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Digital Transformation in the Logistics Industry using Industry 4.0 Technologies

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ABSTRACT

In this modern generation, companies are shifting from manual operations to digitalization that helps to manage business issues, complexity and accessibility-related problems. However, it is difficult to determine the impact of Industry 4.0 technologies on logistics especially in developing countries like Nigeria as just a few instances have been cited. The fundamental objective of this study is to investigate the ways in which Industry 4.0 and the technologies connected with it have an effect on logistics. In addition, this research aims to provide guidance to small and medium-sized organizations.

For the most part, the analysis in this research is driven by qualitative data using a logidtics company called Fairdeal Supplies as the case study. Ten workers in the companies were interviewed using an interview guide. Secondary data for the research came from a variety of sources, including databases, online publications and books.

Industry 4.0 has proven to have a significant influence on logistics, and the technologies that underpin this next iteration of the industrial revolution make it feasible for logistics to be carried out in real-time with the bare minimum of interference from human workers. Despite this, Industry 4.0 is still in its infant phases, with just a small number of installations at this point. There is a significant gap in the resources available to small and large organizations, which results in different approaches to the incorporation of new technologies.

(Keywords): Industry 4.0 Logistics, digital transformation, smart technologies.

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ABBREVIATIONS

AGVS - Automated Guided Vehicle System

AI – Artificial Intelligence

AITS - Automated Inventory Tracking System

ANLCA - Association of Nigerian Licensed Clearing Agent

CAC - Cooperate Affairs Commission

CRFFN - Council of Registered Freight Forwarders of Nigeria

EDI - Electronic Data Interchange,

GIS - Geographic Information System

GPS - Global Positioning System

ICT - Information and Communication Technology

IDT: School of Innovation, Design and Engineering

IoT - Internet of Things

MDU: Mälardalen University

RFID - Radio Frequency Identification

SMEs - small and medium scale enterprises

VRT - Voice Recognition Technology,

WBT - Web-Based Tracking,

CHAPTER ONE

INTRODUTION

1.1 Background of Study

In this modern generation, companies are shifting from manual operations to digitalization that helps to manage business issues, complexity and accessibility-related problems. The digital transformation helps companies to implement automated systems and information systems to improve business processes and efficiency. Digital technologies have the potential to deal with data management, business operations and human errors so that multiple activities can be performed in less time (Acioli et al; 2021). Since the beginning of industrialization, technical advances have sparked fundamental shifts that are now referred to as "industrial revolutions" (Lasi et al., 2014). The "Industry 4.0" approach provides a range of benefits, including improved operational efficiency and the development of new business models, goods and services (Hermann et al., 2016).

In the logistics industry, Industry 4.0 technologies play a major role that enables the logistics companies to shift manual operations to automation and digitalization and increase performance and market capabilities. Industry 4.0 covers various technologies including the internet of things (IoT), cloud computing, big data analytics, cloud computing, Radio frequency identification (RFID) technology, automation and many more. Using such technologies, it is easy for logistics companies to develop automated and remote access controls so that accessing and processing logistics operations can be done effectively (Schumacher et al., 2016). Industry 4.0 has made it possible to track material flows in real-time, manage predictive maintenance, make prompt adaptive decisions, prevent asset breakdowns and increase organizational economic level (Zhong et al., 2017)

Processes utilised in "Industry 4.0" that are applied across a communication channel promote marketing-focused tactics to services (Roblek et al., 2016). Furthermore, the logistics network participants benefit from improved communication and coordination, thanks to fully connected IT infrastructures that include fully integrated apps and agreed-upon data standards (Rai et al., 2006). Businesses are attempting to decentralize their value-adding activities in order to compete on a global market, and this shows the relevance of Industry 4.0 technologies in integrating suppliers, producers, customers or other collaborating firms, recognized as logistics integration

(Gunasekaran and Ngai, 2004). In the same way, the advantages of Industry 4.0 include increasing efficiency, automation and production (Haseeb et al., 2019).

Predecessor industrial stages have previously matured with regard to information and communication technology (ICT) adoption, hence Industry 4.0 has been recognized in developed markets (Dalenogare et al., 2018; Bartodziej, 2017). There may be a substantial disparity between established and developing economies in terms of Industry 4.0 adoption at this stage since nations with highly skilled workers may be able to reap the benefits of a greater degree of automation (Dalenogare et al., 2018). Many emerging nations, on the other hand, have a youthful and tech-savvy workforce that allows them to take advantage of automation potential.

Organisational value and network views may be influenced by disruptions brought on by digitization (BüyÜközkan and Göçer, 2018). The emphasis on digitization is only one aspect of Industry 4.0, which emphasises the need for businesses to become more digital (Glas and Kleemann, 2016). Advanced aspects of Industry 4.0 such as real-time capabilities, the use of ICT systems via vertical and horizontal integration, as well as capacity to interoperate are nevertheless seen as present hurdles for businesses to remain competitive. Industry 4.0, its technologies which assist organisations in operationalising this change need diverse efforts, thus the existing consensus may make it difficult to grasp (Colli et al., 2018). As a result, academics and practitioners alike must contribute to a better understanding of the notion and its long-term implications (Ibarra et al., 2018).

An effective evaluation of Industry 4.0 is a key method of study since the technical architecture of Industry 4.0 may be seen as complicated (Lee et al., 2015). Because of this, academics and practitioners have emphasised the importance of integrating digital systems and smart processes; nevertheless, this inclusion must be taken in both “horizontal level” which is inclusion of all value chain members, and “vertical level” which is incorporation of all spheres of automation (Schumacher et al., 2016).

1.2 Problem formulation

Some studies have suggested paradigms, roadmaps, maturity or preparedness assessments for practical deployment of Industry 4.0 (Schumacher et al., 2016; Ghobakhloo, 2018; Sony and Naik, 2019) but it is still uncertain about the impact of Industry 4.0 systems on the concepts of logistics (Ivanov et al., 2018).

Consequently, it is difficult to determine the impact of Industry 4.0 technologies on logistics especially in developing countries like Nigeria as just a few instances have been cited (Tjahjono et al., 2017). It is hard to explain the connection between improved logistics and the rise of Industry 4.0, given the small number of empirical research that have attempted to detect the technology's impact on logistics (Lin et al., 2018; Ardito et al., 2019; Ivanov et al., 2018).

1.3 Aim and research questions

For growing logistics firms and small and medium scale enterprises (SMEs) looking to gain an edge over their competitors, this research aims to provide a thorough grasp of Industry 4.0 and its influence on already in place logistics. New systems need a considerable investment of human, monetary and physical resources. Therefore, entrepreneurs will have a grand plan and take the necessary actions in order to take opportunities and overcome the challenges in attempt to comprehend the developmental needs as well as their limitations, such as the necessities of quality, structure, educational and professional skills for industrial growth, digitization and international economic integration.

All of these clarifies the primary research question:

i. How does Industry 4.0 affect growing firms and SMEs in the logistics industry in Nigeria?
ii. What are the perspectives of employees on Industry 4.0 in SMEs in the logistics industry in Nigeria?
iii. What is the current maturity of Nigeria logistics industry and which challenges are they facing when considering the implementation of Industry 4.0 technologies?

1.4 Project limitations

Industry 4.0 technology is still relatively new in some countries, and the amount of country-specific academic research that is now available is minimal. The approach for assessing maturity is still in the process of evolving, and future connections with benefits will reinforce findings. As a result, the interviews that were conducted runs the danger of not accurately representing the opinions of a greater population. There is a possibility that one of the obstacles to self-examination is the present level of maturity, or lack thereof, of competency and preparedness with regard to digital technology.

Both a delimitation and a limitation of the research is that it is limited to analysing a single company's operations. It should be feasible to generalise from a single example or a small number of cases in qualitative research. The author's personal and financial restrictions meant that he or she could only devote sufficient time and energy to one enterprise. Generally speaking, the time constraint meant that most components of this research were prepared in one month's time owing to the late availability to source data in relation to the thesis project timeline. Due to the researcher's lonesome efforts, the study can only take place during the researcher's waking hours. Traveling for interviews or making other substantial investments in the data collecting or analysis for the thesis project are out of the question given that this study is financed entirely by the researcher's own, restricted budget.

CHAPTER TWO

RESEARCH METHODOLOGY

This chapter's goal is to detail and explains the research approach and methodology used in this study. Sources and techniques utilized to improve reliability and validity will also be discussed in this report.

2.1 Research method

For research, both qualitative and quantitative methodologies may be used. They vary in that the qualitative technique depends more on the spoken and written words, as well as any visual evidence, while the quantitative method requires a vast study area and is statistically significant in order to answer the issue (Brannen, 2017). The size of the sample is determined by the researcher's requirements.

Quantitative data can be more easily analysed with the help of graphs, statistics and diagrams. On the other hand, qualitative data must be formatted by the researcher in such a way that it can be more easily applied to the research by making use of definitions and phrases that are related to the subject matter of the study (Queiros et al., 2017). In quantitative research, the concepts and hypotheses are used to develop predictions about what is taking place. In quantitative research, measurement is an absolutely necessary component. Quantitative research is often used in situations where the research model has been articulately described and the research hypotheses have been generated from the theory (Streefkerk, 2019).

Because this thesis investigates the implications that Industry 4.0 will have on logistic processes, a qualitative approach is more suited than a quantitative one. This is because perceptions, attitudes, ideas and views are difficult to analyse using quantitative methods. It is possible to employ qualitative methods in order to conduct in-depth research on a firm, its internal behaviour and the external elements that influence it in order to get a better understanding of thoughts and opinions about the effect that Industry 4.0 have on logistics.

2.2 Fairdeal supplies and logistics- Case Study

Fairdeal supplies and logistics limited is a growing logistics firm in the provision of cutting-edge logistics as well as supply chain services and solutions. 2019 marked the beginning of Fairdeal's logistics operations and a registered member of the Council of Registered Freight Forwarders of

Nigeria (CRFFN) and the Association of Nigerian Licensed Clearing Agent (ANLCA). The company is authorised to ship, manage and deliver cargo in addition to providing other types of logistics services. This authorisation comes from the Cooperate Affairs Commission (CAC) of Nigeria. Fairdeal supplies and logistics is in an excellent position to service both local and international clients in the world's marketplaces that are expanding at the quickest rate. The firm has its headquarters located in Lagos, Nigeria.

