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Moderating Effect of Electronic Data Interchange on the Relationship Between Integrated Transportation and Supply Chain Performance of Large Scale Manufacturing Firms in Kenya

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A B S T R A C T

The manufacturing sector is integral to economic development, fostering strong links with other industries, driving technological progress, and presenting significant opportunities for productivity enhancement. In Kenya, the manufacturing sector has averaged a contribution of 8.4% to the nation's GDP between 2015/2016 and 2021/2022. This relatively modest contribution over the past seven years is unlikely to achieve the ambitious target of 20% by 2030. An analysis conducted by Statista between 2018 and 2022 showed significant fluctuations in the sector's performance, with quarterly figures of 4.1% in 2020, 6.2% in 2021, 1.8% in 2022, and 2.6% in 2023. These inconsistencies are largely due to the slow adoption of electronic data interchange technologies, which hinder effective coordination and real-time information sharing with external stakeholders. This study examined the moderating effect of electronic data interchange (EDI) on the relationship between integrated transportation systems and supply chain performance in large-scale manufacturing firms in Kenya. The study used a population of 261 randomly selected firms from a larger sampling frame of 750, ensuring a representative sample from which 261 head of supply chain were taken as respondents. The reliability of the research instrument was confirmed through the Cronbach Alpha Coefficient, with all study constructs exceeding the acceptable threshold of 0.7. Data analysis was conducted via multiple regression analysis, revealing a positive and significant interaction term, indicating that the integration of EDI increased the variance in supply chain performance by 3.1%, with R^2 rising from 68.8% to 71.9%. This significant change in R^2 and the positive coefficient of the interaction term confirmed the moderating role of EDI in enhancing the relationship between integrated transportation and supply chain performance among large-scale manufacturers. Consequently, the study advocates for large-scale manufacturing firms to prioritize investments in digital infrastructure such as high-speed internet, reliable telecommunications networks, and cloud computing services to foster the effective adoption and utilization of EDI technologies.

Keywords: Electronic Data Interchange, Supply chain performance

1. Introduction

1.1 Electronic Data Interchange

Electronic Data Interchange (EDI) is the structured transmission of data between organizations by electronic means. It is a standard format for exchanging business data, such as purchase orders, invoices, and shipping notices, between computers (Hill & Scudder,2002). Electronic Data Interchange (EDI) has emerged as a crucial technology for streamlining communication and data exchange within supply chains, particularly for large-scale manufacturing firms (Craighead, Patterson, Roth & Segars,2006). EDI facilitates the automated exchange of structured business documents, such as purchase orders, invoices, and shipping notices, between different entities across the supply chain (Kumar & Shankar, 2018). In the context of integrated transportation, EDI acts as the backbone for seamless information flow among manufacturers, logistics providers, and customers, paving the way for optimized transportation processes and improved supply chain performance.

The integration of EDI into transportation management systems enables real-time visibility into the movement of goods. For instance, transportation management systems (TMS) can leverage EDI to automatically receive shipment details from manufacturers and transmit them to carriers, thereby eliminating manual data entry and minimizing errors (Mentzer, DeWitt, Keebler, Min,Nix, Smith & Zacharia, 2001).). Similarly, carriers can utilize EDI to send shipment updates, such as location tracking and estimated time of arrival (ETA), directly to manufacturers and customers, fostering enhanced transparency and improved communication. This seamless exchange of information fosters proactive decision-making, enabling firms to optimize routes, manage resources effectively, and anticipate potential delays, ultimately leading to reduced transportation costs and improved delivery reliability (Chopra & Meindl, 2001).

Moreover, EDI facilitates the electronic exchange of transportation documents, like bills of lading and customs declarations, which accelerates the clearance and movement of goods across borders (Pan, Wang & Yan, 2014). This automated process reduces the time and resources spent on manual paperwork and minimizes the risk of errors associated with manual data entry (Ross, 2011). The speed and accuracy of EDI-driven transportation documentation contribute to streamlined customs clearance and faster delivery times, furthering the competitive advantage of large-scale manufacturing firms operating in global markets.

The incorporation of Electronic Data Interchange (EDI) into the overall transportation and logistics ecosystem significantly influences supply chain performance in several ways. Firstly, it increases efficiency by automating numerous manual tasks, which lowers operational costs and boosts productivity (Lambert & Cooper, 2000). Secondly, EDI improves visibility through real-time tracking and monitoring of shipments, which facilitates better inventory management and shorter lead times. This enhanced visibility enables companies to proactively mitigate potential disruptions in the supply chain and reduce their effects (Christopher, 2011). Lastly, EDI promotes collaboration and communication among partners in the supply chain, fostering trust and strengthening relationships, which enhances responsiveness and adaptability to shifts in the market (Stadtler & Kilger, 2008).However, the successful implementation and adoption of EDI in large-scale manufacturing firms require careful consideration of various factors. These include the need for compatible systems and standards among trading partners, the investment in EDI infrastructure and software, and the development of robust security protocols to safeguard sensitive data (Croom, 2010). Overcoming these challenges and ensuring a well-planned implementation process are crucial for reaping the full benefits of EDI in enhancing transportation and supply chain performance.

One of the key benefits of EDI in large scale manufacturing firms is its ability to streamline the supply chain process. According to a study by Huang, Chang, and Wu (2015), EDI can significantly reduce lead time and improve order fulfillment rates in the manufacturing industry. This is achieved through the real-time exchange of information between suppliers, manufacturers, and customers, allowing for better coordination and visibility of the supply chain.

Similarly,according to Zhang, Chao & Liu,(2020), the integration of EDI into supply chain processes significantly reduces the time spent on manual data entry and error correction, thus enabling more accurate and timely information exchange. This improvement in communication fosters better collaboration among supply chain stakeholders, including suppliers, manufacturers, and logistics providers, which is essential for achieving synchronized operations (Aydin & Kucuk, 2015).

Reviewed studies on the impact of electronic data interchange (EDI) on supply chain performance, both globally and locally, have yielded varied findings. A subset of research has documented positive and significant outcomes from the use of EDI in improving supply chain performance, including works by Simiyu *et al.* (2021) in Kenya, Summah *et al.* (2020), Shee *et al*. (2018), Macharia & Ismail (2015), and Kaaria & Mwangangi (2017). Conversely, other studies indicate adverse effect of EDI on company supply chain performance, such as Al-doori's (2019) research revealing a negative impact of EDI on the operational performance of firms in Pakistan, and Shabaz *et al.* (2018) study on manufacturing industries in Malaysia, which found no significant improvement in operational performance due to EDI. Differing from these findings, Kaggira *et al.* (2015) concluded in their study of Kenyan cargo distribution companies that EDI had a variable impact, some EDI components improved supply chain performance while others hindered it. These diverse outcomes suggest that the role of EDI in enhancing supply chain performance remains ambiguous, emphasizing the need for further research in this area.

Similarly prior studies examining the correlation between electronic data interchange and supply chain performance has produced inconsistent findings. Simiyu, Kadima, and Otsyulah (2021) study revealed that technology use practices significantly influenced the procurement performance of Nzoia Sugar Company Limited, Oteki, Namusonge, Sakwa, and Ngeno (2018) findings from a study of sugar processing companies in Kenya indicated a significant positive correlation between electronic order processing practices and supply chain performance. Conversely Okano and Fernandes (2019) found that the main negative aspects of EDI were related to the penalties or demerits imposed by automakers. Similarly, Chang, Wang, and Wang (2022) in their analysis of data from 250 manufacturing and retail firms in China found that EDI often complicates the supply chain due to the substantial investment required for implementation, maintenance, and training and they added that this increased expenditure was attributed to the necessity of upgrading legacy systems and the continual need for technical support. Moreover, the study indicated that EDI systems are vulnerable to cyber-attacks, leading to significant disruptions in the supply chain.

