Research Project Report ON

Review of AI, ML and IoT Application in Supply Chains from the Perspective of Developing Countries

United International **University**

QUEST FOR EXCELLENCE

Submitted To:

Name: Dr. Saad Hasan

Designation: Associate professor

School of Business Administration & Economics

United International University

Submitted By:

Name: MD Ibnul Mashrur Razzya

ID: 111 183 109

Major: Supply Chain Management

Date of Submission: 15th November, 2023.

Letter of Transmittal

15 November, 2023

Saad Hasan
Associate Professor
School of Business and Economics
United International University

Dear Sir,

I am formally submitting my project report titled " AI, ML and IoT in Supply Chain in Developing countries," as a requirement for the completion of my BBA program at the School of Business and Economics, United International University.

In this thesis, I have endeavored to identify the developing nations' perspective in adapting with the emerging digital technologies in their supply chain. The objective of this study was to contribute to our understanding of the impacts and barriers of digital technology in the supply chain practices of developing countries.

I hope that this research aligns with the academic standards of our institution and contributes to the field of supply chain. I believe that your expertise and feedback will further improve the quality of this thesis.

I am grateful for giving me the opportunity to conduct this research under your guidance.

Sincerely yours,

Md. Ibnul Mashrur Razzya
ID: 111 183 109
BBA
School of Business and Economics
United International University

Abstract:

This paper examines how changes are occurring in the management of supply chain from the perspective of digitization—the combination of supply chain procedures and technology. The introductory section highlights the revolutionary effects of cutting-edge technologies on supply chain dynamics, including artificial intelligence (AI), machine learning (ML), and the Internet of Things (IoT). It is highlighted that the focus has shifted from the conventional cost-effectiveness goals to more comprehensive including efficiency, sustainability, and customer satisfaction. After that, the emphasis moves to a thorough examination of AI's application in supply chains, emphasizing its ability to enhance efficiency, optimize capacity planning, provide safer working environments, and forecast demand. There are acknowledged challenges, such as the requirement for specialized technology and cloud-based operations. The importance of machine learning in managing supply chain elements, finding trends, and surpassing traditional statistical techniques is explored, with a focus on how it may be applied to real-world supply chain problems. The IoT is shown to have the ability to detect material movements, monitor vendor deliveries, and maintain product integrity while in transit. The research goal of examining the Fourth Industrial Revolution's (4IR) applications in the supply chains of emerging nations is delineated in the methods section. Reviewing previously published scientific works and determining the scope of upcoming research are among the goals. The last five years' worth of literature are reviewed, and papers addressing the uses, effects, and obstacles of digital technology in developing nation supply chains are analyzed using a literature-based methodology.

The findings of this report show that the supply chain management of developing nations is being greatly impacted by emerging technology. In the healthcare industry, the Internet of Things (IoT) provides real-time data, cost savings, and streamlined processes. Nonetheless, developing nations continue to face difficulties. Supply chain performance is enhanced by digital technologies including blockchain and the Internet of Things, which offer operational efficiency, transparency, and traceability. Blockchain enhances efficiency and safety while addressing sustainability issues. Artificial Intelligence (AI) lowers costs and streamlines operations to improve operational efficiency. Productivity and manufacturing are improved by machine learning. The integration of IoT in food supply chains can enhance operations; nevertheless, obstacles such as inadequate standards and security threats need to be addressed. Adoption of big data improves company performance, while AI improves communication with customers and coordination. Digital closed-loop supply chains use blockchain to save costs and allay environmental concerns, while digital technologies significantly enhance waste management. IoT technologies enhance decision-making, cut down on waste, and improve product quality.

In conclusion, this study shows how advanced technologies completely transform supply chain management in developing nations. But there are still issues with their acceptance, which calls for more study to get past them and enhance resource management, cut down on waste, and advance sustainability.

Table of Contents

Chapter-1

1. Introduction:

Recent decades of the twentieth century experienced a significant impact of technological advances in supply chain management. This combination of technology and supply chain is called digitization of supply chain. In formal words digitization of supply chain is establishing dedicated master data that collect information from the complete supply chain also from the external sources and turn an analog supply chain in digital one. This process has considerable advantages. Above 85% C-level executives predicted that it will inflate the cash flow and reduce days sales outstanding (DDC FPO Solutions, 2023).

The local and global public policy problems which the managers of supply chain have faced stayed unaffected for last few decades like population growth rural areas, freight restrictions, carbon footprints and sustainability, trade and border battles etc., but now they have the opportunity to battle with most of these complications simultaneously. Also, Supply chain has gone through a transformative change and all the credit goes to the innovative technologies such as artificial intelligence (AI), internet of things (IoT), machine learning (ML) etc. These have noteworthy impact in almost every aspect like demand, lead time, product pricing and communication between the stakeholders and with the environment as well. With the assistance of new normal organizations can confront the problems with modern technologies. Besides helping to solve all those mentioned problems, these new normal can also effectively impact the goals achievement of supply chain. Until now the main goal of supply chain managers was to become cost effective. But things have changed a lot so supply managers have to aware about other aspects like customer satisfaction, sustainability and efficiency (The University of Tennessee Knoxville, 2020).

Moreover, ethical behavior holds considerable part in strategic decision-making process. Despite cost reduction is the main focus but it doesn't lead to victory. According to Professor Scott's lessons, in order to offer customer value and profitability, present-day supply chains should work in every area of the business including suppliers, finance, accounting, suppliers, etc. (Scott, 2019)." That's why for achieving those goals supply chain managers have to be innovative with the help of new normal in almost every step of the end-to-end journey. So, they have to try to accomplish these: Gain Visibility, Predict the future and Hire data teams (The University of Tennessee Knoxville, 2020).

