load optimization and organization performance of steel manufacturing companies in Nairobi County. The study concluded that organization performance among steel firms in Nairobi County is influenced by load optimization.

Mogoi and Osoro (2022) assessed on the influence of load optimization on performance of agricultural firms in Murang'a County, Kenya. Descriptive research design was employed with a target population of 142 agricultural firms in Murang'a County. The study found that load optimization has a substantial impact on agricultural company performance in Murang'a County. The study concluded that load optimization has a positive significant impact on agricultural company performance.

RESEARCH METHODOLOGY

The study adopted descriptive research design. This study targeted distribution firms in Nairobi City County, Kenya. From data obtained from Kenya International Freight and Warehousing

Association (KIFWA), there is a total of 1061 distribution firms. The distribution firms formed the unit of analysis while management employees formed the unit of observation. The Yamane formula was adopted to calculate the study sample size. Therefore, the study sample size was 290 respondents. This research used a questionnaire to collect primary data. The researcher collected questionnaires, coded them, and entered them into the Software Package for Social Sciences (SPSS version 26) for analysis. The descriptive statistical techniques of frequency, mean, and standard deviation were used to analyze the quantitative data acquired. The results were displayed using frequency distribution tables, which kept track of how many times a score or response appears. Qualitative data collected was analyzed using content analysis and presented in prose form. Inferential statistics including regression and correlation analysis was used in the study.

RESEARCH FINDINGS AND DISCUSSIONS

The researcher sampled 290 respondents who were each administered with the questionnaires. From the 290 questionnaires 270 were filled and returned hence a response rate of 93.1%. The response rate was considered as suitable for making inferences from the data collected. As indicated by Metsamuuronen (2017), a response rate that is above fifty percent is considered adequate for data analysis and reporting while a response rate that is above 70% is classified as excellent. Hence, the response rate of this study was within the acceptable limits for drawing conclusions and making recommendations.

Descriptive statistics

Route Optimization and Performance of Distribution Firms

The first specific objective of the study was to assess the influence of route optimization on performance of distribution firms in Nairobi City County, Kenya. The respondents were requested to indicate their level of agreement on various statements related to route optimization and performance of distribution firms in Nairobi City County, Kenya. The results were as shown Table 1.

From the results, the respondents agreed that real-time data integration enhances the accuracy of shortest path algorithms in dynamic environments (M=3.995, SD= 0.896). In addition, the respondents agreed that computational complexity influences the practical applicability of shortest path algorithms (M=3.900, SD= 0.876). Further, the respondents agreed that prioritizing travel time reduction enhances operational efficiency and customer satisfaction (M=3.887, SD= 0.782).

The respondents agreed that route diversification strategies minimize travel time variability and improve delivery reliability (M=3.855, SD= 0.685). The respondents also agreed that route optimization strategies reduce fuel consumption and operational costs (M=3.797, SD= 0.698). In addition, the respondents agreed that eco-driving techniques and vehicle maintenance improve fuel efficiency in route planning (M=3.771, SD= 0.727). Further, the respondents agreed that real-time data integration enhances the accuracy of shortest path algorithms in dynamic environments (M=3.687, SD=0.777).

Table 2: Route Optimization and Performance of Distribution Firms

	Mean	Std. Dev.
Real-time data integration enhances the accuracy of shortest path algorithms in dynamic environments.	3.995	0.896
Computational complexity influences the practical applicability of shortest path algorithms.	3.900	0.876
Prioritizing travel time reduction enhances operational efficiency and customer satisfaction.	3.887	0.782
Route diversification strategies minimize travel time variability and improve delivery reliability	3.855	0.685
Route optimization strategies reduce fuel consumption and operational costs.	3.797	0.698
Eco-driving techniques and vehicle maintenance improve fuel efficiency in route planning.	3.771	0.727
Real-time data integration enhances the accuracy of shortest path algorithms in dynamic environments.	3.687	0.777
Aggregate	**3.842**	**0.777**

Load Optimization and Performance of Distribution Firms

The second specific objective of the study was to assess the effect of load optimization on performance of distribution firms in Nairobi City County, Kenya.The respondents were requested to indicate their level of agreement on various statements related to of load optimization and performance of distribution firms in Nairobi City County, Kenya. The results were as shown Table 2.

From the results, the respondents agreed that effective vehicle load planning maximizes transportation efficiency and minimizes costs (M=3.940, SD=0.772). In addition, the respondents agreed that optimizing vehicle load distribution ensures safe transportation and reduces fuel consumption (M=3.840, SD=0.889). Further, the respondents agreed that consolidating shipments optimizes space utilization and reduces transportation expenses (M=3.827, SD=0.768). The respondents also agreed that efficient consolidation reduces the number of vehicles needed, lowering environmental impact (M=3.800, SD=0.562). As shown in the results, the respondents agreed that customizing packaging sizes to fit standardized pallets or containers improves loading efficiency (M=3.743, SD=0.879). In addition, the respondents agreed that innovative packaging designs protect goods during transit and reduce damage risks (M=3.708, SD=0.692). Further, the respondents agreed that effective vehicle load planning maximizes transportation efficiency and minimizes costs (M=3.688, SD=0.760).

Table 2: Load Optimization and Performance of Distribution Firms

	Mean	Std. Dev.
Effective vehicle load planning maximizes transportation efficiency and minimizes costs.	3.940	0.772
Optimizing vehicle load distribution ensures safe transportation and reduces fuel consumption.	3.840	0.889
Consolidating shipments optimizes space utilization and reduces transportation expenses.	3.827	0.768
Efficient consolidation reduces the number of vehicles needed, lowering environmental impact	3.800	0.562
Customizing packaging sizes to fit standardized pallets or containers improves loading efficiency.	3.743	0.879
Innovative packaging designs protect goods during transit and reduce damage risks	3.708	0.692
Effective vehicle load planning maximizes transportation efficiency and minimizes costs.	3.688	0.760
Aggregate	**3.792**	**0.760**

Performance of Distribution Firms

The respondents were requested to indicate their level of agreement on various statements related to performance of distribution firms in Nairobi City County, Kenya. The results were as shown Table 3.