These contradicting findings suggest the presence of a moderating factor that can either intensify or weaken this correlation. Consequently, Ayele and Ram (2023) study investigated the impact of information exchange and logistics methods on Ethiopian firms' supply chain performance. The findings indicated that EDI does moderate the interaction between logistics practices and supply chain performance, confirming the role of electronic data interchange as a moderating element in the link between integrated transportation and firms' supply chain performance. Notably, the potential moderating impact of EDI on the association between integrated transportation and the supply chain performance of manufacturing firms has not been sufficiently explored in local contexts. The present study aims to fill this research void, thereby providing foundational insights for subsequent scholarly pursuits in the domain of supply chain management.

1.2 Integrated Transportation

Integrated transport involves the combining of different modes of transport to maximize ease and efficiency for the user in terms of time, cost, comfort, safety, accessibility and convenience (Tao, Shi, & Wen, 2017). Different modes of transport have differing technical and operational capabilities. Each mode of transport in the system has to develop its capacity to meet specific demand viewed within the total demand for all modes of transport in

the system. In this way, as well as competing with each other, they also supplement each other. Integrated transportation involves multimodal, intermodal and trans modal systems.

According to Tae-Woo Lee, Chhetri, Liu & Lin, (2024), one of the key advantages of multimodal transportation is its ability to leverage the strengths of different modes of transport. For example, rail transport is efficient for long-distance haulage of bulky goods, while trucks are more flexible and accessible for door-to-door deliveries. By integrating these two modes, goods can be transported economically over long distances and then distributed locally. Similarly, water transport, with its large carrying capacity, is ideal for bulk shipments, and air transport provides high-speed connections for time-sensitive goods or perishable items. By combining these modes strategically, multimodal transportation optimizes the use of resources and infrastructure, leading to improved efficiency.

The concept of multimodal transportation arises from the recognition that each mode of transportation has its own strengths and limitations. By combining these modes strategically, multimodal transport offers a range of benefits. It enhances connectivity, reduces congestion on specific modes, lowers transportation costs, minimizes environmental impact, and improves overall logistics and supply chain management. In terms of supply chain, Multimodal transportation is considered a "game-changer" for supply chain and logistics businesses, offering a range of benefits that streamline operations, reduce costs, and enhance customer satisfaction (Tae-Woo Lee, *et al*,2024). One of the key advantages is enhanced efficiency. By integrating multiple modes of transport such as rail, road, water, and air, companies can leverage the strengths of each mode to optimize the movement of goods.

According to (Givoni, & Banister, 2010), the use of multimodal transport systems is assumed to reduce costs, increase system efficiency and service level through the use of sustainable modes of transport, while generating logistical benefits in terms of the reducing widespread distribution of costs. Mutimodalism is reflective of integrated transport segments where frequency and services are better synchronized to favor continuity along the transport chain, consolidation and strategic alliances. This occurs between different carriers and terminal operators enabling them to issue a common contract and improved information and communication technologies enabling actors to interact more efficiently. Kumar, Parida & Swami, (2013), specify that in multi- modalism, one contract covers the entire journey. One carrier takes sole responsibility and ensures door-to-door delivery is completed, despite the involvement of other carriers in the journey.

In inter-modalism or intermodal transportation, there is a separate contract for each individual leg of the journey. Intermodal transportation utilizes two or more 'suitable' transport modes, to form an integrated transport chain aimed at achieving operationally efficient and cost-effective delivery of goods in an environmentally sustainable manner from their point of origin to their final destination (Di Pierro, Iacobellis, Turchiano and Turchiano, 2017). It, therefore, implies that there is more than one responsible entity for the successful delivery of the cargo. Gandhi, Kant, & Thakkar, (2024) posits that if one needs to move a large amount of cargo to another site and the origin and destination are both land landlocked on different continents, then the cargo will need to be moved by truck to a rail yard, by rail to the shipping port, and by vessel to the next port overseas. The latter reverse process will be repeated upon the cargo delivery overseas.

In intermodal transport, each mode of transport has its own advantages: potential capacity, high levels of safety, flexibility, low energy consumption, low environmental impact (Di Pierro, *et al.*, 2017). Intermodal transportation allows each mode to play its role in building transport chains, which overall, are more efficient, cost effective and sustainable (Agamez-Arias & Moyano-Fuentes, 2017). In the logistic infrastructures, there is the need to improve the efficiency of logistics through machine-to-machine communication, cooperative system technologies, effective redaction of fuel consumption and CO2 emission (Slack, 2016).). Such objectives are pursued focusing on services that can optimize freight delivery plan, synchronize different transport modes, reduce the pollution and improve fuel consumption.

1.3 Statement of the Problem

Large-scale manufacturing firms in Kenya face significant challenges in maintaining efficient supply chains, particularly given the complexities of integrated transportation systems. While integrated transportation systems aim to streamline logistics across various modes and locations, achieving optimal supply chain performance remains a hurdle. This is compounded by issues like delayed deliveries, inventory inaccuracies, and communication breakdowns between stakeholders, leading to increased costs, decreased responsiveness, and ultimately, reduced profitability. Network theory offers a framework to understand this challenge, suggesting that the effective integration of electronic data interchange (EDI) within integrated transportation systems can significantly enhance supply chain performance. This is because EDI facilitates seamless and real-time information flow across the network, minimizing delays, errors, and uncertainties associated with traditional paper-based communication. Similarly, a report by the Kenya National Bureau of Statistics revealed that approximately 30% of manufactured goods experience delays in transit, resulting in an estimated annual loss of Ksh 20 billion (USD 180 million) for the manufacturing sector. Additionally, the Kenya Shippers Council estimates that inefficient supply chain processes cost the manufacturing sector an average of 15% of their annual revenue. The Kenya Association of Manufacturers also report that the average lead time for the delivery of raw materials is 14 days, resulting in stockouts and production delays, which can be reduced by up to 50% through the adoption of EDI-enabled transportation systems. Moreover, the World Bank estimates that the implementation of EDI in transportation systems can reduce logistics costs by up to 15%, which can have a significant impact on the bottom line of large-scale manufacturing firms. Therefore, there is an urgent need to explore how EDI moderates the relationship between integrated transportation systems and supply chain performance for large-scale manufacturing companies in Kenya, in order to identify viable solutions to the challenges these firms face.

2.LITERATURE REVIEW

2.1 Theoretical Literature Review

The Theoretical Review section centers on the analysis and evaluation of various interpretations and arguments related to the relevant variables. This analysis provides a comprehensive understanding of the concepts, thereby establishing a solid foundation for the development of hypotheses and the design of empirical testing. The theoretical literature serves as the primary source for extracting and defining constructs, which in turn form the basis for understanding the main variables and creating instruments used for data collection.

2.1.1 Network Theory

Network theory, first introduced in the 1970s and 1980s, has evolved from focusing on simple dyadic relationships (strategic alliances) to encompass complex, multi-faceted interactions among various entities across the entire supply chain. Hearnshaw & Wilson, (2013) highlight that understanding the structure, properties, and formation mechanisms of supply chain networks is crucial for modeling them effectively.One of the foundational principles of network theory is the notion of *nodes and edges*. Nodes represent individual entities, such as warehouses or distribution centers, while edges signify the relationships or connections between these entities, such as transport routes. The relevance of this principle in SC management is apparent as EDI systems facilitate seamless electronic communication between nodes, enhancing data accuracy and reducing latency. According to Daugherty (2011), the implementation of EDI systems has led to a marked improvement in inventory management and order fulfillment rates.

Robustness and resilience in network theory is a principle that refer to the network's ability to maintain functionality despite failures or disruptions. In SC management, disruptions can arise from supplier failures, transportation bottlenecks, or unforeseen external conditions. Network theory's robustness principle informs the design of supply chains to withstand such disruptions. Incorporating EDI systems can augment resilience by providing real-time visibility and predictive analytics, enabling preemptive actions against potential disruptions (Cagliano *et al.*, 2022).