The company is chosen as a case study because of how well it is used by many Nigerians for logistics services and also because of their previous early adoption of logistical technologies that would improve their operations.

2.3 Methods of collecting data

Researchers have two options available to them in order to fulfill their need to obtain data. Interviewing participants and interviewing subject matter experts are both examples of procedures that fall under this category (Bougie and Sekaran, 2019). One of the most common methods to get this information is via the use of interview guides, questionnaires and surveys that have been designed by the researcher. In addition to the correctness of the questions that were asked, primary data collection is a method that may be relied upon for accurate data acquisition. One advantage of utilising primary data is that the information is constantly up to date, which makes it simpler for the researchers to trust in the results of their investigations.

It is possible that collecting and analysing primary data may be time-consuming and expensive if the control groups are large and the questionnaires are completed either by mail or in person. The fact that it is very hard to find individuals to speak with for interviews and that questionnaires and surveys are of very little or no use in this investigation is the primary challenge presented by this methodology.

A second option is to collect secondary data. Finding the most relevant information is done by going through everything including definitions of related terms and past studies on the issue. For researchers, its speed and low cost are the most important advantages (Bougie and Sekaran, 2019). If the information in question is publicly available, however, then this is an option. Due to the fact that a third party has previously processed the information, secondary data analysis may be conducted far more rapidly than the primary data analysis. Secondary data may be analysed to get fresh insights on previously published studies on the topic.

As a result, independent verification in similar research or the author's own study is required to ensure secondary data is as trustworthy as primary data. For new or poorly investigated topics, researchers must sift through vast amounts of unrelated secondary data before they can begin to draw conclusions about their original study. Secondary research data is especially difficult to get when the primary study is new or poorly established (Bougie and Sekaran, 2019).

The collection of primary data was carried out for the aim of this thesis. Surveying the personnel of a logistics firm (Fairdeal supplies and logistics) using open-ended questions and conducting in-depth interviews with the goal of obtaining the most accurate data available. The author was able to make the trip to Nigeria in order to acquire primary data in relation to the culture and economics of the nation. Several staff of Fairdeal logistics were interviewed in order to ensure that the study is as precise as possible. It has been determined to be of the utmost importance, in terms of the digital transformation of the logistics industry, to have a more in-depth familiarity with the Nigerian culture via first-hand experience as well as academic research. This method is referred to as interpretivism by Bryman and Bell (2005). Interpretivism means that the researcher studies the item in its natural situation in order to obtain a grasp of the theory, which in this case refers to the effects of Industry 4.0 on logistics.

2.3.1 Method of data collection for theoretical framework

In order to address the issue of the study, a number of different databases were reviewed. It is essential to search for information using databases that have been validated by the organisation. ScienceDirect, Scopus, Emerald, ProQuest, Google Scholar and Malardalen university search engine, primo were used to locate relevant literatures. In order to locate the materials that are pertinent, a number of search phrases, such as "logistics," "digital transformation," "industry 4.0," were used. In conclusion, this thesis will discuss some of the works that have been done on the issue of the influence that digital transformation would have on the logistics business by using industry 4.0.

2.4 The respondents

The portion of the overall population, also known as the sample, has been chosen for this study on the basis of a non-profitability approach. This approach indicates that the sample has not been picked via the use of a technique that involves random selection. In order to choose respondents for the case study, we went for a method called purposeful sampling (Fairdeal). Purposeful sampling, also recognised as selective, judgemental or subjective sampling is a type of non-

profitability sampling in which researchers rely on their own judgements when selecting individuals from the population to take part in their survey (Etikan et al., 2016). There were ten people selected to participate, and the criteria that led to their selection included the roles and positions held in the firm and also, familiarity with Industry 4.0 and the ways in which it would affect logistics operations.

2.5 Interviews

It is important to gather as much data as possible from the chosen firm in order to have a better knowledge of the impacts that Industry 4.0 is having on the logistics industry.

Qualitative interviews were used to gather primary data. Qualitative interviewing differs greatly from quantitative interviewing in many ways. For example, qualitative interviewing is often far less formal than quantitative interviewing (Bryman et al., 2007). Qualitative interviews are flexible in that the interviewer can deviate from a set schedule, new questions can arise from responses from interviewees, and the order of questions can be revised in response to responses from interviewees. In addition, qualitative interviews are flexible because they allow the interviewer to respond to interviewees and adjust their approach to the interviewee (Bryman et al., 2007).

Qualitative interviews may be conducted in a variety of ways, including unstructured and semi-structured methods. In an unstructured interview, the researcher asks a question and then attentively listens to the respondents as they speak freely, while in a semi-structured interview, the researcher follows a checklist of topics and questions they want to cover throughout the session (Bryman et al., 2007). Semi-structured interviews were chosen because we wanted to promote respondents' open discussions of what is preventing their businesses from growing. Using open-ended questions, we will be able to tailor our questions to the specifics of each company and the difficulties they are facing. The semi-structured interview, according to McIntoch and Morse (2015), is neither a free discussion nor a heavily organised questionnaire. When conducting semi-structured interviews, the interviewer may choose the sequence of questions, allowing respondents to talk freely on a wide range of topics rather than depending solely on pre-determined themes and questions. Semi-structured interviews, on the other hand, are more adaptable than a traditional procedure like the structured interview or survey.

Qualitative interviews using open-ended questions suffer from the issue of being "flavoured" by the interviewer's interest and ideas (Balfe et al., 2016). This kind of interview has a pre-

determined topic, but the follow-up questions will be based on the interviewer's own preferences. Miscommunication and erroneous interpretations of one another's statements are still potential sources of conflict. In order to boost the validity of the responses of the respondents, every interview was recorded and thereafter, transcribed.

2.6 Data Analysis

The obtained raw data is processed in order to provide relevant information, which has been crucial in assisting the provision of improved knowledge and comprehension of the topic that is being studied. Since this is a qualitative study, the data collected are subject to qualitative analysis, and the findings are given in form of texts based on what the participants in the study have said (Dubovec et al., 2016). The data collected is analyzed through the use of narrative analysis, a technique that is used to analyze how the respondents construct the stories and feedback that they are providing to determine whether they are able to provide meaningful information that can be relied upon and help in building a better understanding of the research topic being presented.

2.7 Reliability and validity

Qualitative research relies solely on the notions of reliability and validity, which are critical to determining the study's objectivity (Cypress, 2017). The degree of trustworthiness and credibility of a study may be gauged by looking at its reliability and validity. There are two distinct conceptions of reliability and validity, which are internal and external, according to Bryman et al. (2007). As long as there is at least one researcher in the study group, observers are able to what they see and hear. If a study's findings are similar to those of the original, it is said to have "external reliability". High external dependability may be challenging to obtain since the situation and setting are likely to vary from the initial study to a second done. A technique suggested by Bryman et al. (2007) is to take on a position comparable to the original researchers in order to duplicate the original study. As a result, in order to ensure the validity of this thesis, this chapter goes into great length on the methods used to collect data and conduct interviews. Appendix 1 contains all of the questions that were asked during the interview. The full explanation makes it easier for another researcher to duplicate this study under identical circumstances and get the same or similar findings.

The term "internal validity" refers to the extent to which the researchers are able to concur and arrive at the same conclusions, more specifically, it examines whether or not there is a good

match between the researchers' observations and the theoretical ideas that they develop throughout the course of the research (Bryman et al., 2007). Because qualitative researchers have a tendency to study the social milieu for an extended period of time, which often results in great correspondence between observations and conceptions, internal validity is typically considered to be a strength of qualitative research (Bryman et al., 2007). External validity, on the other hand, might be perceived as an issue within qualitative research due to the fact that it relates to the amount to which results can be applied in different social situations, and qualitative researchers often make use of small sample and case studies (Bryman et al., 2007). In this thesis, all interviews have been recorded, and after the interviews have been transcribed, the content was given back to the respondents to obtain their endorsements of the transcribed material. This was done to increase the validity of the research and to decrease the likelihood that the author used his own interpretation of the data.

2.8 Ethical considerations

As the research involves data collection through the use of primary techniques, there are certainly ethical considerations that must be taken into account in order to generate viable conclusions and help in building up research that is inclusive. However, the respondents' identities have been agreed to be kept anonymous for the purpose of protecting them. The participants were not coerced in any way to engage in the research, rather, they were allowed to participate out of their goodwill. Prior to the conduct of the research, the respondents' informed consent were sought so they could be aware of the research questions and prepare in advance for the research. The information collected from the research will only be used for research purposes, hence it will be kept confidential. The results generated will be communicated to the respondents before they can be released to the public.

2.9 Time plan

The research was conducted within a period of six (6) months in which the activities conducted included preparation of research, literature review session which involved the collection of relevant literature that was used for the research, data collection, analysis of data collection and presentation of the research for the final examination. All these activities followed each other in quick processions an act that provides an opportunity through which relevant information can be generated for the research.

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CHAPTER THREE

THEORETIC FRAMEWORK

The primary objective of this chapter is to provide an explanation of the idea of Industry 4.0 as well as the technologies that are associated with it. This topic is important to this research because it provides information that can be used as a foundation for further analysis of the impact that Industry 4.0 will have. As a result, it is essential to have a solid understanding of all of them that are associated with this study in order to fully appreciate its relevance.

3.1 Industry 4.0

The fourth industrial revolution, known as "Industry 4.0" is characterized by the interconnectedness of industrial systems via the use of the Internet of Things (IoT), automated machinery, real-time data management and analysis, as well as other technologies (Hasnan and Yusoff, 2018). Bag et al., (2021) reported that Industry 4.0 technology focuses on digitalization and enable companies to access emerging technologies and automated systems. It is capable to combine internet networks and communication technologies and connecting with business operations so that manual activities can be done through automated systems and technologies. In this digital era, logistics firms are providing online services through web servers and applications where digital technologies are effective to deal with data management and accessibility-related problems. Figure 1 highlights the various technological pillars of Industry 4.0

Figure 1: Industry 4.0 technological pillars (Bad et al; 2020)

For the first time in the history of the world, the fourth industrial revolution grew out of all three scientific and technological revolutions rather than just one (Morrar et al., 2017). Because as the third industrial revolution's technological advances, particularly the internet, the social element of life has undergone radical transformation, while the global economy has seen tremendous growth.