From the results, the respondents agreed that profitability is a key indicator of financial health and success in distribution firms (M=3.902, SD= 0.766). In addition, the respondents agreed that effective cost management and pricing strategies drive profitability in distribution operations (M=3.887, SD= 0.886). Further, the respondents agreed that strategic market expansion initiatives can boost distribution firm market share (M=3.849, SD= 0.785). Further, the respondents agreed that tracking market trends and competitor activities is crucial for optimizing market share (M=3.827, SD= 0.678). The respondents also agreed that continuous improvement initiatives enhance efficiency and responsiveness in distribution. (M=3.696, SD= 0.554). In addition, the respondents agreed that optimizing inventory management and logistics reduces waste and enhances efficiency (M=3.677, SD=0.734).

Table 3: Performance of Distribution Firms

	Mean	Std. Deviation
Profitability is a key indicator of financial health and success in distribution firms.	3.902	0.766
Effective cost management and pricing strategies drive profitability in distribution operations.	3.887	0.886
Strategic market expansion initiatives can boost distribution firm market share.	3.849	0.785
Tracking market trends and competitor activities is crucial for optimizing market share	3.827	0.678
Continuous improvement initiatives enhance efficiency and responsiveness in distribution.	3.696	0.554
Optimizing inventory management and logistics reduces waste and enhances efficiency.	3.677	0.734
Aggregate	**3.806**	**0.734**

Correlation Analysis

This research adopted Pearson correlation analysis determine how the dependent variable (performance of distribution firms in Nairobi City County, Kenya) relates with the independent variables (route optimization, load optimization).

Table 4: Correlation Coefficients

		Performance of Distribution Firms	Route Optimization	Load Optimization
Performance of Distribution Firms	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	270		
Route Optimization	Pearson Correlation	.815**	1	
	Sig. (2-tailed)	.003		
	N	270	270	
Load Optimization	Pearson Correlation	.825**	.327	1
	Sig. (2-tailed)	.002	.032	
	N	270	270	270

From the results, there was a very strong relationship between route optimization and performance of distribution firms in Nairobi City County, Kenya (r = 0.815, p value =0.003). The relationship was significant since the p value 0.003 was less than 0.05 (significant level). The findings are in line with the findings of Vedaste and Muiruri (2021) who indicated that there is a very strong relationship between route optimization and performance of distribution firms.

Moreover, there was a very strong relationship between load optimization and performance of distribution firms in Nairobi City County, Kenya (r = 0.825, p value =0.002). The relationship was significant since the p value 0.002 was less than 0.05 (significant level). The findings are in line with the findings of Ologbon and Adesina (2020) who indicated that there is a very strong relationship between load optimization and performance of distribution firms.

Regression Analysis

Multivariate regression analysis was used to assess the relationship between independent variables (route optimization, load optimization) and the dependent variable (performance of distribution firms in Nairobi City County, Kenya).

Table 5: Regression Coefficients

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Sig.**
	B	Std. Error	Beta		
(Constant)	0.331	0.084		3.940	0.001
Route Optimization	0.386	0.097	0.387	3.979	0.000
Load Optimization	0.376	0.095	0.375	3.957	0.001

The regression model was as follows:

$$\mathbf{Y = 0.331 + 0.386X_1 + 0.376X_2}$$

According to the results, route optimization has a significant effect on performance of distribution firms in Nairobi City County, Kenya β_1=0.386, p value= 0.000). The relationship was considered significant since the p value 0.000 was less than the significant level of 0.05. The findings are in line with the findings of Vedaste and Muiruri (2021) who indicated that there is a very strong relationship between route optimization and performance of distribution firms.

The results also revealed that load optimization has a significant effect on performance of distribution firms in Nairobi City County, Kenya β1=0.376, p value= 0.001). The relationship was considered significant since the p value 0.001 was less than the significant level of 0.05. The findings are in line with the findings of Ologbon and Adesina (2020) who indicated that there is a very strong relationship between load optimization and performance of distribution firms.

Conclusion

The study concludes that route optimization has a positive and significant influence on performance of distribution firms in Nairobi City County, Kenya. Findings revealed that shortest path algorithms, travel time reduction and fuel efficiency influence performance of distribution firms in Nairobi City County, Kenya.

In addition, the study concludes that load optimization has a positive and significant influence on performance of distribution firms in Nairobi City County, Kenya. Findings revealed that vehicle load planning, consolidation, and packaging optimization influence performance of distribution firms in Nairobi City County, Kenya.

Recommendations

The study recommends that the management of distribution firms should implement real-time route monitoring and adjustment systems. By leveraging advanced technologies such as GPS tracking, predictive analytics, and machine learning algorithms, distribution firms can continuously monitor their fleet's movements and dynamically adjust routes based on current traffic conditions, weather patterns, and unexpected delays.

In addition, the study recommends that the management of distribution firms should implement dynamic load balancing and consolidation strategies. By utilizing advanced software solutions

and algorithms, firms can analyse order patterns, product characteristics, and delivery routes to dynamically optimize how goods are loaded onto trucks or other transport vehicles.

Suggestions for Further Studies

This study was limited to the influence of transport optimization on performance of distribution firms in Nairobi City County, Kenya hence the study findings cannot be generalized to firm performance of other firms in Kenya. The study therefore suggests further studies on the influence of transport optimization on firm performance in other firms in Kenya.

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