According to Ford & Mouzas (2013), the application of network theory to supply chain management allows for a detailed assessment of the various supply chain components and their relationships — nodes represent entities such as suppliers, manufacturers, and distributors, while edges stand for the relationships or transactions between these players. Using network analysis, firms can identify central nodes, which are crucial to the flow of goods and information, and assess their vulnerability to disruptions. Network theory helps in identifying the most critical nodes and connections within the network—those that, if disrupted, could severely impact the entire system. Welch, & Wilkinson (2002) emphasized that supply chains with a strategic application of EDI can employ network theory to optimize connectivity and data flow, ensuring that their structures are resilient against disruptions and adaptable to changes.

Furthermore, the use of network analysis techniques can provide firms with insights into the most influential players in their supply chain networks. This helps in prioritizing relationships and EDI integrations that might yield the greatest benefits in terms of supply chain responsiveness and agility. By understanding the centrality of each node, firms can target improvements in transaction processing, inventory management, and demand forecasting (Barabási & Albert, (1999). According to Castells,(2011), Network theory also plays a role in the analysis of network density and clustering within supply chain networks. A high degree of density in an EDI-enabled supply chain suggests that information is being shared seamlessly across multiple nodes, fostering an environment of collaboration and synchronization. Conversely, excessive clustering might indicate silos within the network that can lead to inefficiencies, such as duplicated efforts or inconsistent information exchange, (Swaminathan & Tayur, 2003)

2.2 Empirical Literature Review

Simiyu, Kadima, and Otsyulah (2021) conducted a study to assess the impact of technology use on the procurement performance of Nzoia Sugar Company Limited in the County Government of Bungoma, Kenya. Employing a descriptive research design, the study targeted employees directly involved in procurement decision-making at the factory. Using a census technique, the entire population was surveyed as it was manageable. The primary data collection instrument was a structured questionnaire, and a pilot study at Butali Sugar Company Limited was conducted to ensure validity and reliability. The study employed a structural regression equation model and the results revealed that technology use practices significantly influenced the procurement performance of Nzoia Sugar Company Limited in the County Government of Bungoma, Kenya. The above study was limiting in scope, coverage and focuses on a single manufacturing company while the current study will encompass small, medium and large manufacturing firms in Kenya.

Chang, Wang, and Wang (2022) analyzed data from 250 manufacturing and retail firms in China. The research revealed that while EDI facilitates real-time data exchange, it often complicates the supply chain due to the substantial investment required for implementation, maintenance, and training. Approximately 68% of the firms reported higher operational costs post-EDI implementation. This increased expenditure was attributed to the necessity of upgrading legacy systems and the continual need for technical support. Moreover, the study indicated that EDI systems are vulnerable to cyber-attacks, leading to significant disruptions in the supply chain. Qualitative findings showed that firms reported losses due to data breaches and unauthorized access to sensitive information. It further showed that a cyber-attack on a multinational retailer's EDI system resulted in a two-week disruption, leading to significant revenue losses and damaged reputations.

Sumah, Masudin, Zulfikarijah & Restuputri,(2020) investigated logistics management and electronic data interchange effects on logistics service providers' competitive advantage. A total of 100 questionnaires were distributed to senior managers, middle-level managers and junior- level managers. The study adopted a quantitative method through simple and multiple linear regression analysis and qualitative descriptive method through analysis of variance (ANOVA). The results of this study found that logistics management dimensions such as transport management, physical distribution management, inventory management and warehousing management have a significant positive effect on competitive advantage. As for EDI, it was found that two out of the three dimensions such as better communication, and improved billing had a significant positive effect on competitive advantage. While quick access to information was found to have a significant negative effect on competitive advantage. The results further revealed that logistics management had a significant positive effect on competitive advantage. This study failed to integrate electronic data interchange to supply chain performance as in the current study. Its findings were inconsistent with regards to effect of EDI on competitive advantage. Specifically, the current study fosters cost reduction, efficiency and information flow between the integrated transportation leg of carriers.

Another study by Golicic, Foggin & Mentzer (2002) provides empirical evidence that organizations employing EDI experience superior Supply chain performance in comparison to those relying solely on traditional communication methods. The research underscores the role of EDI in improving real-time visibility and coherence in transportation activities, which in turn improves overall supply chain efficiency. Moreover, empirical evidence from the 2007 study by Chae *et al.* reveals that EDI supports better decision-making capabilities within integrated transportation systems. They argue that by enabling high-quality data dissemination, EDI allows managers to make more informed tactical and strategic decisions, leading to optimized routing, scheduling, and load planning.

A study by Fawcett and Magnan (2002) examined the influencing role of information technology on transport logistics and found that EDI is significantly related to improving supply chain performance. In their work, multimodal transport necessitated real-time tracking and effective communication between different stakeholders. Another study by Singh *et al.* (2006) corroborated these findings, demonstrating that EDI plays a moderating role where the complexities of multimodal transport are involved. The moderated model suggested that when EDI use was high, companies benefited more from the agility and integration offered by multimodal transport systems. Moreover, the return on investment from both transport integrations is amplified when EDI is effectively employed (Riyadi, 2020).

Ayele & Ram (2023), examined the effect of information sharing and logistics practices on supply chain performances. The study aimed to investigate the effect of information sharing and logistics practices on the supply chain performances of firms. The study targeted the supply chain practices of some companies operating in Ethiopia. Data was collected from 452 respondents including employees, suppliers, and distributors of the companies under study. The specified objective and proposed hypotheses in this study was tested by structural equation modelling (SEM). The result showed that the higher information sharing (EDI) the better logistic management, which in turn leads to a greater supply chain performance of firms. The study concluded that information sharing has both direct and indirect effects on the supply chain performances, whereas logistics practices have a direct effect on the supply chain performance. Generally, the results theoretically and practically allow the companies and industries to recognize the significant effects of EDI and logistics practices.

Riyadi,(2020) did a study on the mediating role of technology competences, supply chain technology between supply chain management, total quality management and firms supply chain performance in Indonesian textile sector. The objective of this study was to investigate the association among the practices of supply chain management (SCM), total quality management (TQM), through the information technology (IT) competencies and the adoption of innovation in SCM with the firm's supply chain performance (FSCP). Moreover, this study sought to find out the mediating role of the IT competencies and the adoption of SC technology in the association between SCM, TQM and the FSCP. The results of the study showed that with respect to the association among TQM, SCM and supply performance, the IT competencies and SC technology mutually act as mediators.

Nyambura, (2018) examined the moderating effect of information communication technology on supply chain risks and firm performance among manufacturing firms in Kenya. This study sought to investigate the moderating effect of ICT on supply chain risks and performance among manufacturing firms in Kenya. Cross-sectional survey design was adopted as the research design for this study using both qualitative and quantitative approaches. The target population was 94 firms in Kiambu County who were both members and potential members of the Kenya Association of Manufacturers (KAM). The results showed that statistically, there was no significant relationship between information flow risk and performance among the manufacturing firms in Kenya. ICT use as a moderator of the relationship between financial flow risk and performance among the manufacturing firms in Kenya was also not significant. Financial flow risk did not significantly predict the performance of manufacturing firms in Kenya. ICT use was also not a significant moderator of the relationship between financial flow risk and performance of the manufacturing firms in Kenya. Similarly material flow risk did not significantly affect the performance of the manufacturing firms in Kenya. ICT use was also not a significant moderator of the relationship between material flow risk and performance of the manufacturing firms in Kenya.

Bae, (2016) looked at the moderating effect of logistics information systems on interorganizational collaboration and performance of Korean shipping and logistics firms. this research aimed at verifying the moderating effect of logistics information systems (LIS) on inter-organizational collaboration (IOC) and performance. The population of the study was Korean shipping and logistics firms in the Republic of Korea and a survey was carried out by members of liners and international freight forwarders. The results showed that LIS was confirmed as a factor in enhancing the relationship between IOC and performance. This means that the firms perform IOC by LIS in supply chains and as a result, they can achieve high performance. In addition, the relationship between IOC and performance was explained by a resource-based view as is and the relationship between LIS and performance is also explained by a resource-based view.

