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ROLE OF TECHNOLOGY AND INNOVATION ON ENHANCING THE LAST-MILE DELIVERY AND ENVIRONMENT CONSERVATION SUSTAINABILITY POST COVID-19

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ABSTRACT

The purpose of the study was to assess the role technology on enhancing the last-mile delivery and environment conservation sustainability. Specifically, it focused on providing answers to the following questions: Is technology enhancing last mile deliveries post Covid-19 pandemic? Are businesses using technology solutions to mitigate last mile delivery challenges? Is use of technology in last mile delivery helping in environment conservation sustainability? Does technology enhance effective B2B and B2C deliveries? The study adopted desktop research design and used secondary data based on analysing published scientific papers through platforms; Web of Science, Scopus and Emerald with majority of information derived from journals or conference proceedings not more than three years after covid-19 i.e. 2023 from the internet sources. The study found that technology enhanced last mile delivery, due to the accelerating pace of digital innovation, increased online participation, rapid growth in data analytics and transmission, and platforms facilitating innovation. The sampled papers proved that new technological development increased the efficiency, visibility, transparency of inventory levels, demand forecasting, production processes, and logistics which emphasized the role of technology as a facilitator of supply chain. The findings showed that, Technology on e-commerce experienced a massive growth within the years after Covid-19 and more and more businesses headed to the online system to sell their products and services and more customers turned to online due to convenience of the online purchase system. The results showed that, technology use in last mile delivery enhanced environmental conservation sustainability by reducing traffic in roads since orders for one location can be delivered by one truck. The study also, found challenges of last-mile delivery and presented a detailed understanding on the technology innovative solutions to mitigate the challenges. As depicted by the sampled researches last mile delivery challenges included delivery inefficiency, high costs, delayed deliveries, low-visibility, outdated technology, inaccurate route planning. Therefore, modern technology proved to be a main facilitator in addressing these challenges by providing faster deliveries, higher visibility and better quality and environment conservation sustainability. The study recommended increase of use of modern technology to enhance further last mile delivery and environment conservation sustainability.

Keywords: Last-mile Delivery, Supply Chain, Technology, E-commerce, Environment Conservation Sustainability.

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1. INTRODUCTION

Supply chains (SCs) and production logistics processes are an important part of all enterprises business enterprises. Effective supply chain management offers multiple benefits to business. Having an effective supply chain is important helps businesses deliver products to their customers promptly, improves customer service and boosting customer loyalty (Min et al., 20 23). The impact of the new digital era on the fourth industrial revolution, the Information and Communication Technologies and the Internet of Things (IoT)-based cyber-physical system (CPS) architecture for production logistics and SC applications have led to the implementation and acceleration of innovations that are required for the digitization of the industry (Singh, 2020).

Supply Chains are not static rather in constant changes in different markets. They are prone of technological and innovative development, economic, environmental and social aspects. Last-mile delivery is one of the processes of the supply chain and it is the most expensive part of the logistic process due to the challenging target service level, high level of dispersal of destinations and the small dimension of orders (Macioszek, 2022). As e-commerce sales are increasing enormously, the customers prefer to receive their products within a day and most preferably within few hours after ordering. Despite the fast delivery requirements, most of the customers are not willing to pay extra money for such logistic requirements (Borsenberger, 2023). Therefore, a special attention should be paid to time performances (Ludwig Hausmann, 2023), specifically the time-window of the delivery. Many studies have appeared in the last years, especially those focused on the technological and innovative solutions to last-mile delivery efficiency. In the same vein big companies such as Amazon have come up with innovative solutions to increase the efficiency such as “drone delivery”, to overcome the issue of delivery delays or failed deliveries. Despite the innovative solutions, smart cities have used their resources to overcome the issues such as parcel lockers (Vyt et al., 2022), crowdsourcing logistics (Gielens, et al., 2020) and pick-up points (Olsson, et al., 2019). In spite of many researches contribution and internet resources there has been confusion about impact of technology on last mile delivery and environment conservation sustainability which prompted this study to bring out the highly required understanding.