The third-industrial revolution-inspired advances in nanomaterial-based sensing technologies are also a part of the fourth industrial revolution's foundation. Because of advances in bio-electromagnetic circuits and artificial intelligence (AI), which can decode and analyse enormous volumes of data at lightning-fast rates and even infrared radiations, such as brain waves and emotions, previously considered to be inaudible (Bansal et al., 2019).

Industry 4.0 technology, however, has the potential to propose effective systems and networks which are capable to identify and manage the problems associated with business operations. Bag et al., (2020) examined that Industry 4.0 technology is not just about implementing new technologies and tools to improve efficiency but also focuses on revolutionizing business operations. Industry 4.0 technology focuses on digitalization and companies need to update systems and processes and connect with the technologies and automation so that internal and external issues can be resolved.

The features of the fourth industrial revolution according to Lee et al. (2018) are as follows:

I. Industries around the globe are being transformed by this explosive growth.
II. Everything from production, administration and management to service and human entertainment is being affected on a worldwide scale by this development.
III. Humans, robots and the virtual world all work together to create a symbiotic ecosystem
IV. Technology for waste-free product production has begun to emerge.

3.1.1 Internet of Things (IoT)

In the context of logistics operations, IoT technology helps to track products and provides remote access controls by which consumers can receive real-time updates and resolve queries related to the products and data tracking. Big data analysis is an effective Industry 4.0 technology that has the ability to create predictive analytical programs for logistic companies. Today, consumers are

accessing e-commerce and online shopping platforms that create larger and more complex data and it is challenging for companies to review and evaluate the larger datasets.

IoT-based communication systems are effective and reliable that enable logistics and other companies to create effective communication platforms and infrastructure so that connectivity can be maintained. IoT networks also various smart devices can be linked, monitored, communicated and controlled so that business issues and data access-related problems can be resolved. Bigliardi et al; (2020) identified that IoT-enabled devices and systems are capable to deal with communication problems and help companies to exchange information in the workplace.

For example, Amazon is an e-commerce company that has implemented Industry 4.0 technologies and IoT networks to obtain real-time information regarding the supply chain, logistic operations and inventory controls so that effective decisions can be taken (Yul et al., 2019). In this manner, Amazon enables the consumers to receive real-time updates in regards to product delivery and proper tracking programs can be provided. The presence of IoT networks in logistic systems is effective that delivering a way to connect various systems and departments through a single network so that data or information can be exchanged in less time (Tran-Dang et al., 2022)

3.1.2 Big Data Analytics

Data analysis is one of the major problems associated with the logistic systems and operations as collected data from consumers contains structured and unstructured data where analysis cannot be done effectively. Industry 4.0 technology provides big data analytical tools which are capable to analyze and evaluate the collected data so that data management and handling issues can be resolved (Cimini, et al., 2019). In order to manage such data handling problems, Industry 4.0 provides big data analytical tools which are capable to create effective analytical programs and connect with the data collection processes. Logistics companies through big data analytics can review the obtained data and identify the requirements of consumers and demands of the logistic services. Predictive analysis is a part of big data that has the ability to predict and examine the demands and review the gathered data so that significant information can be extracted and effective decisions can be created. Hopkins, (2021) identified that data analysis helps to predict more accurately the demand and the organization can increase the effective use of the logistic assets and deliver convenient facilities to the consumers. Sensors are now added in the logistic

operations and systems which are capable to record the conditions of machines and networks used in the warehouses and also provide proper tracking and monitoring facilities.

With the help of Industry 4.0 technologies, logistic companies can maintain the effectiveness of the supply chain and inventory control-related issues and also enable the consumers to access logistic facilities and manage queries in less time. Jagtap et al., (2021) stated that digital technologies contain the developments of automated systems and programs by which logistic companies can perform business operations automatically and manage complexity. Digital transformation contains the developments of digital technologies and systems for the companies and in the logistic industry, digital transformation increases market capabilities and operational efficiency. Therefore, it is important for the management to implement big data analytics that can help to extract effective information from the larger datasets so that challenges and issues faced by the consumers can be minimized and problems related to product delivery can be reduced.

3.1.3 Blockchain technology

Blockchain is another Industry 4.0 technology that helps logistics companies to build effective business models and store transactional data. Blockchain is mainly designed for dealing with financial and transactional problems that provide decentralized systems to store the collected data and manage accessibility issues (Aoun et al., 2021). Data transparency is a major feature of blockchain technology that has the ability to increase the transparency of collected data as it enables the logistics companies to manage requirements of additional resources and third parties so that transparency can be enhanced (Yaqoob et al., 2021).

In terms of security, logistics companies face data breaches and hacking problems as the collected data from consumers and product information can be accessed by hackers easily (Kumar et al., 2020). In order to manage data breaches and security problems, Industry 4.0 delivers blockchain-based security programs which are capable to deal with insider and external threats. The blockchain contains cryptography programs that are capable to convert data into codes using private keys so that logistic companies can collect transactional data from consumers and third parties and store it in databases with higher security. Nascimento, et al., (2019) reported that as compared to traditional logistics, modern and advanced logistic systems are capable to deal with accessibility, data storage and performance-related concerns.

3.1.4 Artificial Intelligence (AI)

AI is an effective Industry 4.0 technology that has the ability to create automated systems and programs by which logistic companies are capable to create automated systems and machines for logistic and supply chain management. AI-enabled devices are capable to perform logistic operations and activities automatically and reducing human errors and problems in less time so that the effectiveness of the logistic companies can be improved (Hacioglu and Sevgilioglu, 2019).

As compared to other Industry 4.0 technologies, AI technology is more effective and suitable for the logistics industry that has the ability to improve learning, thinking, perception and action through training from data and algorithms. With the help of AI robots and automated machines, logistic companies are capable to manage human errors, predicting the demands of logistic facilities and maintaining market abilities by understanding and managing the internal problems related to supply chain and inventory controls. Communication plays a major contribution in the logistic industry that helps to interconnect with the computing systems and perform business operations easily. Artificial intelligence is capable to create automated communication systems through machine learning by which communication with consumers can be done in less time and their queries can be resolved properly without requiring human assistance (Oleśków-Szłapka, and Stachowiak, 2018).

Using such automated systems and networks, it is easy for the logistics companies to maintain satisfaction and consumer experience that helps to increase operational efficiency and productivity. Delivering a better consumer experience is significant to keep the business performance and manage satisfaction level. Using Industry 4.0 technologies, logistic providers are capable to offer real values along with the supply chain by which problems and issues related to consumer satisfaction and product distribution can be reduced effectively. Papadopoulos, et al., (2021) agreed and found that Industry 4.0 technologies propose business models and plans by which the logistic companies are capable to create effective plans and strategies so that operational performance and objectives can be achieved. Smart warehouses are now developed by the logistic companies through Industry 4.0 that contains digital networks, AI robots and remote access controls by which storing, distributing and delivering products to the consumers can be done in less time (Van Geest et al., 2021).

Industry 4.0 technology enables warehouse managers to monitor products down to the item level, streamline order processing through robots and AI systems and increase inventory accuracy by dealing with the complexities and human errors (Radivojević, and Milosavljević, 2019). The applications of wearable technology in logistic operations help to expedite picking operations in the warehouses and monitor the effectiveness of the logistic systems and programs. In the context of data-driven marketing and decision making, Industry 4.0 technology helps logistic companies to review data related to the products and consumers and develop effective decisions to achieve the organizational goals or objectives.

3.1.5 Cloud computing

Cloud computing is increasing rapidly which helps to operate logistics operations and activities through cloud-based servers and programs by which it is easy to access services and deal with data storage and management-related concerns (Iyoob et al., 2013). Therefore, it is important for the logistics companies to implement Industry 4.0 technologies that can help to manage the complexity and enable the consumers to receive real-time updates and track data in less time by which operational efficiency and productivity can be improved. Cloud computing is another technology included in **Industry 4.0** that has the ability to provide on-demand data storage systems and networks (Bongomin et al., 2020).

Today, companies collect data from consumers that contains larger datasets and it is difficult for the management to store and review such complex data. Cloud computing delivers a platform to store or record the collected data from consumers easily so that data management and handling problems can be reduced. Buntak et al. (2019) stated that cloud technology delivers the central platform for the data storage and integration of configurable information technology sources. With the help of cloud technologies, it is easy for logistic companies to build service-oriented architecture and provide software-based services to customers so that the accessibility of collected data can be accessed easily.

3.2 Impact of Industry 4.0 technology on the operational efficiency of the logistics industry

According to Cimini et al; (2019), the logistics industry is capable to implement digital technologies and systems which are capable to deal with business problems and issues easily. Industry 4.0 technology has the potential to propose automated systems by which logistics companies can automate logistics operations and processes and enable the management to deal with business problems. As compared to the traditional operations, technologies and automated

systems reduced the efforts and complexity of the logistic operations by delivering analytical, data management and processing systems. Using information technologies and communication networks, it is easy for logistic companies to manage business problems and process logistic and supply chain operations automatically (Feng and Ye, 2021).

Dachs et al., (2019) stated that logistic performance has a crucial role in the industry that requires proper systems and programs to deal with logistics-related concerns. Industry 4.0 has the potential to examine and review the issues and complexity associated with the supply chain and logistic operations. In the last four years, Industry 4.0 technologies have shifted logistics operations to automated and digitalization and provided better facilities to both consumers and logistic companies (Efthymious and Ponis, 2021). Industry 4.0 technology plays a major contribution in the digital transformation in a logistic sector that provided innovative ideas and systems to maintain productivity and enhance operational efficiency.

The inherent digital transformation enhances particularly responsiveness in the fluctuation in demands and increases flexibility related to the supply chain and logistic operations. Information system has the ability to process and evaluate data storage and review the business processes through computing tools and systems. According to Dalmarco et al., (2018), Industry 4.0 technology develops communication and IT infrastructure by which manual operations and programs can be shifted to digitalization and communication gaps can be minimized. Optimizing logistic processes and operations requires advanced technologies and systems and Industry 4.0 enabled the companies to create effective optimization systems so that supply chain and inventory control activities can be optimized effectively.

The rapid development of IT and Industry 4.0 technologies create digital logistic and supply chain systems by which it is easy for the companies to personalize the products and services for the consumers. Industry 4.0 technology also makes it possible to adjust to the requirements of users and reduce the requirement of additional resources and systems by which logistic companies can manage financial and expenses related issues (Dalmarco, et al., 2019). The major feature of the Industry 4.0 technology is that it enables the logistics companies to create effective communication systems to interact with the management and consumers easily and provide real-time updates regarding supply chain and product distribution.