Another study by Golicic, Foggin & Mentzer (2002) provides empirical evidence that organizations employing EDI experience superior Supply chain performance in comparison to those relying solely on traditional communication methods. The research underscores the role of EDI in improving real-time visibility and coherence in transportation activities, which in turn improves overall supply chain efficiency. Moreover, empirical evidence from the 2007 study by Chae *et al.* reveals that EDI supports better decision-making capabilities within integrated transportation systems. They argue that by enabling high-quality data dissemination, EDI allows managers to make more informed tactical and strategic decisions, leading to optimized routing, scheduling, and load planning.

Al-Doori (2019) conducted an empirical investigation within the supply chain department of automotive industries in Pakistan to explore the potential benefits of supply chain collaboration for achieving operational performance. The study involved 232 members of the supply chain, including suppliers, manufacturers, and distributors. Utilizing factor analysis and multiple regressions through SPSS for data analysis, the findings indicated that two supply chain management approaches, information sharing (IS) and joint decision making (JDM), had a significant positive impact on operational performance. However, the study found that Electronic Data Interchange (EDI) did not have a significant effect on operational performance in the context of the automotive supply chain in Pakistan. The lack of a significant effect of Electronic Data Interchange (EDI) on operational performance raises questions about the specific contextual factors or industry-specific dynamics that might influence the effectiveness of EDI in different settings necessitating a moderation role.

Macharia & Ismail (2015) looked at the role of electronic data interchange on supply chain performance in manufacturing sector in Kenya: A case of Bidco Oil Refinery. The study was built upon the supply chain operations theory, Resource based theory, Transaction based theory and E-technology perspective theory and specific objectives of this study were to examine; customer service level on EDI, cost reduction on EDI, buyer and supplier integration and organizational policies on supply chain performance. The study adopted descriptive survey and targeted 470 employees and sample of 47 employees or 10% of the target population was considered, random sampling technique method was used and data collected through the use of questionnaires. The findings showed EDI had a positive influence on SCP of firms and buyer/supplier integration was the most significant factor followed by customer service level then the cost reduction and finally the organizational policies.

Martinez Sanchez & Perez Perez, (2005) analyzed EDI and the moderator effect of interorganizational cooperation in the supply chain. The study developed a research model to study the influence of interorganizational cooperation on the drivers of EDI adoption and use to test several research hypotheses on a sample of Spanish automotive suppliers. The empirical results indicated that automotive suppliers that had adopted EDI received more operational benefits, more external pressure, more mutual understanding, and fewer technical and organizational difficulties than nonadopters. On the other hand, EDI intensive users who were early adopters, had a proactive management, and perceive more strategic benefits, fewer cost difficulties, and fewer organizational difficulties. The results also indicated that cooperation is a moderator for EDI adoption and use.

2.3 Summary of Reviewed Literature and Gaps

The studies reviewed on the impact of electronic data interchange (EDI) on supply chain performance, both on a global and local scale, have produced varied results. Some research has demonstrated positive and significant effects of EDI on enhancing supply chain performance, including the work of Simiyu *et al.* (2021) in Kenya, Summah *et al.* (2020), Shee *et al.* (2018), Macharia & Ismail (2015). Conversely, other studies have reported negative impacts of EDI on company supply chain performance. Al-dooris (2019) found a negative impact of EDI on the operational performance of firms in Pakistan, while Shabaz *et al*. (2018) observed no significant improvement in operational performance due to EDI in manufacturing industries in Malaysia. Differing from these findings, Kaggira *et al.* (2015) concluded in their study of Kenyan cargo distribution companies that EDI had a variable impact; some components of EDI enhanced supply chain performance while others impeded it. These diverse outcomes indicate that the role of EDI in improving supply chain performance is still ambiguous, highlighting the necessity for further research in this area.

3.METHODOLOGY

3.1 Research Design

This study utilized a correlational research design. The design was chosen for its ability to explore the strength and direction of relationships between variables (Krause, 2018). This approach is particularly well-suited for examining complex systems like supply chain management, where multiple factors can influence outcomes, such as the relationship between integrated transportation and supply chain performance. Correlational research allows researchers to measure and analyze these variables simultaneously, providing insights into potential moderating effects like that of Electronic Data Interchange (EDI). Unlike experimental research, which manipulates variables to determine causality, correlational research identifies patterns and associations without establishing direct cause-and-effect relationships. This is valuable in situations where controlled experiments are impractical or ethically challenging (Hair *et al.,* 2010).

Furthermore, the correlational approach aligns with the quantitative nature of this study. As a quantitative research method, it employs statistical techniques to analyze data collected through questionnaires or other suitable data collection methods (Curtis, Comiskey & Dempsey, 2015). This approach is ideal for examining the moderating effect of integrated EDI, which relies on primary data sources to measure the relationships between variables. As noted by Nachmias and Nachmias (2008), correlational research helps determine the presence and degree of a relationship between quantifiable variables.

3.2 Target Population

Population refers to the entire group of individuals to whom the results of a study was generalized (Ingram & Schneider,1991). The Kenya Association of manufacturers (KAM) updated records show that there are 750 large scale manufacturing firms in Kenya. Large scale manufacturing firms, according to KAM are defined as firms with a monthly production turnover of over 28 tones. These firms will form the population of this study because typically at the forefront of technological adoption due to their resources and the scale of their operations. Their capacity to invest in sophisticated IT infrastructure, coupled with a larger volume of transactions that demand efficiency, makes them prime candidates for reaping maximum benefits from EDI systems. These firms are therefore likely to provide valuable insights into the practicalities of EDI implementation and integration with existing business to business processes.

3.3 Instrument Validity Test

Validity, in the context of research, refers to the extent to which a research instrument measures what it is intended to measure (Mohamad, Sulaiman, Sern & Salleh, 2015). The first step in validating the research instrument is to establish face validity. Face validity assesses whether the instrument appears to measure the intended construct at face value (DeVellis, (2016). This step often involves expert judgments from individuals knowledgeable in the subject matter. For this study, experts' practitioners in supply chain management were used. These experts evaluated if the questions or items on the instrument seem suitable for what is being measured. This form of validity does not guarantee the instrument's accuracy, but it is a preliminary step towards ensuring content alignment (Trochim & Donnelly, 2006).

After ensuring face validity, the researcher conducted content validity. This involved a systematic examination of each item in the instrument to ascertain whether they fully represent the construct and cover all its dimensions (Almanasreh, Moles & Chen, 2019). A panel of experts were used to rate each item's relevance to the construct, often using a Likert scale. The Content Validity Index (CVI was calculated from these ratings to provides a quantifiable measure of the extent to which the items are representative of the construct. Construct validity was the third step and is considered the most rigorous form of validity testing. It involved testing the theory behind the instrument. This was done through convergent and discriminant validities. Convergent validity refers to the degree to which two measures of constructs that are supposed to be related are actually related. Discriminant validity on the other hand assesses the extent to which a construct is truly distinct from other constructs by means of being uncorrelated with them. The researcher used the Average Variance Extracted (AVE) which serve as a statistical measure for convergent validity, with values above 0.50 indicating acceptable convergent validity (Fornell & Larcker, 1981). The scholars also suggest that the square root of the AVE for each construct should be greater than the correlations with other constructs, indicating adequate discriminant validity. This entails that the shared variance between a construct and its indicators should be greater than the shared variance with other constructs. Similarly, (Henseler, Ringle, & Sinkovics, 2009) also suggest that for discriminant validity, Heterotrait-Monotrait ratio calculation of correlations can be used where values below 0.85 or 0.90 suggest discriminant validity.