1.1 Problem Statement

Companies worldwide are investing in technology in their supply chain processes and e-commerce. More advanced technology and technologically innovative tools are employed by companies to improve delivery of their products and services (Lauenstein and Schank, 2022). Influential companies such as Amazon have used technology and technological innovations to have a more efficient last mile delivery. The technological innovations have included the use of AI (Artificial Intelligence) in delivery of products and services. Despite many researches on the literature there has been no clear attempt to bring out the understanding on the the role of technology on last mile delivery as found by the previous studies. In the same vein there is has been little efforts to highlight what the previous studies in the literature have in terms use of technology in last mile delivery and environment conservation sustainability. This is a vital issue as researches on use of technology have been done however, an evaluation is mandatory to enumerate the findings of these previous studies about the role of technology on last-mile delivery and environment conservation sustainability. Therefore, this study evaluated the researches in the literature to highlight the understanding whether technology make supply chain more efficient, effective, less costly, faster, lower the amount of pollution hence enhancing environment

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conservation sustainability. In addition, this research assessed the challenges facing last mile delivery and whether technology is primary contributors to address challenges of last mile delivery and supply chain process.

1.2 Research Objectives

The aim of this study was to provide review of the literature on the role of technology on enhancing the last-mile delivery and environment conservation sustainability post Covid-19.

2. LITERATURE REVIEW

The study was based on interchangeable relationship and the United Nations Sustainability Goals structure model.

2.1 The interchangeable last mile delivery relationship model.

This model was postulated by Klein and Popp (2022). The model proposes a visually the interchangeable relationship that exists between e-commerce, supply chain, last-mile delivery and technology.

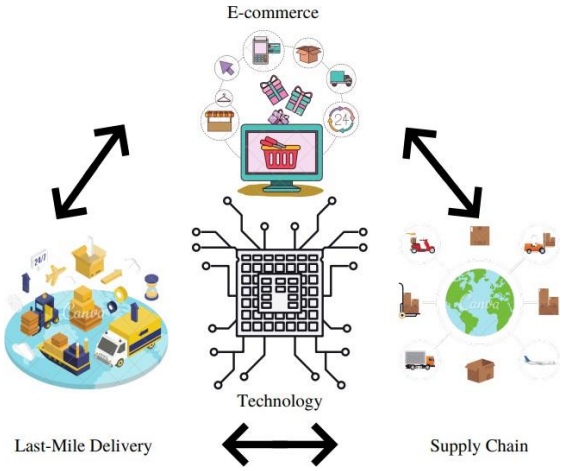

Figure 1. The interchangeable relationship Model between Technology, E-commerce, Supply Chains, Last-Mile Delivery and Environment Conservation sustainability.

In this regard the interchangeable last mile delivery relationship model observes that the relationship that exist must be of advantage to each of the elements: Technology, E-commerce, Supply Chains, Last-Mile Delivery and Environment Conservation sustainability. According to Viu-Roig and Alvarez-Palau. (2023) in search a relationship meant that technology could be serving a positive or a negative role to the other elements. Therefore, this model was used in the study to gauge and understand whether the researches in the literature delineated the interchangeable relationship between e-commerce, supply chain, last-mile delivery and technology. Most importantly whether technology had any positive role on last mile delivery and environment conservation stability.

2.2 United Nations Sustainability Goals structure model.

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Developed by United Nations and as described in the Sustainable Development goals (UN, 2015). There are 17 core goals of the agenda that aim to improve health and education, reduce inequality and spur economic growth-all while tackling climate change leading to environment conservation (United Nations, 2015). This study focused about the role of technology on last mile delivery and environment conservation sustainability. Therefore, this theory was important the effects of use technology in last mile delivery on environment conservation sustainability which one of the pillars of the Sustainable Development goals. The model also was used to understand whether use of technology by business, smart cities and governments are helping in environment conservation as stipulated by the sustainable development goal 6 and 15. Also important to use this model was evaluate whether the businesses are using technology and technological innovations to address challenges facing last mile in connection to environment conservation i.e. using technology in last mile for climate change mitigations.