Tracking is one of the major features provided by Industry 4.0 technology that helps the logistics companies to track and monitor the updates regarding products and supply chain activities by

which it is easy to create decisions and deal with the queries of consumers. To make accurate and effective decisions, Industry 4.0 technology provides analytical programs and tools by which management is capable to access real-time supply chain and logistic data and provides better assistance to the consumers.

Industry 4.0 technology is capable to create automated and remote access control-related systems in logistics companies to collect, analyze, integrate and interpret the higher quality and focus on consumer satisfaction and efficiency-related problems. Elbasani et al; (2020) examined that Industry 4.0 technology build automation and digital systems by which it is easy for the logistics companies to manage the accessibility and data handling related problems. The automated systems are beneficial for the logistic companies to manage products in the warehouses and also track the products and deliver to the consumers with proper tracking facilities. In the context of operational efficiency, Industry 4.0 plays a major contribution as it provides advanced technologies and communication systems by which maintaining communication gaps and getting proper information can be done in less time that positively influences operational performance. Figure 2 helps summarises how Industry 4.0 is utilized in the logistics industry.

Leading logistics companies such as UPS and DHL have already implemented Industry 4.0 technologies and human robots to collect products and stores into the warehouses without requiring human efforts and also manage complexity and errors effectively. IoT is one of the effective technologies that can be implemented in logistics companies as it is capable to deliver communication platforms and interconnecting various devices, networks and programs through a single system so that monitoring and tracking can be done in less time. Facchini, et al., (2020) stated that IoT technology helps to track products and objects and also share data or information from one server to another without requiring additional resources so that collecting real-time information regarding logistics and supply chains can be done easily. With the help of IoT networks, logistics companies can propose remote access controls where accessing supply chain and logistics operations can be done from any location.

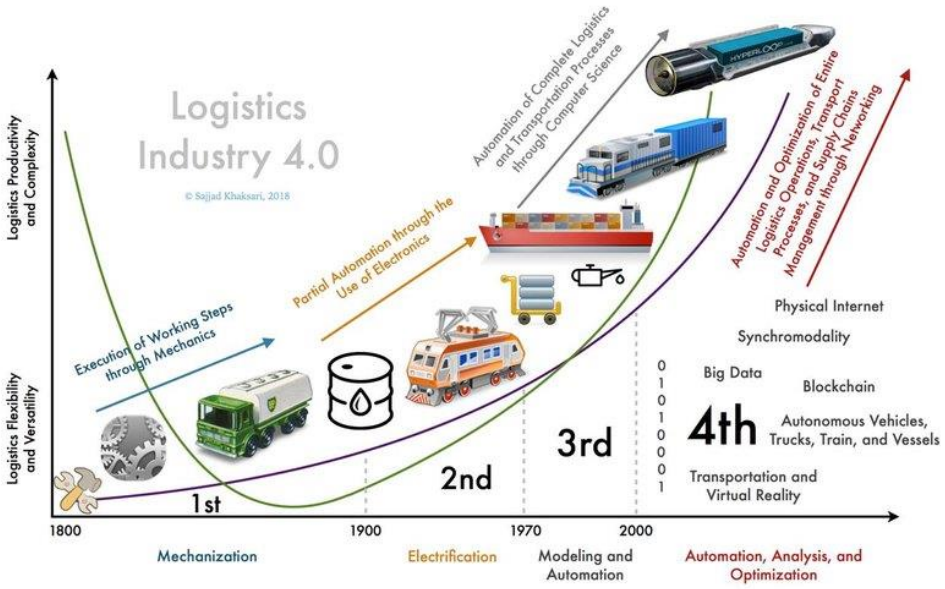

Figure 2: Industry 4.0 in the logistics industry (Dalmarco, et al., 2019)

3.2.1 Technology in Nigerian Logistics Industry

The logistics and supply chain industry is one of the fastest growing businesses in Nigeria, but still in its fledgling stage. Revitalizing the courier, logistics, and transport business in Nigeria via effective legislation and strong management oversight is essential to the country's efforts to diversify its economy. According to Business Day Online (2018), Nigeria's economic development and market competitiveness depend on the country's success in international trade logistics. It suggests that the logistics industry in countries is increasingly being seen as an engine for development.

As a result of the country's large population, rapidly increasing urbanisation, and booming economy, logistics development now accounts for 18.8% of GDP in Nigeria. When thinking about the Nigerian economy, it is useful to look at Lagos state as a case study. The Logistics Performance Index (2008) reports that over the previous two years, the performance of Nigeria's logistics companies has plummeted owing to issues with tracking and tracing, the clearing procedure, the high cost of acquiring effective IT infrastructure, and delays in delivery. Due to the sector's continued underperformance, the 200 billion dollar industry has dropped from its 2014 ranking of #70 to #90 out of 160 nations in the 2017 study, dropping the country's overall ranking by 4%.

In addition, the prohibitive expense of maintaining IT facilities or replacing their inferior technology with current facilities means that most logistics organisations in Nigeria still use the

rudimentary methods of operations for information collecting (Apulu et al., 2013; Tallapragada, 2009; Akpan-Obong, 2009; Alam and Noor; 2009). By 2025, Lagos is projected to overtake New York City as the world's 12th most populated metro area, thanks in large part to the city's thriving consumer-facing service sector and rapid urbanisation (approximately 50 percent) (Obi, 2017). This suggests that Nigeria would develop into an industrial and services-based economy as a result of high rates of urbanisation and the incorporation of technology in logistics and manufacturing enterprises.

Barcoding, RFID, Voice Recognition Technology, Electronic Data Interchange, Global Positioning System, Geographic Information System, Web-Based Tracking, Automated Guided Vehicle System, and Automated Inventory Tracking System are just some of the technologies that have been identified as having the potential to improve logistics performance in Nigeria.

3.3 Benefits of implementing Industry 4.0 technology in logistics operations

Implementing Industry 4.0 technologies are beneficial for logistics companies to control and reduce the challenges associated with logistic operations and handle the supply chain problems in less time. Raj, et al., (2020) stated that Industry 4.0 technologies focus on the digitalization of logistics and supply chain operations by which management can maintain performance and reduce the complexity or errors. The key feature of Industry 4.0 technology is that it creates digital transformation programs by which product delivery, warehouse operations and data processing can be done in a significant manner. Through digital transformation, the logistic industry alters current operations, integrates new initiatives and implements efficient driven cultures by which consumer experience can be enhanced and market capabilities can be improved (Dolgui and Ivanov, 2022).

The following are some of the benefits or advantages of implementing Industry 4.0 technologies in the logistic industry:

- ✓ **Provides automated vehicles and systems**

Automation plays a major contribution in logistic operations and Industry 4.0 technology is capable to create effective automated systems and digital networks that enable logistic companies to shift manual operations to digitalization. Bag et al., (2021) examined that the logistic industry mainly deals with various processes including data management, warehouse operations, inventory controls and supply chain operations where manual processes are less capable to

provide better outcomes. In order to manage such concerns, Industry 4.0 technology provides AI-enabled devices and automated vehicles to the logistic industry which are capable to perform product distribution, management in warehouses and shipment-related activities automation.

Autonomous vehicles are now added in the warehouses to control and reduce the errors or complexity faced by humans and also enable the management to store products in a reliable manner. Autonomous trucks or vehicles promise effective benefits for the logistics industry that reduce the problems and issues associated with warehouse operations and enable the logistics companies to increase performance through automated systems and machines (Othman, 2022). Bongomin et al., (2020) conducted research and observed that autonomous vehicles are beneficial for the logistics industry to reduce human errors, manage inventory-related problems and save time to distribute orders from warehouses to the consumers. In terms of speed, autonomous vehicles are faster and more reliable that deliver a platform to store and transport products from one location to another without requiring human assistance.

In this manner, wireless sensor networks and machine learning algorithms are used to create automation and also exchange information between machines and devices easily. Autonomous vehicles are capable to help logistics businesses completely integrate inventory administration using ERP and AI systems. Buntak, et al; (2019) stated that from a business organization perspective, autonomous driving in the logistics sector would be more effective as compared to manual operations that can provide real-time updates and monitoring facilities to the management. Many processes in the logistics industry could be made well-organized through automation and digital transformation. Without automated systems, it is challenging for logistics companies to control and monitor the products management and shipment activities in the warehouses (Cichosz et al., 2020). Figure 3 compares how much digitalization is used presently in logistics industry to how much was planned initially.

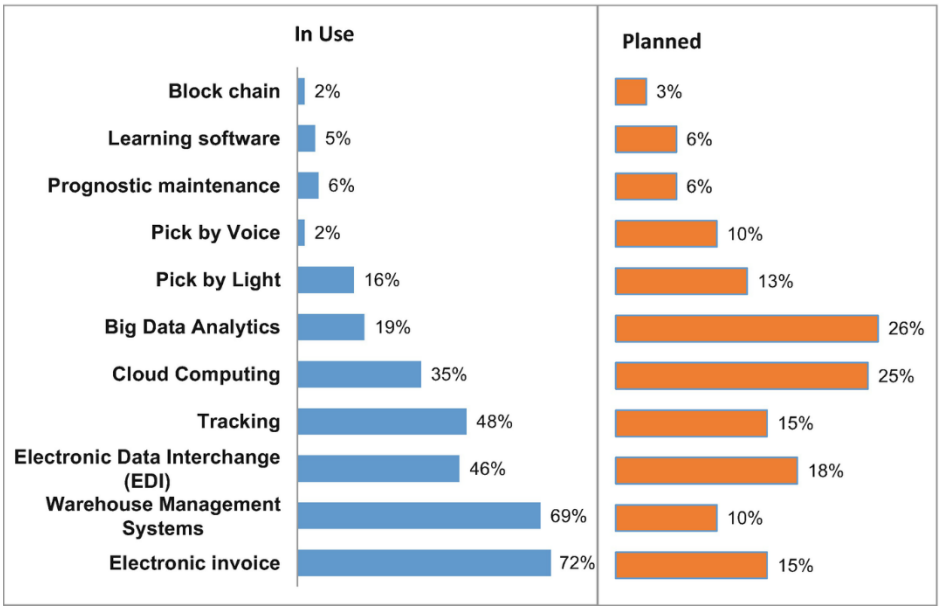

Figure 3: Digitalization of logistic operations (Cimini, et al., 2019)

Currently, more than 40% of the logistics companies have shifted towards automation and autonomous vehicles to deal with the problems associated with the warehouses and also provides better facilities to integrate supply chain activities (Cimini, et al., 2019). Despite driving 1.4 million miles without a single occurrence, numerous businesses believe that using such Industry 4.0 technology in the logistics industry can lead to increase operational efficiency and also manage the business concerns (Varriale et al., 2021).