3.4 Reliability Test of the Research Instrument

According to Bolarinwa (2015), reliability is indicative of the consistency and stability of the results obtained from research. For findings to be considered reliable, they must be replicable under consistent conditions, meaning that if another researcher were to carry out the same study, following the same procedures and methods, they would be able to arrive at comparable results. It therefore becomes imperative to assess and confirm reliability in any study, to substantiate the legitimacy of the results. Internal consistency reliability will be used to measure the extent to which different parts of a test or tool are consistent with each other. Internal consistency refers to the degree to which the items within a test or survey are measuring the same underlying construct. In other words, internal consistency is an assessment of the homogeneity or unidimensionality of the items that are supposed to reflect the same latent variable. This was typically be assessed using Cronbach's Alpha, a statistic that evaluates the average correlation between all possible item pairs. It ranges from 0 to 1, with higher values indicating better internal consistency. A standard rule of thumb is that a Cronbach's alpha above 0.7 is acceptable, although this threshold may be adjusted depending on the context and purpose of the study. The reliability test results showed that all the constructs of integrated transportation, EDI and supply chain performance surpassed the Cronbach's alpha coefficient threshold meaning that the research instrument was reliable. The results are shown in the table below:

Table 1: Reliability Statistics

Construct	α coefficient	No. of Items Tested
o Multiple contracts	.735	9
o Multiple coordination	.837	9
o Single contracts	.828	9
o Single coordination	.802	9
o Efficient Consumer Response	.735	9
o Value Added Network	.739	9

o	Real Time Transaction	.726	9
o	Supply Chain Delivery time	.788	9
o	Supply Chain Lead time	.797	9
o	μ of α coefficients	.776	9

Source: Survey Data,2024)

4. RESULTS AND DISCUSSION

4.1 Response Rate

This study involved 261 heads of supply chain from diverse sectors within Kenya's large-scale manufacturing industry. A purposive sample of managers received electronically distributed questionnaires via user-friendly Google Forms, resulting in a 100% response rate. This exceptional response rate facilitated convenient data collection and surpasse**d** the 70% threshold often considered excellent for meaningful generalizations (Nulty, 2008). The study's high participation aligns with the core purpose of surveys, as outlined by Fowler (2002), which is to acquire accurate data for robust analysis and inferences about the target population. Consequently, despite the lack of a universally defined minimum response rate, the achieved level of participation permits statistically significant conclusions about the characteristics of Kenya's large-scale manufacturing firms.

4.2 Moderating Effect of EDI in the Relationship Between Integrated Transport and Supply Chain Performance of Large-scale *Manufacturing Firms*

The main objective of this study was to establish the moderating effect of Electronic Data Interchange EDI on the relationship between Integrated Transportation (IT) and supply chain performance of manufacturing firms in Kenya. To accomplish this objective, the average of the elements of Integrated Transportation (intermodal and multimodal transport systems) were obtained to create a new variable known as IT. Similarly, the average of the elements of Electronic Data Interchange (Efficient Consumer Response and Value-Added Network) were obtained to create a new variable known as EDI. The product of IT and EDI was then calculated to create another new variable to be used in the model called **Interaction term.** A stepwise regression analysis was then carried out using the new variables created by first entering the dependent variable (Supply Chain Performance into the model then IT, followed by EDI and finally interaction term. This stepwise regression was used because it shows the change in performance in terms a change in R square when every new variable is introduced into the model. The summary of the model is shown below:

Table 2: Moderating Effect of EDI in the Relationship Between IT and SCP

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.216	.086		37.605	.000		
	IT	.356	.021	.730	17.206	.000	1.000	1.000
2	(Constant)	1.832	.141		12.994	.000		
	IT	.125	.026	.257	4.724	.000	.409	2.448
	EDI	.516	.046	.616	11.316	.000	.409	2.448
3	(Constant)	1.242	.175		7.108	.000		
	IT	.325	.046	.667	7.139	.000	.335	2.982
	EDI	.620	.048	.740	13.005	.000	.339	2.953
	Interaction term	.039	.007	.541	5.273	.000	.383	2.612

a. Dependent Variable: Supply chain performance

Model Summary [d]

Model	R	R Square	Adjusted R	Std. Error of the	Change Statistics	Durbin-

			Square	Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Watson
1	.730[a]	.533	.532	.33385	.533	296.046	1	259	.000	
2	.830[b]	.688	.686	.27345	.155	128.055	1	258	.000	
3	.848[c]	.719	.715	.26026	.030	27.800	1	257	.000	2.098

a. Predictors: (Constant), IT

b. Predictors: (Constant), IT, EDI

c. Predictors: (Constant), IT, EDI, Interaction

d. Dependent Variable: SCP

Source: Survey Data,(2024)

The model summary of table 2 above shows that R^2 in model 1 was 53.3% meaning that integrated transportation accounted for 53.3% variance of supply chain performance of manufacturing firms in Kenya. When EDI was added in the same model, R^2 changed by 15.5% (68.8-53.3) % to ahigh of 68.8%. The purpose of adding EDI in a model containing integrated transportation was to determine the exact contribution of EDI to supply chain performance. Finally, when the interaction term was added to the same model containing IT and EDI, the coefficient of determination further rose to 71.9%. This meant that the interaction term necessitated a further change in supply change a margin of (71.9-68.8) = 2.7%. Since the unstandardized coefficient of the interaction term was positive (0.039) and significant, and R square change was also significant, the moderation effect of EDI in the relationship between integrated transportation and supply chain performance of manufacturing firms was confirmed.

The given table provides three models with the first model having only IT as the predictor of supply chain performance. In this model, the unstandardized Beta coefficient is 0.356 indicating that one unit increase in IT is associated with a 0.356 increase in supply chain performance of the firms. Similarly, the standardized Beta coefficient for IT is 0.730 and significant suggesting that IT is a strong predictor of supply chain performance. The collinearity statistics also show that the model has no multicollinearity issue by having both tolerance and VIF statistics at 1.00.

The second model has two predictors where EDI has been added to the existing IT in the model. The unstandardized Beta coefficient for IT and EDI are 0.125 and 0.516 respectively. These imply that a unit change in IT and EDI is associated with 0.125 and 0.516 increase in supply chain performance respectively. On the other hand, the standardized Beta coefficients show that EDI (0.616) is a stronger predictor of supply chain performance than IT (0.257). The collinearity statistics for both IT and EDI shows that VIF and its inverse, the Tolerance stand at 0.409 and 2.448 respectively. This shows that multicollinearity is not a problem in this model as the VIF is below the threshold of 10 proposed by Adebayo *et al*, (2014). Upon factoring in the interaction term, the unstandardized β coefficients for IT, EDI, and the interaction term are reported as 0.325, 0.620 and 0.039. It is however noted that the introduction of interaction term into the model containing IT and EDI has led to a positive change in both their standardized and unstandardized beta coefficients. The interaction term is also positive and significant confirming a moderating effect of EDI in the relationship between IT and SCP of manufacturing firms in Kenya. The null hypothesis apportioning 0 as a coefficient of the interaction term is therefore rejected as the coefficient of the interaction term is positive and significant. These findings confirm the hypothesized moderation model.

Y = 1.242 + 0.325IT + 0.620EDI + 0.039IT*EDI.

The moderator regression has an un-standardized coefficient of 0.039. Therefore, a rise in the interaction term by one-unit results in a 0.039 increase in the X to Y slope. With an increase in the Electronic Data Interchange by one unit, a corresponding rise of 0.039 occurs in the slope that connects Integrated Transportation to the Supply Chain performance. This Findings aligns with theories presented by Irwin & McClelland (2001) and Whisman and McClelland (2005) who asserted that a negative interaction term coefficient will decrease the slope as the moderator variable increases, and the contrary is also true.

Incorporating the interaction term into the regression model improves the accuracy of predictions, as highlighted by Dawson (2014). Fairchild and MacKinnon (2009) contend that the presence of a positive or negative coefficient for the interaction term confirms the moderating effect in regression. Additionally, Hayes (2018) explains that a significant interaction term helps to validate this moderation effect, but he also emphasizes that there is no universally applicable percentage of the interaction term that can be generalized across all analyses. This variability arises because the moderation effect is context-dependent and differs among various research situations. Nonetheless, Jaccard and Turrisi (2003) propose that an increase of 1% to 3% in variance due to the interaction term, in addition to the main effects, is generally considered acceptable to confirm moderation effect. Whisman and McClelland (2005) suggest that the presence of a moderator variable may be inferred if the interaction term contributes significantly to predicting the dependent variable, beyond the explanatory power of the independent variables alone. They also emphasize that in moderator regression models, coefficients should be reported as unstandardized or raw values. This is important because these coefficients reflect simple effects, rather than the main effects seen in additive regression models.