2.3 Technology in E-Commerce and Last Mile Delivery post Covid-19.

Post Covid-19 increased the use of technology in the world and thus e-commerce businesses took center stage for many companies and enterprises (Viu-Roig and Alvarez-Palau, 2023). This according to Wang, et al., (2023) was for business to stay competitive. This urgent reason led to business to digitize their customer and supply chain (McKinsey et al., 2023). These immediate changes included even changes that companies did not previously consider undertaking, precisely increases in technological costs as a critical and mandatory action. However, the many studies in the literature there has been scarce evaluation of whether availability of literature has accelerated e-commerce and last mile deliveries. This study investigated the previous studies findings on whether availability of technology made it easier for companies to embrace e-commerce and last mile deliveries. The Figure 2. below shows for different regions and technological digitization of customer interactions and overall business operation post Covid-19.

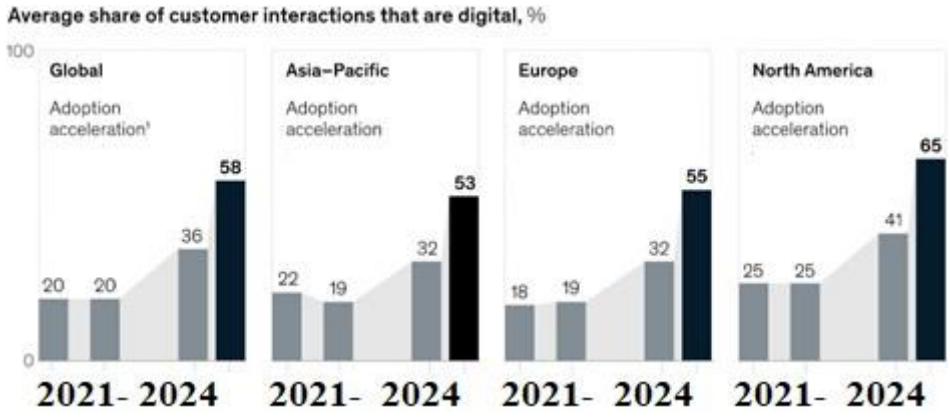

Figure 2. Technological digitalization acceleration post Covid-19 Source: McKinsey, (2024).

According to the McKinsey, 2024 report, the changes undertaken by companies were related to: remote working, customer demand for online purchasing, increase the use of advanced technologies in operations, increase the use of advanced technologies in business decision making, customer needs/expectations, increase of asset migration, change of ownership of last- mile delivery, increase in nearshoring and/or insourcing practices, increase spending on data security

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and build redundancies into supply chain. However, this is based only on the McKinsey, 2024 report and other researches in the literature ignored. In a clear issue undertaken by this current research this McKinsey, 2024 report does not indicate whether the use of technology in e-commerce and last mile had any effects on environment conservation prompting a clear manifestation of the need to evaluate the literature in the quest to maintaining a safer world through climate change mitigation strategies.

3. MATERIALS AND METHODS

The study adopted desktop research design and used secondary data. The study considered scientific papers from previous researchers, academic databases such as Web of Science, and Scopus; recent articles published on the internet post-Covid-19. Reviewed the role of technology e-commerce, supply chain and last mile. Furthermore, the resources were carefully selected by categorizing the information related to the topic discussed including: post Covid- 19 studies, role technology in supply chains, e-commerce, technology in last mile delivery and environmental conservation sustainability, technology and smart cities, effects of technology in last mile on transportation. The study considered articles published not older than three years post Covid-19 i.e. 2023. The abstracts, conclusions and their compatibility with the current study were analyzed. The articles were selected by the credibility of the websites, authors, and quality of reports published. Specifically, articles were reviewed and selected only those that were related to the topic under investigation which was the role of technology on last-mile delivery and environment conservation in post Covid-19 pandemic. Due to these stringent selection criteria only the relevant researches, 73 papers were selected and incorporated in the study. Consequently, the reference lists of the selected researches were considered to determine the quality of the published reports. The findings from the sampled articles were written down and delineated as per the evidence indicated by the research.