Dachs, et al., (2019) identified that autonomous vehicles used for transportation in the logistic industry can manage the safety concerns faced by humans and also perform multiple operations through a single system that can help to enhance the performance of the warehouses. Using autonomous vehicles and digital programs, the logistic industry is capable to disregard the accident degree for cars driven by humans that increase safety levels. Autonomous vehicles can not only eliminate driver-related errors, improve vehicle safety but also ensure that products reach the destination with higher safety and reduce damaging problems (Bechtsis et al., 2018).

Autonomous vehicles have the ability to make split-second decisions that are not conceivable for persons that enable the logistics companies to propose effective decisions regarding the supply chain and inventory controls (Raj, et al., 2020). With the usage of Industry 4.0 technologies, autonomous vehicles can process larger data and products in a few seconds and find the finest travel routes to minimalize time on-road, drive at the best speed, thereby, refining the efficiency of logistics businesses (James, 2018). Therefore, Industry 4.0 technology is beneficial for the

logistics industry to create automated systems and autonomous vehicles to increase operational performance and manage problems from warehouses and supply chain operations.

✓ **Smooth Operations:**

Industry 4.0 technology has the potential to manage the complexity of logistic operations and create effective systems and programs by which business problems and issues can be resolved. The presence of digital transformations and automation in logistics operations can increase efficiency and provide smooth operations to perform supply chain and inventory control related activities effectively. Raut, et al., (2020) examined that the logistics industry is now moving towards digitalization where Industry 4.0 technology helps to serve better services and provides proper tracking and real-time data in less time. Connectivity is a major feature of Industry 4.0 technology that helps logistic management to interconnect various departments and systems together so that data transmission and exchange can be done easily (Javaid et al., 2021).

Using Industry 4.0 technologies like IoT and big data analytics, the logistics industry can increase operational performance and develop remote access controls to collect data or products and store them in warehouses and share them with the consumers remotely. Consumers require proper information regarding product distribution and IoT-enabled devices to track products easily and deliver real-time information and tracking facilities to the consumers. Rejikumar, et al., (2019) observed that Industry 4.0 technology has the potential to build automated systems and platforms by which data management, processing and operational concerns can be minimized. Also, Industry 4.0 technology-based digital transformation can help the logistics industry to remain more informed on the time of shipment and also provide complete information to the management and consumers remotely that positively influence productivity. Moreover, Industry 4.0 technologies including IoT, AI, machine learning and big data analytics are reliable for the logistics industry to quickly deal with logistics and supply chain issues and increase the smoothness and efficiency of the operations.

Through Industry 4.0 technology, management is capable to interact with the various systems, departments, team members and consumers easily and also exchanging information in less time helps to maintain efficiency and performance in the workplace. Therefore, it is true that implementing Industry 4.0 technology and digital transformation in the logistics industry can

increase smoothness and enable the employees to manage errors, difficulties and issues from logistics and supply chain operations (Xu et al., 2018).

✓ **Reduce errors and complexity:**

The logistics industry deals with large datasets, real-time updates and decision-making where manual operations are less capable to provides better outcomes and managing business concerns. Industry 4.0 technology provides a platform to shift manual operations to digitalization that can help the management to perform daily operations easily. Safiullin, et al., (2019) reported that the presence of human errors and complexity in logistics operations can negatively influence productivity and efficiency due to which proper information cannot be received. In order to manage such problems, it is significant for the logistics industry to implement Industry 4.0 technology due to its ability to create digital platforms and manage errors and decrease performance concerns. Automation is one of the major parts of the Industry 4.0 technology that contains AI and machine learning programs by which business activities like communication, data collection, product distribution and inventory controls can be done in less time (Ashima et al., 2021).

The key part of automation in the logistics industry is that it helps the team members to reduce errors and reduce complexity to manage and store products in the warehouses by which operational efficiency can be improved. Data analysis is a major complexity faced by the logistics companies where Industry 4.0 technology can be applied that provide predictive analytical models by which analyzing collected data can be done automatically and errors or complexity can be reduced. Extracting information is difficult from manual operations due to which improper data or information regarding logistics can be obtained that can affect decision-making processes negatively (Nagi et al., 2018).

All these problems can be minimized and reduced through Industry 4.0 technology that provides automated and digital programs by which performance can be enhanced. An automated system is less likely to make similar mistakes and deal with the challenges related to logistics operations. Salkin, et al., (2018) examined that Industry 4.0 technology is mainly associated with the digital transformation that helps to identify the risk factors and issues linked with logistics operations. It is true that Industry 4.0 technology is beneficial for the logistics industry and the performance of the employees can be managed through digital systems so that chances of data loss- and decision-making-related issues can be reduced.

✓ **Increases operational performance and speed:**

Industry 4.0 technology has the ability to create effective communication and remote access controls by which delivering quality services can be done easily. Skapinyecz, et al. (2018) reported that traditional logistics systems were not capable to manage performance and efficiency issues but Industry 4.0 technology provided a digital transformation to reduce internal and external problems from logistics operations. Customer communication is one of the effective ways to reduce the problems and queries of consumers regarding product shipments and distribution.

Mainly, consumers perform online shopping activities and need to receive real-time information where Industry 4.0 technology helps to interact with the customers easily and provides proper support to resolve queries. Using digital technologies like cloud computing, artificial intelligence, IoT,etc, it is possible for logistics management to optimize and increase the speed of warehouse operations, product shipment and delivery activities (Tang and Veelenturf, 2019). Slusarczyk and UL HAQUE, (2019) identified that human-based logistics operations require more time and effort to collect data and manage products in the warehouses but Industry 4.0 technology helps to perform such activities digitally. Smart devices and networks send data on their movements and enable dynamic route planning that increases performance and provides better accessibility of logistics operations. So, using Industry 4.0 technology, it is easy for the logistics industry to enhance the performance of the logistics operations and enable employees to control and monitor the logistics and inventory control activities effectively.

✓ **Increase connectivity and communication:**

Communication is one of the key factors affecting the performance of logistics operations as communication gaps between management and logistics systems can increase barriers and difficulties in gathering real-time information. Ślusarczyk, et al., (2020) stated that Industry 4.0 delivers communication networks and technologies by which effective communication infrastructures can be developed for the logistics industry. Using wireless sensor networks, IoT and communication systems, logistics companies can interconnect various systems, inventory controls, warehouses and supply chains easily.

Moreover, Industry 4.0 technology ensures that proper connections are delivered to the departments and collected data from the consumers can be stored and reviewed easily by which quality services and tracking facilities can be provided. Therefore, implementing Industry 4.0

technology in the logistics industry can lead to increase in connectivity and managing communication gaps by which proper information can be shared in the workplace and inventory controls can be done with proper communication (Oztemel and Gursev, 2020).

✓ **Bringing in intelligence in the logistics business:**

AI refers to artificial intelligence which is an Industry 4.0 technology that has the ability to develop automated machines and systems for the logistics industry to change the operational activities and perform through machines and computing devices. AI technology is capable to build intelligence systems by which analytical and prediction-related activities in the logistics industry can be done easily. Business intelligence is completely based on AI and machine learning programs that help the management review and evaluate the business operations and perform inventory controls and supply chain activities through digital and automated systems.

According to Strandhagen, et al., (2020) AI and intelligence systems are capable of transforming warehousing procedures including gathering and analyzing information, inventory process and enabling the logistics industry to enhance efficiency and boost revenues. In the field of logistics, AI-based intelligence is developed to make demand predictions, modify orders and re-route products in transit so that shipment and distribution can be done in less time. Management can adjust orders as per the predictions and have the in-demand products delivered to the warehouses by which consumers can receive proper assistance and build relations with the logistics management.

AI-based intelligence systems are capable to find the best and possible ways to transport the inventory and also predicting the demands of logistics and supply chain facilities in the market (Tang and Veelenturf, 2019). With the digitalization and Industry 4.0 technology, data is rapidly growing in the logistics businesses where intelligence and analytical tools are effective to deal with analysis-related problems. Decision-making is a major characteristic of an intelligence system that has the ability to review datasets and extract reliable information about logistics and supply chains so that effective decisions and business plans can be developed. Therefore, using Industry 4.0 technology, the logistics industry can build intelligence and analytical programs that can increase operational efficiency and productivity (Awan et al., 2021).

✓ **Enhancing consumer experience:**

Customer satisfaction is one of the challenging tasks for the logistics industry as the consumers requires proper information and reliable services from the logistics companies. Industry 4.0 technology delivers tracking and accessibility-related facilities to the consumers by which it is easy for the consumers to receive real-time information about products. Wang, et al., (2020) reported that digital technologies are capable to develop proper communication platforms that can help consumers to communicate with the management and receive the proper support. AI chatbots are now implemented in the logistics industry that contains machine learning programs and are able to interact with consumers without human assistance so that queries or issues can be resolved in less time (Nuruzzaman and Hussain, 2018).

Providing better quality and services to the consumers can increase satisfaction and experience and Industry 4.0 technology provides AI-based analytical programs by which problems related to consumer satisfaction can be identified easily. The prediction and identification of product demands are important that can help to improve market capabilities. In the context of the logistics industry, Industry 4.0 technologies are helpful by which the requirements of consumers can be identified and analytical activities can be performed so that consumer satisfaction and experience can be improved (Yan et al., 2019).

Therefore, implementing Industry 4.0 technology can lead to increase consumer experience and also provides better and quality services that build trust and enhance satisfaction levels. Yaqiong et al., (2018) conducted a study and examined that Industry 4.0 technology is beneficial for the logistics industry to focus on the consumer perception towards the logistic and supply chain operations and create effective decisions. As compared to the traditional systems, Industry 4.0 technology-based logistics are capable to focus on data monitoring, supply chain operations and reducing the problems faced by the consumers using digital technologies and automated systems. So, implementing Industry 4.0 technology can lead to increase consumer experience and manage the satisfaction and loyalty related concerns in a significant manner (Dutta et al., 2020).