The evaluation of R^2 variation highlighted that any notable change in R^2 confirms the existence of a moderating effect. The data presented in Table 18 reveals a positive change in R^2, with a significance level of 0.005 ($p < 0.01$). The introduction of the interaction term in model necessitated a change in R-square from 68.8% to 71.9%. This implies that EDI enhanced the supply chain performance since the unstandardized coefficient of interaction term

was positive and significant. While the change was relatively small, it still held significance (Fairchild & MacKinnon, 2009). Both models – Model 2, which included IT and EDI, and Model 3, which added the interaction term – effectively predicted the variance in supply chain performance among the large scale manufacturing firms in Kenya. Its noteworthy that the adjusted R square value further increases from 0.686 in model 2 to 0.715 in model 3 indicating that the inclusion of the interaction term in the model significantly improves the models' explanatory power.

The first model recorded an adjusted R^2 of 0.532 and an R^2 of 0.533. Upon the incorporation of the EDI into the model, there is a shift in the R^2 to 0.688, whereas the adjusted R^2 reduced to 0.890. The variations within each model's R^2 cases for both models fall below the prescribed 0.5 cap suggested by Field, (2013). This negligible variance insinuates that the models are credible and steady for predicting the dependent variable, the environmental performance of the firms, with a variance of 88.8% and 89.3% respectively. The interaction effect, calculated as 0.5% (89.3% - 88.8%), which is fairly low, supports the notion of moderation. This is because according to Fairchild & MacKinnon (2009), a positive or negative and significant interaction term coefficient validates the moderating effect in regression. Moderation is therefore not confirmed if the interaction term is zero. The significant interaction suggests that the assumed moderator (EDI) indeed influences the effect of the predictor (Integrated transportation) on the supply chain performance of large-scale manufacturing firms in Kenya.

The affirmation that electronic data interchange plays a moderating role in the association between integrated transportation system and supply chain performance of large-scale manufacturing firms in Kenya echoes the findings of Westler (2020), who did an examination of various case studies in Malaysia's transport sector, indicated that EDI is essential for optimizing supply chain performance within the transportation industry. Golicic, Foggin, and Mentzer (2002) also provided empirical evidence suggesting that organizations utilizing EDI experience superior supply chain performance compared to those relying solely on traditional communication methods. Their research highlights the role of EDI in enhancing real-time visibility and coherence in transportation activities, thereby improving overall supply chain efficiency. Furthermore, Chae *et al.* (2007) provides empirical evidence that EDI supports better decision-making capabilities within integrated transportation systems. They argued that by facilitating high-quality data dissemination, EDI enables managers to make more informed tactical and strategic decisions, leading to optimized routing, scheduling, and load planning.

The studies by Westler (2020), Hill and Scudder (2002), Golicic *et al*. (2002), and Chae *et al*. (2007) all provide evidence that EDI enhances supply chain performance by improving operational efficiency, real-time visibility, and decision-making capabilities within transportation and logistics systems. The research by Fawcett and Magnan (2002) and Singh *et al*. (2006) further corroborates the critical role of EDI in improving supply chain performance, especially in the context of complex, multimodal transportation. The findings from Sumah *et al.* (2020) and Adele and Ram (2023) underscore the positive impact of both logistics management and information sharing (EDI) on supply chain performance. These studies highlight the synergistic effects of effective logistics practices and improved information exchange in enhancing overall supply chain competitiveness

However, the study by Chang *et al.* (2022) cautions that while EDI facilitates real-time data exchange, it can also increase operational costs due to the substantial investment required for implementation, maintenance, and training. Additionally, the vulnerability of EDI systems to cyber-attacks can lead to significant supply chain disruptions. Riyadi's (2020) study further reinforces the mediating role of technology competencies and supply chain technology, including EDI, in the relationship between supply chain management, total quality management, and firm supply chain performance.

The studies by Westler (2020), Hill & Scudder (2002), Golicic, Foggin & Mentzer (2002), Chae *et al.* (2007), Fawcett and Magnan (2002), Singh *et al*. (2006), Simiyu, *et al* (2021), Chang, Wang, and Wang (2022), Sumah, *et al,* (2020), Adele & Ram (2023), and Riyadi (2020) primarily focus on the direct impact of EDI on supply chain performance, finding a generally positive relationship. This aligns with the findings of Macharia & Ismail (2015) who found that EDI had a positive influence on the supply chain performance of Bidco Oil Refinery in Kenya. However, the study by Nyambura (2018) contradicts this trend, finding no significant relationship between ICT use and supply chain performance in Kenyan manufacturing firms. This discrepancy could be attributed to the specific context of the study, focusing on manufacturing firms and the use of ICT rather than EDI specifically.

The study by Bae (2016) provides a different perspective, focusing on the moderating effect of logistics information systems (LIS) on the relationship between inter-organizational collaboration (IOC) and performance. This study found that LIS significantly enhanced the relationship between IOC and performance, suggesting that technology can play a crucial role in facilitating collaboration and achieving higher performance. This finding resonates with the moderating effect of EDI on the relationship between integrated transportation (IT) and supply chain performance, as highlighted in the earlier studies. Martinez Sanchez & Perez Perez (2005) further explored the moderating effect of interorganizational cooperation on EDI adoption and use. Their study found that cooperation significantly moderated the relationship, indicating that successful EDI adoption and use are strongly influenced by collaborative efforts between organizations. This supports the broader idea that technology implementation is not simply about technology itself, but also about the organizational and collaborative context in which it is deployed.

In conclusion, while the literature consistently points to the positive impact of technology on supply chain performance, the specific findings vary depending on the context, the type of technology examined, and the research methodology employed. The studies by Nyambura (2018) and Macharia & Ismail (2015) highlight the need for further research to understand the specific factors influencing the effectiveness of technology adoption in different contexts. The studies by Bae (2016) and Martinez Sanchez & Perez Perez (2005) emphasize the importance of considering the moderating effects of collaboration and organizational factors when evaluating the impact of technology on supply chain performance.

4. Conclusions and Recommendations

4.1 Conclusion of the Study

The study provides valuable insights into the understanding of the role of electronic data interchange in the manufacturing and transport sector. First, the widespread use of EDI among the firms studied highlights its importance in supply chain management. EDI elements such as Efficient Consumer Response and Value-Added Network services were identified as significant predictors of supply chain performance. This highlights the value of electronic data exchange in facilitating smoother and more efficient supply chain operations. Secondly, the study concludes that EDI not only contributes directly to supply chain performance but also plays a moderating role in the relationship between integrated transportation and supply chain performance. The interaction between EDI and integrated transportation systems reveals that EDI enhances the effectiveness of transportation strategies, leading to even better supply chain outcomes.

From the findings this study also concluded that large scale manufacturing firms in Kenya have adopted the use of electronic data interchange systems and integrated transportation systems in their operations. Nevertheless, the degree of implementation of each EDI and integrated transportation systems varies across different companies. Similarly, integrated transportation has been found to be a significant predictor of the supply chain performance of these firms. Specifically, Intermodal and multimodal transportation systems individually explain the variation in supply chain performance by the manufacturing firms. It is also reasonable to conclude that electronic data interchange also has positive significance on supply chain performance.

In addition, the study also concludes that electronic data interchange plays a significant moderating role, enhancing the positive relationship between integrated transportation and supply chain performance. Indeed, the findings suggests that firms that invest in both IT and EDI capabilities are likely to achieve higher levels of supply chain performance compared to those that focus on only one of these factors.

4.2 Recommendations of the Study

The study recommends that increasing the integration of Electronic Data Interchange (EDI) within supply chain processes should be a priority. This integration can be further enhanced by adopting Efficient Consumer Response (ECR) and Value-Added Network (VAN) services, both of which have proven to be substantial predictors of improved supply chain performance. Providing adequate training and support for staff in the effective use of EDI systems can streamline data exchange and improve overall supply chain operations. Recognizing that EDI plays a critical role in moderating the relationship between integrated transportation and supply chain performance, firms should focus on optimizing how EDI interacts with their transportation systems to amplify the benefits derived from these integrated strategies. Moreover, manufacturing firms should contemplate investing in advanced IT solutions that ensure seamless integration between EDI and transportation management systems. This investment is essential for maximizing supply chain efficiency and responsiveness.