4. RESULTS

Technology on E-commerce.

According to study technology on e-commerce experienced a massive growth in post Covid- 19 and more and more businesses are heading to the online system to sell their products and services and more and more customers are embracing online purchasing due to convenience the online purchase system offers. The customers prefer to purchase their goods with a click of a button instead of heading to the stores where they would have incurred cost inform of transport. From the sampled studies four main reasons were found influencing the growth of e-commerce which included: the accelerating pace of digital innovation, increased online participation, rapid growth in data analytics and transmission, and platforms facilitating innovation. In the researches investigated it was found that the sudden outbreak of the Covid-19 brought businesses and government challenges they were not prepared for. Due to health safety containment measurements, customers were purchasing their goods online, which put current businesses operating online to have a surge in demand of products, running out of stocks, delaying the goods due to que of orders, having to invest in technologies for better demand accuracy, more efficient supply chains and last mile delivery. On the other hand, from the sampled papers business not operating online had to think wise and quick to display their services and goods in online platforms for customers. The researches in the literature opine that E-commerce posed an important influence

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on the environment conservation sustainability. As the number of deliveries increased, customers needed to receive goods within 1-2 business days put pressure on companies to transport orders from one location in one truck and these reduced the number of vehicles in the roads unlike when each individual drive or commute to the stores. This led to decrease of gas emissions. The sampled papers state that less developed countries faced more difficulties in modernizing their e-commerce and supply chains due to outdated systems. Businesses undertook changes and increased their technological costs by digitizing their customers and supply chains. Updated digital technology and innovation accelerated the profits and helped businesses maintain their competitive advantage in the market and go through the crisis successfully (Nogueira, et al., 2022). This finding concurred with the results of Dana et al., (2022) who opined that investments in digital and cashless payment, ICT infrastructure, cybersecurity protection, e-commerce skills development, blockchain and AI accelerated post Covid-19 and enhanced last mile deliveries. The results also were similar to the findings of Chen, et al., (2022) who stated that post Covid-19 and with increase of e- commerce there were fewer trucks in the roads hence reducing gas emissions thus enhancing environment conservation.

Technology on Supply Chain.

The supply chain management included material and information flow from raw material suppliers to the end-user. The sampled papers proved that new technological development increased the efficiency, visibility, transparence of inventory levels, demand forecasting, production processes, and logistics which emphasized technology as a facilitator to provide solutions to challenges facing supply chain. As the market expanded beyond borders and the demand increases, supply chain managers had no option whether to digitize their supply chains or not. As companies had little visibility which put revenue and costs at risk. Digitizing their supply chains helped businesses to: avoid breakdown of operations, increase real-time visibility, avoid any lags, build integrity and trust among partners, smooth decision-making, more accurate demand planning. Also, the use of AI surfaced in the literature to help in accurate planning, better management of inventories and operation optimization. In the previous studies technology was indicated as a good facilitator for both upstream and downstream operations via the use of disruptive technologies such IoT, AI, Blockchain by making supply chains more responsive, reliable, transparent, visible and traceable. The studies acknowledge the high use of technology in supply chain has also enhanced environment conservation by reducing traffic in roads which could have been used instead of technology. These findings were supported by Chen et al., (2022) when observed that the start of the pandemic disrupted supply chains worldwide and emphasized the importance of investing in digital technologies in order to keep supplying to customers. These technological innovations brought in artificial intelligence, cloud technologies, image recognition technologies, connected sensors, robotics, IoT and automated guided vehicles.