✓ **Increase tracking of consumer data:**

Today, logistics companies receive larger and more complex data from the consumers and online resources that create problems and barriers to dealing with the huge datasets. Industry 4.0 technology provides cloud-based resources which are capable to maintain accountability and increasing accessibility of data through web servers and applications. Yavas and Ozkan-Ozen,

(2020) examined that digital technology has the potential to control and reduce data management and accessibility-related concerns. Cloud computing is an effective Industry 4.0 technology that provides on-demand database services by which collected data can be stored and recorded easily. Tracking consumer data is easy using Industry 4.0 technology and cloud servers that enable logistics companies to review and evaluate the gathered data so that effective information can be extracted (Ammar et al., 2021).

The key part of cloud computing is that it provides software as a service to the logistics companies and consumers by which controlling and managing the data tracking problems can be resolved in less time (Borangiu et al., 2019). Data tracking is also capable to track and review the information gathered from the consumers by which the logistics industry can deal with business problems and accessibility issues. Závadská and Závadský, (2020) reported that IoT-enabled devices are beneficial to managing consumer data tracking concerns that deliver proper communication and integration facilities and increase operational efficiency. With Industry 4.0 technology, logistics operations and activities can be performed efficiently and tracking products or shipments can decrease conflicts that can affect overall efficiency.

✓ **Reduce operational costs:**

Industry 4.0 technologies are reliable to reduce the operational costs that help to create technological systems and networks to perform business operations and decrease requirements of the additional resources. Zheng, et al., (2018) identified that the logistics industry requires to perform multiple operations and activities at a time and it is difficult for individuals to operate a supply chain, inventory controls and warehouse operations effectively. However, digital technologies have changed the way of businesses and enabled the logistics industry to build computing systems and automated networks by which multiple operations can be performed in less time.

According to Yavas and Ozkan-Ozen, (2020), implementing digital technologies in logistics operations can help to optimize freight spending and reduce fees or additional expenses by which operational efficiency can be improved. Zheng, et al., (2021) stated that Industry 4.0 helps the logistics industry to update transportation and product distribution-related activities can be performed in less time and real-time updates can be obtained without requiring additional efforts and systems. Industry 4.0 technology permits the utilization of shipping data to enhance logistic

management including tracking and proof of delivery to be shared to the consumers in real-time by which the management can deal with the higher operational and maintenance costs.

Due to higher transportation costs, it is challenging for logistic companies to manage operational expenses and performance. In this era, Industry 4.0 technologies has helped the logistics industry to identify and manage the problems and transportation issues where including tracking systems are beneficial to manage the complexity and tracking problems and also deal with the operational costs or expenses (Tang and Veelenturf, 2019). Traditionally, logistics companies need to perform business operations manually and paperwork requirements that increased problems and difficulties to track and monitor the operations.

Using Industry 4.0 technologies, it is easy for logistics companies to manage paperwork and problems related to manual operations that directly decrease operational costs and provides better remote accessibilities. Ammar, et al., (2021) reported that digitization of papers cuts down not only the number of errors but also the time promise, release logistics specialists to distillate on more productive and helpful tasks that decrease logistics costs.

Industry 4.0 technology also permits for information to be stored in a dominant location, making it available to everyone who desires it (Fernandez-Carames et al., 2019). The final consequence of the assistances outlined is happier customers where tracking-related facilities enable the consumers to receive real-time information and manage accessibility issues (Alam, 2021). More effectual logistics processes mean that parcels get out the warehouse door and to the client's door quicker, while unified data storage plus real-time track and trace eliminate the uncertainty for clients of when their order will arrive. Integrated procedures and arrangements rise transparency and interaction among the corporation, carrier, and client in ways that have never before been possible. Therefore, implementing Industry 4.0 technology can lead to reducing operational costs and provide higher efficiency and performance (Awan et al., 2021).

✓ **Provides more opportunities to make decisions:**

Industry 4.0 technologies are capable to provide better opportunities to logistics companies and also integrate the business operations or activities effectively. In terms of decision making, digital transformation plays a major contribution that has the potential to propose effective digital technologies and systems by which communication and data collection related activities can be done in less time. The major feature of the analytical technology is that it helps the logistics industry to review and evaluate the obtained data and create effective decision making and data

extraction platforms. More than 70% of logistics companies in Europe have implemented big data analytical tools to perform analytical activities and create effective decisions and plans (Queiroz and Telles, 2018).

Strandhagen, et al., (2020) identified that timely distribution of products is an imperative factor in guaranteeing customer satisfaction and Industry 4.0 technology helps to review the requirements of the consumers using proper analytical programs. Digital solutions can help in enhancing the speed of delivery and in keeping the client conversant about the product distribution schedule. Digital processes can be intended to keep customers conversant throughout the process, from order validation to order completion and analytical tools are used to identify and review the problems faced by the consumers. Industry 4.0 technology can also deliver a platform for customers to track their orders, enhancing a customer's sense of self-sufficiency and controller, while at a similar time transporting client service that helps to develop effective decisions and improve efficiency (Safiullin et al., 2019).

Using Industry 4.0 technologies such as AI, IoT, cloud computing, big data and information technologies are beneficial for the logistics industry to conduct analysis and predictive analytical activities to extract information and manage the problems associated with the current systems and programs. Therefore, it is reported that digital transformation is able to deliver better opportunities to logistics companies and also helps to understand the requirements and demands of logistics operations and activities.

- ✓ **Increase cyber-security of database systems:**

Cyber-security is one of the major concerns associated with the internet and communication networks that enable hackers to perform criminal activities and influence data privacy. Logistics companies are now performing business operations through internet and web servers that require proper security and data breach protection. Industry 4.0 provides advanced technologies and cyber-security controls that are capable to identify and review the security issues related to the computing networks and enable the management to secure personal details (El Mamy et al., 2020). Safiullin, et al; (2019) identified that AI is an effective technology that proposes machine learning-based risk detection programs which are capable to identify and monitor the security threats from logistic operations. Using digital technologies and systems, it is easy for logistics companies to develop communication infrastructures and security architectures by which collected data and information from consumers can be secured from hackers.

✓ **Efficient management structure:**

Companies may face difficulties not just in terms of technology but also in terms of management if they decide to implement the concept of Industry 4.0, which calls for a shift in management across the whole firm. When seen from the standpoint of management, it primarily encompasses the authority and skills possessed by business managers, in addition to the abilities necessary to function effectively inside a data-driven company (Isaiah, 2015). Training in information technology that is both ongoing and gradual and that is provided at all level managers will enable organizations to prepare for Industry 4.0 and maybe bring the company to a level that is more compatible with the idea. The most fundamental job facing businesses in the modern day is to guarantee that their infrastructures, processes, management, and people are all prepared for change in the context of the working of an organization at all management levels. The notion of Industry 4.0 describes the components that need be present in a manufacturing business in order for this transition to be successfully implemented and maintained. Industry 4.0 and other related initiatives have come to the realization that in order to construct self-managing production processes in an efficient manner, open operating system and communication services standards are required (Isaiah, 2015). These standards must make it possible for sensors, embedded processors, people, machines, equipment, and logistics systems to communicate and collaborate with one another directly (Perwej et al., 2019).

CHAPTER FOUR

EMPIRICAL FINDINGS

Here in the thesis, the replies to the questions in the interview guide will be discussed in depth. It is the responsibility of the operations team to carry out daily operations and determine the amount to which technology may affect logistical operations' overall performance and success throughout their work and implementation. Therefore, it is critical to recognize the operational team's contributions to the company's overall performance. A few key individuals in charge of warehouse operations, order processing, and dispatch together with two drivers were interviewed as part of this study to establish the degree to which Industry 4.0 will assist upgrade operations at the organization. Respondents to the interviews on Industry 4.0 technology applications raised the following issues:

4.1 Effect of Industry 4.0 on workplace digitization:

Logistics operations are enhanced and improved with the development of Industry 4.0 technology. The respondents such as the dispatch team claimed that the company will be able to automate processes such as order processing and clearance of trucks to leave the warehouse units if Industry 4.0 technology is implemented in their daily operations. However, the team lead reiterated that digitization is creating an opportunity through which paperwork can be reduced and also the process of processing orders will be enhanced, hence increasing the flexibility of operations.

One of the warehouse managers interviewed claimed that:

"*The technology will provide an opportunity through which our operations will be eased through reduction of paperwork and long bureaucratic clearance processes which used to delay loading, unloading and dispatch".*

This is evident that the application of Industry 4.0 technology will provide an opportunity through which processes at the workplace can be improved and enhanced. The effective automation processes created by this technology have provided an opportunity through which logistics companies are shifting operations from manual to digitization, an act that has provided

an opportunity through which the company is able to enhance its operations by increasing the speed through which orders are processed and dispatched.

4.2 Effect of Industry 4.0 on reduction of errors:

Errors in logistics operations are commonly experienced by companies that engage in manual operations. Automation in logistic operations has brought about the development and use of programs such as autonomous vehicles and robots which are using Artificial Intelligence technology to conduct operations at a fast rate compared to work conducted by human beings.

This view was supported by the operations team leader at the company who said:

"Introducing robots at the workplace will assist conduct operations and reduce lead times and order processing durations."

Errors that arise as a result of manual operations often affect the company's returns and profit maximizations.

The driver interviewed noted that the company is yet to introduce autonomous vehicles which will be used to process orders on time. These vehicles will provide an opportunity through which the company will be able to reduce errors that are associated the with manual processing of orders, an aspect that contributes to delays in dispatch and potential errors might arise that will contribute to lowering the company returns.

In supporting the benefits of using autonomous vehicles, autonomous vehicles contribute to reducing human errors and the management of inventory. The same sentiments were shared by workers interviewed in the warehousing unit whereby they claimed that the use of automatic robots will provide an opportunity through which the company will be able to reduce errors which are associated with processing orders received and handling containers at the terminals. Industry 4.0 technology will enable easing operations by providing an opportunity through which the machine devices deployed will be able to detect containers and place them on dispatch mode within a reasonable time as compared to when human beings are conducting the work manually.