To remain competitive, firms must continuously monitor the performance of their IT systems alongside their supply chain operations. Adapting strategies based on emerging technologies and shifting market conditions is vital. Furthermore, fostering a culture of innovation in IT and supply chain management practices will empower firms to enhance their operational capabilities and improve supply chain performance over time. The research also advises that manufacturing firms should prioritize investment in integrated transportation infrastructure, systems and capabilities to enhance their supply chain performance. This could include implementing advanced enterprise resource planning (ERP) systems, developing data analytics capabilities and automating various supply chain processes. More over future scholars should conduct comparative studies across different geographical regions to understand the contextual factors that may shape the effects of intermodal and multimodal transportation.

The study also proposes that Policymakers should develop initiatives and incentives to encourage large-scale manufacturing firms to adopt and integrate EDI systems, such as ECR and VAN, into their supply chain operations. Large scale manufacturing firms should also should prioritize investments in digital infrastructure, such as high-speed internet, reliable telecommunications networks, and cloud computing services, to support the widespread adoption and effective utilization of EDI technologies. Finally, Firms should actively engage with their suppliers, customers, and logistics service providers to facilitate the exchange of information and data through EDI systems.

5. Contributions of the Study

The study significantly contributes to academic literature by bridging gaps in existing research on supply chain management. Specifically, it expands the theoretical framework surrounding integrated transportation and EDI, offering insights into how these factors interrelate within the context of emerging economies. Additionally, this research's findings can stimulate academic debates, serving as an impetus for further explorations. The study provides empirical data drawn from large-scale manufacturing firms in Kenya, enriching the discourse on supply chain dynamics in Africa. This localized research highlights unique challenges and opportunities that can differ significantly from those observed in developed economies.

For policymakers, the findings of this study present several valuable insights aimed at improving the performance of the manufacturing sector and enhancing the overall economic landscape. The study's results advocate for the promotion of EDI systems within manufacturing firms. Policymakers can use this evidence to develop frameworks that encourage the adoption of such technologies, ensuring that manufacturers can leverage them to enhance supply chain efficiency. The findings can also inform regulations that promote interoperability between different EDI systems used by trading partners, ensuring a smoother exchange of information across firms. This can enhance supply chain resilience and agility in response to market changes.

The study can also inform policymakers about the critical role of EDI in enhancing the effectiveness of integrated transportation strategies, providing evidence-based justification for policies and initiatives that encourage the adoption and integration of EDI systems by large-scale manufacturing firms.

The study can also provide valuable insights to supply chain practitioners, guiding them in making strategic decisions regarding the investment and implementation of EDI systems to support their integrated transportation strategies. Practitioners can use the findings to develop a more holistic understanding of the synergies between EDI, integrated transportation, and supply chain performance, informing their technology adoption and supply chain management priorities. The study can emphasize the importance of collaboration and information sharing among supply chain partners, facilitated by EDI, in maximizing the benefits of integrated transportation.

References

Agamez-Arias, A. D. M., & Moyano-Fuentes, J. (2017). Intermodal transport in freight distribution: a literature review. *Transport Reviews*, *37*(6), 782-807.

Al-Doori, J. A. (2019). The impact of supply chain collaboration on performance in automotive industry: Empirical evidence. *Journal of Industrial Engineering and Management*, *12*(2), 241-253.

Al-Doori, J. A. (2019). The impact of supply chain collaboration on performance in automotive industry: Empirical evidence. *Journal of Industrial Engineering and Management*, *12*(2), 241-253.

Aldoori, Jamal. (2019). The impact of supply chain collaboration on performance in automotive industry: Empirical evidence. *Journal of Industrial Engineering and Management. 12. 241.* 10.3926/jiem.2835.

Almanasreh, E., Moles, R., & Chen, T. F. (2019). Evaluation of methods used for estimating content validity. *Research in social and administrative pharmacy*, *15*(2), 214-221.

Aydin, M., & Kucuk, H. (2015). The Role of EDI in Supply Chain Management: Theoretical Perspectives. *Journal of Business Logistics*, 36(4), 242-255.

Ayele, D., & Ram, T. (2023). The effects of information sharing and logistics practices on supply chain performances. *International Journal of Supply Chain and Operations Resilience*, *6*(1), 26-52.

Ayele, D., & Ram, T. (2023). The effects of information sharing and logistics practices on supply chain performances. *International Journal of Supply Chain and Operations Resilience*, *6*(1), 26-52.

Bae, H. S. (2016). The moderating effect of logistics information systems on interorganizational collaboration and performance of Korean shipping and logistics firms. *International Journal of e-Navigation and Maritime Economy*, *5*, 85-96.

Bolarinwa, O. A. (2015). Principles and methods of validity and reliability testing of questionnaires used in social and health science researches. *Nigerian postgraduate medical journal*, *22*(4), 195-201.

Cagliano, A. C., Mangano, G., Rafele, C., & Grimaldi, S. (2022). Classifying healthcare warehouses according to their performance. A Cluster Analysis-based approach. *The International Journal of Logistics Management*, *33*(1), 311-338

Castells, M. (2011). Network theory| A network theory of power. *International journal of communication*, *5*, 15.

Chang, H., Wang, Z., & Wang, Y. (2022). The adverse impacts of Electronic Data Interchange on supply chain efficiency. *Journal of Operations Management, 52*(3), 145-158.

Chang, H., Wang, Z., & Wang, Y. (2022). The adverse impacts of Electronic Data Interchange on supply chain efficiency. *Journal of Operations Management, 52*(3), 145-158.

Chopra, S., & Meindl, P. (2001). Strategy, planning, and operation. *Supply Chain Management*, *15*(5), 71-85.

Craighead, C. W., Patterson, J. W., Roth, P. L., & Segars, A. H. (2006). Enabling the benefits of supply chain management systems: an empirical study of electronic data interchange (EDI) in manufacturing. *International Journal of Production Research*, *44*(1), 135-157.

Curtis, E., Comiskey, C., & Dempsey, O. (2015). Correlational research: Importance and use in nursing and health research. *Nurse researcher*, *6*(1), 20-25.

Daugherty, P. J., Richey, R. G., Roath, A. S., Min, S., Chen, H., Arndt, A. D., & Genchev, S. E. (2006). Is collaboration paying off for firms?. *Business horizons*, *49*(1), 61-70.

DeVellis, R. F. (2016). Scale Development: Theory and Applications (4th ed.). SAGE Publications, Inc.

Di Pierro, B., Iacobellis, G., Turchiano, B., & Ukovich, W. (2017, September). Performance assessment for intermodal transportation systems: a case study. In *2017 IEEE International Conference on Service Operations and Logistics, and Informatics (SOLI)* (pp. 236-241). IEEE.

Ford, D., & Mouzas, S. (2013). The theory and practice of business networking. *Industrial Marketing Management*, *42*(3), 433-442.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of marketing research*, *18*(1), 39-50.

Fowler Jr, F. J., Gallagher, P. M., Stringfellow, V. L., Zaslavsky, A. M., Thompson, J. W., & Cleary, P. D. (2002). Using telephone interviews to reduce nonresponse bias to mail surveys of health plan members. *Medical care*, *40*(3), 190-200.

Gandhi, N., Kant, R., & Thakkar, J. J. (2024). Evaluation of benefits due to adoption of enablers of unimodal road to intermodal railroad freight transportation. *Transport Policy*, *146*, 295-311.

Givoni, M., & Banister, D. (2010). Integrated transport. *From policy to practice*.

Golicic, S. L., Foggin, J. H., & Mentzer, J. T. (2003). Relationship magnitude and its role in interorganizational relationship structure. *Journal of business logistics*, *24*(1), 57-75.

Hair, J., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2010). Multivariate Data Analysis. 6th (ed.) Upper Saddle River NJ.