Last-Mile Delivery

In analyzing the sampled studies in the literature, last-mile delivery represented the most significant phase of the supply chain. As depicted by the research's technology enhanced efficient of last mile delivery. The researches in the literature outlined challenges facing last mile which included delivery inefficiency, high costs, delayed deliveries, low-visibility, outdated technology, inaccurate route planning. The papers explain that modern technology acted as a facilitator in

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addressing these challenges by providing faster deliveries, low cost, accurate routing, higher visibility and efficient deliveries. Advanced technologies such as AI and Machine Learning (ML) helped last-mile delivery by managing complex set of data, using data systems to control patterns and phenomena, create models on predictive analysis. AI in the studies is indicated as helped demand planning to forecast more accurately followed by more optimized inventories, dispatches and reduced errors by 30%-50%. The use of robotics in warehouses helped with the tracking, locating and picking up inventories faster by allocating the workforce skills in areas where they are needed the most. AI and Machine Learning helped in providing full visibility of goods by providing information on disruptions, delays or risks in routes. Vital Record Online (VRO) which are a comprehensive solution designed to streamline and simplify the management of vital records applications aimed to solve the inadequate and long routes by minimizing transport costs, reducing the number of vehicles on the roads, reducing the level of gas emission hence led to environment conservation. Smart cities embraced the use of autonomous vehicles such electric cargo bikes, drones and robots for faster and cleaner delivery again affirming that technology helped in environment conservation sustainability. Start-ups used technological innovations to solve the challenges faced by last- mile delivery by using technology to mitigate: routes, demand forecast, real-time visibility, faster delivery, route optimization, track packages and be aware of delivery times, delays anticipations or deviations. Technology in the literature showed efficiency in Business to Customer (B2C) and Business to Business (B2B) models. Precisely for B2C businesses by investing and innovating in customer' communication tools such messaging apps, chatbot, offering them visibility over their product location via geo-location apps. On the other hand, for B2B businesses, technology made it more efficient. Some of the advanced used to facilitate business recorded were Artificial Intelligence (AI) and Machine Learning (ML) in the supply chain processes, IoT in location management, inventory tracking, delivery status, and warehouse management, Blockchain in reducing bottlenecks and increasing transparency, cloud and robots in increasing efficiency in delivery and warehousing. All these technologies were opined in the literature to have led to environment conservation since they do not release any harmful gases to the environment. These results were supported by Wang, et al., (2023) when stated that the success of last-mile delivery is closely linked to technological developments, usage of autonomous vehicles, IoT, AI, and Machine Learning.

5. CONCLUSIONS

The study concluded that the researches in the literature opined that more business turned into online business system post Covid-19 pandemic. The study also concluded technology enhanced last mile delivery by enhancing its effectiveness. The study concluded that last-mile experienced some challenges and use of technology was a strong contributor to solutions of mitigating the challenges. The study also concluded that the use of technology enhanced environment conservation sustainability by reducing the number of vehicles in the roads in which orders of one specific location were transported in one track instead of each individual driving to the stores.

6. RECOMMENDATIONS

The study recommended increase of use of modern technology to enhance further last mile delivery. The study also recommended that technology should be used by consumers in the pre-planning process and order multiple goods at the same time specifically if they are ordering from

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the same company this would make sure all their goods are delivered once instead of several different trips. By ordering all goods together, the distributing company can provide these goods in one truck in one trip reducing gas emissions. Also, the distributing company can use one big package instead of usage of multiple small boxes which will be deposited as trash and thus increasing the environment pollution. Using technology in mitigating planning in advance means receiving goods when needed, instead of spending extra money on rushed deliveries, which add more trucks on the roads, more traffic, more likely accidents and increased levels of environmental pollution. The study also recommended that start-ups attempting to enter the market embrace modern technology to enhance last mile delivery and enhance environment conservation sustainability. The study recommended companies to embrace technology in their supply chain and governments to collaborate closely with start-ups, businesses and consumers for dissemination of possible technology solutions thus enhance more last mile deliveries and increase environment conservation sustainability.

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