4.3 Effect of Industry 4.0 on enhanced operations:

Global logistic companies face intense operations which require real-time operations to determine to what extent the company can be able to enhance and improve service delivery. The

company is currently experiencing intense operations globally which calls for real-time data processing to ensure that delays are reduced and operations are done with high accuracy. Complex logistic operations are able to be handled with the use of technology hence indicating that technology is important for development and enhanced operations.

The warehouse manager interviewed stated for instance that:

"Since the company is yet to adopt automation of operations, we haven't been able to experience smooth operations, hence facing the challenges of real-time data processing. Moreover, automation of processing cranes and forklifts will eradicate manual labor at the warehouse hence enhancing and creating smooth operations".

On the other hand, a junior staff interviewed claimed that:

"As employees, we are engaged at minimum levels as most of the operations are yet to be automated hence we spend more time processing deliveries. However, there are also fears for the future of our employments if these technologies are introduced and implemented".

4.4 Effect of Industry 4.0 on speed and performance:

Speed is regarded as one of the means through which a processing unit can be able to improve logistics service delivery and stand a chance to increase its demand among customers based on how customer queries are handled and solved. Industry 4.0 technology comes along with a package of enhanced speed in which the user is able to process information in real-time as compared to manual techniques.

The warehouse manager interviewed claimed that:

"The use of this technology will not only improve service delivery at the facility but also, it will provide an opportunity through which internal and external technical hitches that use to delay operations will be solved."

Since the company is dealing with a number of customers, there is a need to ensure that they are able to process data and deliver to customers within a reasonable timeframe.

4.5 Effect of Industry 4.0 on customer relationship management:

It is essential for any company to manage its customer relationships, regardless of the industry. Consumers may not notice the benefits of Industry 4.0 technology but this is far from the reality. Some of the capabilities provided by Industry 4.0 are currently in use by many big firms and may help them enhance their interactions with customers.

This was further buttressed by one of the junior staff who said:

"He is aware that Industry 4.0 technology is used in a DME (digital manufacturing enterprise) to create value across the supply chain. Since the DMEs are more proactive in their interactions with clients, this is the major distinction between them and conventional firms. Because of this, businesses may use the data to anticipate the demands of their customers before they even know what they are."

The respondents unanimously concluded that when it comes to the administration of customer relationships, being proactive will be the central focus of customer relationship management version 4.0.

4.6 The impact of industry 4.0 on procurement

With new technologies like IoT and Big Data outlined in the previous section, information may flow more easily across a corporation, and therefore every department or even every single supply chain can be linked to one another. According to the operations team leader:

"Data may be shared between suppliers and manufacturers via cloud technology, allowing for improved coordination of supply. In addition, the data obtained may be restricted so that the provider does not learn confidential information about the business. Augmented reality (AR) helps the firm by giving a means for long-distance supply expectations, meeting with suppliers, and resolving raw material concerns. All of the real-time data relating to material transportation, present departmental demands, and the state of raw material supply may be provided through AR headsets as well. Because of the simple access to data and the lack of physical presence required to verify that goods are arriving on time, this method provides for much better and faster sourcing."

Industry 4.0 technologies will have a substantial impact on procurement over the next several years, according to this study. The procurement department of organisations may become more

closely linked with production as a result of these developments, or possibly become entirely merged.

CHAPTER FIVE

ANALYSIS AND DISCUSSION

5.1 Challenges due to absence of Industry 4.0 in growing firms and SMEs in the logistics industry in Nigeria

In terms of workplace digitization, Industry 4.0 technology presents a chance to improve and enhance workplace operations. According to Bag et al; (2021), the effective automation processes created by this technology have provided an opportunity for logistics companies to shift operations from manual to digitization. This act has allowed the company to improve its operations by increasing how orders are processed and dispatched.

For Fairdeal Logistics, they are still stuck with some manual processes that is, they are yet to embrace Industry 4.0 technologies. However, according to some of the interviewees, this is due to the high cost of implementing new technologies. According to the findings of the research, Apulu et al. (2013) indicate that the adequate supply of state power prevents certain Nigeria SMEs from trying to embrace ICT. Although, it is well known that Nigeria is the largest producer of oil in Africa and it holds about one-third of the proven gas reserves, the country has continued to struggle with a severe lack of electricity supply (Baker, 2008), which in turn has an effect on the adoption of ICT. Despite the fact that it has enormous energy resources, such as abundance of gas, water and mineral resources, Nigeria suffers from a severe lack of energy (Tallapragada, 2009). In addition, Akpan-Obong (2009) claims that many rural regions do not have access to any kind of electrical supply, but the provision of electricity in towns and cities that do have access to electricity is restricted. It is quite unusual to go a single day without continuous supply of electricity in Nigeria, despite the fact that the costs involved with its provision are rather considerable.

MacGregor et al. (1996) argue that SMEs in Nigeria tend to reject the use of ICT in their operations if they perceive it to be difficult. This is another problem with the adoption. According to Alam and Noor (2009), a significant obstacle for SMEs in terms of adopting ICT is the lack of suitable technical and managerial staff with sufficient ICT expertise. They draw the conclusion that SMEs typically have a workforce that is deficient in skills. In a similar vein, Apulu et al., (2011) found that in their research involving 25 SMEs that skills deficiencies are a contributing factor that prevents a number of SMEs that have successfully adopted ICT from adopting more sophisticated ICT solutions. Reynolds et al., (1994) assert that owner-managers

of SMEs are not likely to embrace new technologies if they do not possess the necessary skills and abilities.

The loading and unloading of trucks are an example of one of the manual operations that Fairdeal employs. Despite the fact that the flow of movements in its warehouse is intense and constant, there is little assistance available for the workers engaged in terms of how to utilize technology. In addition, the reception of products is an essential step in the logistics process. However, this is not the case at Fairdeal; items that arrive at the warehouse are not subjected to the standard practice of passing through a checkpoint that verifies whether or not the goods satisfy the criteria specified for their storage on the racks.

Companies like Fairdeal that engage in manual processes frequently face errors in logistics operations. These errors that occur as a result of manual procedures frequently impact the company's profits and returns. According to one of the drivers interviewed, the company is yet to introduce autonomous vehicles that will be utilized to handle orders on schedule. This aspect contributes to delays in delivery and the potential for errors to occur, both of which contribute to poorer corporate returns. These cars, however, when introduced will allow the company to reduce errors connected to manual order processing.

The arrival of Industry 4.0 has presented Nigeria with a significant obstacle: the availability of abundant and inexpensive labour sources is no longer a feature that may provide a competitive advantage and attract global investment to Nigeria. In the next generation of manufacturing, known as industry 4.0, machines will take over many of the tasks formerly performed by humans. As a result, rather than having an advantage in the form of a cheap labour force, Nigeria will develop into a country that is "obsessed" with joblessness and will see a rise in the level of social instability. As a result, Nigeria's goal of becoming a processing and manufacturing hub of the globe by the year 2030 with the intention of achieving a high level of employment would become unattainable as a result of the impact of industry 4.0.

5.2 Impact of Industry 4.0 on growing firms and SMEs in the logistics industry in Nigeria

The use of automated solutions in logistics activities that are capable of being automated has become a strategic choice for many different kinds of businesses. Picking, carrying and storing are just some of the duties that may be quickly and securely completed by automated handling equipment. However, companies strive to reduce the number of errors that result from the human management of their products by using process automation. In a similar vein, companies that

experience a high volume of movement in their warehouses often engage in automation in order to maintain a steady flow of merchandise.

Increasing operational performance necessitates ensuring that accurate data is available and that the facility can handle data in real-time and impact the company's performance. Smooth logistic delivery operations are a significant necessity that such businesses should remember to minimize losses such as client loss due to inadequate service delivery. Manual activities frequently affect task delivery by posing a threat to the data processed in terms of supplying erroneous data and delaying dispatch, both of which impact the company's overall performance. Industry 4.0 has been viewed as a way to improve productivity.

In supporting the benefits of using autonomous vehicles, Bongomin et al., (2020) claimed that autonomous vehicles reduce human errors and inventory management. The same sentiments were shared by workers interviewed in the warehousing unit. They claimed that the use of automatic robots will provide an opportunity through which the company will be able to reduce errors associated with processing orders received and handling containers at the terminals. It is therefore essential to note that the use of technology has provided an opportunity to control and reduce errors that would have affected the company’s reputation in the market. The same sentiments were shared by Buntak et al. (2019), who argued that the use of autonomous vehicles in processing orders provides an opportunity through which real-time updates of data can be processed and improve operations at the facility, hence enhancing operations and improving customer satisfaction.

Overall, the company's operations can be enhanced, which will increase the company's overall performance when compared to its competitors. Speed and accuracy are a critical component that provides an opportunity through which the facility can handle a large volume of orders and dispatch them within a reasonable period an aspect that has provided an opportunity through which the company can enhance its competitive advantage in the logistics and delivery market. Skapinyecz et al; (2018) supported technology in logistics operations. They argued that the application of technology enhances the company's performance by enhancing the efficiency of operations which is ideal for maintaining better performance. Similar sentiments were shared by Ślusarczyk and Ulhaque (2019). They also claimed that through technology, companies can process data in real-time, hence enhancing the company's performance.

5.3 The impact of industry 4.0 on customer service

The management of customer connections is critical for every firm, regardless of sector. On the surface, industry 4.0 technologies do not seem to engage with consumers, yet this is far from the truth. Some of the capabilities provided by Industry 4.0 are currently in use by many big firms and may help them enhance their interactions with consumers (Tang and Veelenturf, 2019).

A DME, or digital manufacturing enterprise, is a business that makes use of industry 4.0 technology to provide value across the whole supply chain. Since DMEs are more proactive in their interactions with clients, this is the major distinction between them and conventional firms. Because of this, businesses may use the data to anticipate the demands of their customers before they even know what they are. Aside from these benefits, the continual exchange of information with the client is facilitated by the consistent data flow: for example, any product that receives a negative reception from any consumer group is quickly remedied before it becomes a bigger problem, for example (Ganji et al., 2018).

Data management is the key benefit of the fourth industrial revolution, according to Savastano et al. (2019). This implies that customer connections are much simpler to manage because of the massive amounts of data that can be managed. Gathering data from various time periods and examining sales statistics of any organisation makes it much simpler to monitor customer preferences and demand. Using this data, future management planning may be developed, making it much simpler to meet client expectations more quickly. Customer loyalty would rise if the needs of the consumers were better met. As a result, AI and Big Data technologies enable companies to obtain insight into different client groups without having to devote a market study group to each one of them if they want to increase their customer base.