Hearnshaw, E. J., & Wilson, M. M. (2013). A complex network approach to supply chain network theory. *International Journal of Operations & Production Management*, *33*(4), 442-469.

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. In *New challenges to international marketing* (pp. 277-319). Emerald Group Publishing Limited.

Hill, C. A., & Scudder, G. D. (2002). The use of electronic data interchange for supply chain coordination in the food industry. *Journal of operations management*, *20*(4), 375-387.

Hill, C. A., & Scudder, G. D. (2002). The use of electronic data interchange for supply chain coordination in the food industry. *Journal of operations management*, *20*(4), 375-387.

Huang, S. J., Chang, C. C., & Wu, C. C. (2015). Effects of EDI adoption on supply chain performance and competitive advantage. International Journal of Production Economics, 169, 235-246.

Ingram, H., & Schneider, A. (1991). The choice of target populations. *Administration & Society*, *23*(3), 333-356.

Kanja, D.W. and Mwangangi, P. (2017) Influence of Logistics Management on Supply Chain Performance in Retail Chain Stores in Kenya: A Case of Nakumatt Holdings Limted. The Strategic *Journal of Business & Change Management, 4*, 425-444.

Kiggira, R. W., Mwirigi, F. M., & Shale, N. I. (2015). Role of Electronic Data Interchange On Supply Chain Performance in Cargo Distribution Management in Kenya: A Case of Mombasa Port. *International Journal of Academic Research in Business and Social Sciences*, *5*(6), 50-74.

Krause, M. S. (2018). Associational versus correlational research study design and data analysis. *Quality & Quantity*, *52*(6), 2691-2707.

Kumar, P. P., Parida, M., & Swami, M. (2013). Performance evaluation of multimodal transportation systems. *Procedia-Social and Behavioral Sciences*, *104*, 795-804.. Performance evaluation of multimodal transportation systems. *Procedia-Social and Behavioral Sciences*, *104*, 795-804.

Lambert, D. M., & Cooper, M. C. (2000). Issues in supply chain management. *Industrial marketing management*, *29*(1), 65-83.

Lambert, D. M., J. R. Stock, and L. M. Ellram. (1998). *Fundamentals of Logistics Management*, Irwin/McGraw-Hill, Boston, MA.

Macharia, C. W., & Ismail, N. (2015). Role of electronic data interchange on supply chain performance in manufacturing sector in Kenya: A case of Bidco Oil Refinery. *International Academic Journal of Procurement and Supply Chain Management*, *1*(4), 1-11.

Macharia, C. W., & Ismail, N. (2015). Role of electronic data interchange on supply chain performance in manufacturing sector in Kenya: A case of Bidco Oil Refinery. *International Academic Journal of Procurement and Supply Chain Management*, *1*(4), 1-11.

Martinez Sanchez, A., & Perez Perez, M. (2005). EDI and the moderator effect of interorganizational cooperation in the supply chain. *Journal of Organizational Computing and Electronic Commerce*, *15*(2), 83-104.

Mason, R., & Lalwani, C. (2006). Transport integration tools for supply chain management. *International Journal of Logistics: Research and Applications*, *9*(1), 57-74.

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. (2001). Defining supply chain management. *Journal of Business logistics*, *22*(2), 1-25.

Mohamad, M. M., Sulaiman, N. L., Sern, L. C., & Salleh, K. M. (2015). Measuring the validity and reliability of research instruments. *Procedia-Social and Behavioral Sciences*, *204*, 164-171.

Mohamad, M. M., Sulaiman, N. L., Sern, L. C., & Salleh, K. M. (2015). Measuring the validity and reliability of research instruments. *Procedia-Social and Behavioral Sciences*, *204*, 164-171.

Mosca, A., Vidyarthi, N., & Satir, A. (2019). Integrated transportation–inventory models: A review. *Operations Research Perspectives*, *6*, 100101.

Nachmias, C. F., & Nachmias, D. (2008). *Research methods in the social sciences.* New York, Worth.

Nulty, D. D. (2008). The adequacy of response rates to online and paper surveys: what can be done?. *Assessment & evaluation in higher education*, *33*(3), 301-314.

Nyambura, M. T. (2018). *Moderating effect of information communication technology on supply chain risks and firm performance among manufacturing firms in Kenya* (Doctoral dissertation, JKUAT).*OUP Catalogue*.

Okano, M. T., & Fernandes, M. E. (2019). Electronic data interchange (EDI): An interorganizational system applied in the auto parts industry supply chain. *Int. J. Supply Chain Manag*, *8*(6), 65-74.

Oteki, E. B., Namusonge, G. S., Sakwa, M., & Ngeno, J. (2018). Influence of electronic order processing on supply chain performance of sugar processing firms in Kenya.

Pan, H. H., Wang, S. C., & Yan, K. Q. (2014). An integrated data exchange platform for Intelligent Transportation Systems. *Computer Standards & Interfaces*, *36*(3), 657-671.

Riyadi, S. (2020). The mediating role of technology competences, supply chain technology between supply chain management, total quality management and firms supply chain performance in Indonesian textile sector. *International Journal of Supply Chain Management*, *9*(2), 452-459.

Ross, D. F., & Ross, D. F. (2015). Transportation management. *Distribution Planning and Control: Managing in the Era of Supply Chain Management*, 687-760.

Shahbaz, Muhammad & RM Rasi, Raja Zuraidah & Ahmad, Md & Rakiman, Umol. (2019). The Impact of Supply Chain Collaboration on Operational performance: Empirical Evidence from Manufacturing of Malaysia. Nóesis. Revista de Ciencias Sociales y Humanidades. 4. 59-73.

Shee, H., Miah, S. J., Fairfield, L., & Pujawan, N. (2018). The impact of cloud-enabled process integration on supply chain performance and firm sustainability: the moderating role of top management. *Supply Chain Management: An International Journal*, *23*(6), 500-517.

Simiyu, F. N., Kadima, J. M., & Otsyulah, J. O. (2021). Influence of technology use on procurement performance in Nzoia Sugar Company Limited, Bungoma County; Kenya. *The Strategic Journal of Business & Change Management,* 8 (1), 662 – 673.

Simiyu, F. N., Kadima, J. M., & Otsyulah, J. O. (2021). Influence of technology use on procurement performance in Nzoia Sugar Company Limited, Bungoma County; Kenya. *The Strategic Journal of Business & Change Management,* 8 (1), 662 – 673.

Slack, B. (2016). Intermodal transportation. In *Sustainable Railway Futures* (pp. 219-232). Routledge.

Stank, T. P., & Goldsby, T. J. (2000). A framework for transportation decision making in an integrated supply chain. *Supply Chain Management: An International Journal*, *5*(2), 71-78.

Sumah, B., Masudin, I., Zulfikarijah, F., & Restuputri, D. P. (2020). Logistics management and electronic data interchange effects on logistics service providers' competitive advantage. *Journal of Business and Economic Analysis*, *3*(02), 171-194.

Swaminathan, J. M., & Tayur, S. R. (2003). Models for supply chains in e-business. *Management science*, *49*(10), 1387-1406.

Tae-Woo Lee, P., Chhetri, P., Liu, W., & Lin, C. W. (2024). Integrated transport and logistics for sustainable global trade. *International Journal of Logistics Research and Applications*, *27*(3), 359-362.

Tao, Shi, & Wen, H. (2017). Optimization of vehicle routing problem with time windows for cold chain logistics based on carbon tax. Sustainability, 9(5), 694.

Trochim, W. M., & Donnelly, J. P. (2001). *Research methods knowledge base* (Vol. 2). Cincinnati, OH: Atomic dog publishing.

Welch, C., & Wilkinson, I. (2002). Idea logics and network theory in business marketing. *Journal of Business-to-Business Marketing*, *9*(3), 27-48.

Westler, R. (2020). EDI in Transportation.

Zhang, Y., Chao, C., & Liu, J. (2020). Evaluating the Effectiveness of EDI in Supply Chain Integration. *Operations Research Perspectives*, 7, 103-118.