With the introduction of a variety of digital tools, businesses now have the ability to monetize those tools by offering supplemental services that are sold in conjunction with the acquisition of those tools. The manner in which a product or service is monetized might vary significantly depending not just on the firm that provides the product or service but also on the product or service itself. The consumer will acquire extra information into the product that was bought or simply gain access to other services that would go with the product as a result of this. This enables the product to transcend its physical limitations and gain value in its digital form. If they are used effectively, the digital tools have the potential to generate more money for the firm, which would, in turn, help the company obtain an edge over its rivals (Ramakurthi et al., 2022).

According to Demir et al. (2020), not all of the technologies have a direct influence on the customer relationship management; nonetheless, a handful of the technologies do have a substantial impact on the customer relationship management.

To begin, augmented reality (also known as AR) gives clients the opportunity to see a product in its whole three-dimensional form before making a purchase of it. Because of this, it is no longer necessary for the buyer to travel to a particular store to purchase it in order to see how it appears or functions inside a digital world.

Secondly, AI may review the buying patterns of a consumer and provide recommendations for products or services that are more tailored to their requirements based on the findings. This technology is already being used by a number of different online retailers, and it enables customers to have a shopping experience that is unique to them.

Thirdly, the use of GPS makes it simpler for both the corporation and the client to monitor the whereabouts of the goods as it moves from one location to another. The corporation has an advantage in being able to determine whether or not there are any delays in the delivery process so that they may provide advanced notice to the customer. On the other hand, the client has the advantage of being aware of both the location and the precise time of delivery (Hood et al., 2016)

When it comes to the administration of customer relationships, being proactive will be the central focus of customer relationship management version 4.0. In the future, data will be the most essential resource, and if it is used well, it will be able to offer a major edge over the competition. It is now possible, thanks to advances in technology, to anticipate the requirements of customers and provide responses to those requirements in advance, which paves the way for a far more devoted client base. A product may now be introduced to new markets and new client groups with more precision thanks to Industry 4.0, regardless of the size of the organisation.

5.4 The impact of industry 4.0 on delivery

A supply chain is only as strong as the products and supplies it produces. Modern supply chains, which might span numerous nations and continents, benefit greatly from quicker delivery times. Industry 4.0 has had a significant impact on the distribution industry (Tang and Veelenturf, 2019). Internally and externally to the supply chain, a self-sustaining automated network is created by interconnecting machines. The position of the final client is always being re-navigated by smart delivery. Event simulation may be used to forecast the delivery time of a delivery system. Deliveries may be made more efficient by using big data analytics to analyse and propose the best route. The supply chains have gotten more complicated as enterprises have increased their delivery capabilities. Lead times and delivery dates may be predicted using an analytic method.

Delivery time is not the goal of industry 4.0 technology, but rather the optimization of delivery time. Despite the benefits of employing contemporary transportation, packages might still be

delayed due to unforeseen events. A single delay in raw materials may have a significant influence on the whole production line and the company's ability to operate.

While it's hard to foresee every conceivable roadblock to delivery, it is feasible to ensure that the supply chain as a whole isn't disrupted in the event of a barrier. There are several benefits to using GPS technology to monitor the items that are being delivered, as well as helping drivers get to their destinations more quickly (figure 4). Trucks' GPS systems and live operators have been connected by a large number of transportation businesses, allowing them to plan the optimal delivery route in advance and avoiding traffic jams, right turns on the road and routes that are closed or under construction. Upon arrival of the delivery truck, dispatchers check the route to see if there are any issues that need to be addressed. If so, the driver receives an amended route immediately.

The route management may be automated with the use of Industry 4.0 technology to get better outcomes. There are a number of ways in which Big Data technology can aid in the storage of route information so that AI can later analyse it to create a much better route, as well as the ability to completely manage how trucks are moved in real time by updating the routes in real time with precision and speed that humans cannot match. There is also the option of doing simulations to evaluate how long it will take to resolve any issues that may arise during the delivery. Weather, traffic, and truck malfunctions may all be simulated.

Simulators may also aid in determining how deliveries could affect the environment in terms of emissions and noise. The regulations governing the effect of transportation on the environment must be adhered to by most contemporary businesses. When planning routes, it is possible to take into account not only the most efficient routes but also those that are less polluting and avoid densely populated regions, if feasible, in order to minimise noise pollution. As a result, gasoline expenses will be reduced, and laws will be adhered to.

However, the supply chain must be very transparent in order for this to operate. If a problem arises, both the supplier and the firm on which it depends will be made aware of it via the use of a two-way data exchange system. The supply chain may be less disrupted this manner, and contingency measures can be developed in the event of a disruption. Suppliers and companies may use a cloud network to facilitate the exchange of huge amounts of data or even build solutions that might help in the event of a transportation problem.

In the future, drones and self-driving cars may be able to totally replace conventional modes of transportation in the delivery process. Several corporations, including Amazon, have already made investments in this technology, even if it isn't yet complete. The firms would need to either

employ VR/AR technology to remotely operate them, or use an automated system and AI to pick the best delivery route and adapt to the surroundings in real time. (Gunal and colleagues, 2019)
The distribution method might be a lot more flexible with a collaborative system like this one. Both the supplier and the firm would be able to see the status of every delivery in real time. In addition, all deliveries will be connected into a single supply chain: another provider might automatically accept part of the deliveries from another one, depending on how overcrowded one delivery company/supplier is. If a vehicle carrying products is now stuck in traffic, another truck from the same supplier may pick up the items and deliver them if necessary. Suppliers, logistics providers, and manufacturers working together to improve supply chain flexibility and adaptability would benefit all parties involved (Efthymiou and Ponis, 2021).
As a result, new methods of distribution may be introduced by Industry 4.0. Using IoT and the cloud network, data can be exchanged and gathered during the whole delivery process. Artificial Intelligence systems may now monitor and adjust the route in real time, allowing drivers to seek support from both human operators and the systems themselves. Collaboration is the most important aspect of Delivery 4.0. Only through allowing data exchange and collaboration among all parties concerned can the whole potential of new technologies be realised. The fourth industrial revolution necessitates enterprises to collaborate with suppliers and logistics providers in order to adapt to new technology. The use of enhanced logic to coordinate resources in Industry 4.0 has resulted in a more coordinated and synchronised work environment. Algorithms for complex orchestration may become accessible in the future.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

Industry 4.0 is a global phenomenon that permeates every sector of the economy. Thus, logistics are included in this trend and are strongly impacted on many fronts, including but not limited to the development of smart factories, the implementation of automated warehouse management, the integration of the vast data system used by the logistics sector, and the maintenance of a highly skilled labour force.

Industry 4.0 is reshaping logistics because technologies make it possible for companies to operate more efficiently and gain a significant competitive advantage. Some firms have had great success with the implementation of Industry 4.0 technology, while others haven’t yet.

The research demonstrates that there will be big shifts in the logistics business; nevertheless, this is a lengthy process that has just started. The pace at which new technologies are being adopted is currently fairly modest, but in the not-too-distant future, the logistics sector may undergo a total transformation.

Automation and the use of data are already altering the conventional view of how the logistics business functions. The data that is created by customers throughout the process of creating a product is now more valuable than it has ever been, and its worth will continue to expand as the various parts of the logistics business would utilize it to boost their efficiency. It is possible that the common idiom "works like a clock" is the best way to describe the future of the logistics industry. In this industry, every segment will be connected to another, and the whole chain will work together to convey a final product to the consumer, safe from the human error that is currently present.

Because the technologies are new and haven't been extensively accepted, the cost of adoption is substantially greater than for technologies that are commonplace in the industry. Therefore, organisations are less likely to embrace them quickly, and there are other barriers to adoption such as a shortage of personnel who can deal with industry 4.0 technologies and IT specialists and data scientists in addition to those already mentioned. In addition, the new technologies need a digital environment that is ready to handle massive amounts of data and the capacity to collect it through sensors linked via an IoT system in order to be effective. SMEs, on the other hand, are clearly at a disadvantage because of their much smaller pool of resources when compared to bigger corporations. Because of this, small and medium-sized businesses (SMEs) must depend increasingly on thorough planning and analysis of their supply chain's strengths and limitations.

Most large corporations nowadays have engineering managers in charge of numerous departments. Managers in the engineering sector are responsible for the overall management of projects, the development of comprehensive strategies to achieve set objectives, and the coordination and integration of technical activities. Along with studying relevant technologies and evaluating project viability, an engineering manager is responsible for planning and managing the installation, testing, operation, maintenance, and repair of improved technologies for facilities and equipment. As a result, adopting Industry 4.0 is a huge task that falls within their purview.

Therefore, it is necessary for them to be exposed to the notion so that they may carry out their duties more efficiently. The engineering manager may have a better understanding of Industry 4.0 and its many facets by reading this study. They also learn about the various smart factory infrastructures used by Industry 4.0's supply chain.

This study contributes to engineering managers by demonstrating how Industry 4.0 might serve as a framework for tackling the so-called "grand challenges" of engineering management, such as improving productivity, traceability, openness, and efficiency in the production system. Better decision criteria for the implementation of Industry 4.0 and digitalization are provided as a result of this review's analysis of the benefits and drawbacks of the concept, as well as its present condition in the supply chain, which places greater emphasis on theory.

They may be able to understand the methods that businesses use to adopt Industry 4.0 and digitalization. Many factors, including the lengthy return time and high initial investment needed, have reduced the number of organisations ready to experiment with and deploy Industry 4.0. Managers may make more educated judgments about the implementation process if they have a deeper grasp of the technology.

This study recommends that surveys should be carried out in Nigeria to explore how its logistics industry is considering Industry 4.0

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7.0 APPENDICES

INTERVIEW GUIDE ON DIGITAL TRANSFORMATION IN THE LOGISTICS INDUSTRY USING INDUSTRY 4.0 TECHNOLOGIES

1. What is your name?
2. What is your position in this country?
3. How long have you been in the logistics industry?
4. Do you know what industry 4.0 technologies are? How well do you know the logistics processes in your company?
5. What are the manual processes you still undergo in your company?
6. Have you been using any logistics 4.0 technologies in your company?
7. How do you think logistics 4.0 can help your company?
8. What do you think will be the barriers to the adoption of logistics 4.0 in your company and how can these be solved?