1.1 Innovative Technologies and objectives:

1.1.1 Artificial Intelligence (AI):

When human intellectual processes are replicated by machines, specifically computers then it is called artificial intelligence. Few particular applications of AI are recognizing speeches, natural language processing and machine vision etc. AI requires the writing and training of machine learning algorithms using specialized hardware and software. Although there are various programing languages that can be used with AI but among them Python, R, Java, C++ and Julia are mostly used by AI developers (Laskowski & Tucci, 2023).

Moreover, for enhancing safety in working environment AI can deliver potent optimization that is being used for accurate capacity planning, improved forecasting of demand, decreasing cost, raising productivity in supply chains. Worldwide outbreak of influenza and following interruptions have exhibited the noteworthy effect of uncertainties on supply chains, also emphasized that intelligent emergency systems have become a necessity for the businesses to successfully manage the risks emerged from uncertainty (Jacobs, 2023).

Accurate inventory management may guarantee that goods enter and exit a storage space in the proper sequence. In short, it can assist in avoiding unexpected stock-outs, insufficient or excessive stocking, and overstocking. However, there are a number of inventory-related factors involved in the inventory management process, which can add time and increase the likelihood of mistakes. This is where AI-powered supply chain planning solutions predicted to be more impactful as those have the ability of managing huge amounts of information. These intelligent systems can quickly analyze and understand large datasets, allowing them to provide in time supply and demand forecasting guidance. Some are very powerful because those can anticipate and find out new customer patterns, also predict periodic demand. Automation powered by artificial intelligence (AI) may provide more intelligent scheduling and effective warehouse management, improving item and security for employees. AI has the capacity to assess data on workplace safety and notify businesses of any possible risks. In addition to the necessary feedback loops, it can track stocking parameters, update procedures, and carry out preventative maintenance. This gives companies the ability to act swiftly and firmly to keep safe, secure warehouses that follow the law (Jacobs, 2023).

One benefit of artificial intelligence system that cannot be avoided is automated intelligent operations, it can not only work accurately for longer periods of time but also decreases the workplace accidents and mistakes done by employees, ranging from client service to the storage. Furthermore, warehouse robots may achieve better production levels with greater speed and precision, which will all translate into lower operating expenses. By reducing the need for manual labor, AI technologies contribute to a quicker, safer, and more intelligent process overall. As a result immediate deliveries can be fulfilled easily. In order to meet delivery deadlines, automated technologies expedite conventional warehouse processes and eliminate operational obstacles throughout the value chain with little effort (Jacobs, 2023).

There is no denying AI's potential in logistics and supply chains. But it would be misleading to claim that the road to AI power is clear of obstacles. It's important to be aware of potential obstacles in order to create AI-powered supply chains that are effective. AI systems require a lot of bandwidth because they are mostly cloud-based. To leverage these AI capabilities, operators could also need specialized technologies, which

can be a costly for primary investment for many supply chain players. Adoption of AI and its efficient usage will necessitate employee training, just like any other new technological solution. This will entail a large time and financial commitment. During the integration phase, supply chain partners have to collaborate closely with AI providers for delivering a training solution that is both impactful and inexpensive, which might have an effect on company productivity (Jacobs, 2023).

A few businesses, including supply chain, seized the chance to widely use these contemporary technologies, while many others are still fighting to recover from the pandemic's aftereffects. Artificial intelligence (AI), which has the ability to drastically alter processes, decision-making, and total efficiency, is one of the most innovative technologies that businesses must employ to stay ahead of the curve (Srivastava, 2023).

1.1.2   Machine Learning (ML):

In addition to being a component of AI, machine learning (ML) is significantly changing a number of sectors. By using IT systems, it is possible to identify patterns in already-existing databases and algorithms, which helps to build the decision-making process and provide appropriate answers (Younis, Sundarakani, & Alsharairi, 2021).

The application and creation of machine learning (ML) is having the ability to acquire and modify knowledge despite explicit direction by examining data trends and making inferences through statistical models and algorithms (What Is Machine Learning?, 2023).

Machine learning which uses big datasets to automatically find and extract patterns across variables. Machine learning algorithms are capable of producing new insights, directing researchers in the correct path, and uncovering patterns in data that had not been seen before. Applications of machine learning (ML) may be found in many domains, including manufacturing, housing, operation and healthcare.

Furthermore, ML is frequently utilized to manage various supply chain regions and characteristics. Researchers have recently developed an interest in ML algorithms and the ways through which supply chains can be managed by those algorithms and analyze vast portion of data. Switching to machine learning approaches from conventional methods contains many reasons. Because of the shortcomings of conventional methods in analyzing big data, researchers are switching to machine learning techniques that are highly capable of interpreting and deciphering mass data. There are also more justifications for switching. Firstly, nonlinear issues, which are common in real-world supply chains, are outside the scope of standard approaches. This is a nonlinear issue that ML approaches can adequately address. Second, whereas ML approaches are specifically designed to handle huge and unstructured data, old methods are not capable to manage massive and unorganized documents that originate from many supply chain locations. Thirdly, when it comes to determining and predicting the factors that have the greatest impact on supply chain performance, machine learning techniques perform better than traditional statistical techniques (Tirkolaee, Sadeghi, Mooseloo, Vandchali, & Aeini, 2021).

1.1.3   Internet of Things (IoT):

3

The term "Internet of things" refers to devices that include software, hardware, sensors, and other technologies that connect to and communicate information with other gadgets and systems over the Internet or other communication networks. Electronics, communication, and computer science and engineering are all included in the IOT (What Is the Internet of Things (IoT)? 2023).

Internet of things can do a lot of things; it can track all the necessary steps given below (Halstead, 2018):

1. Monitor vendor deliveries to the production site

2. Monitor material and delivery movements throughout your manufacturing plant.

3. Monitor material and delivery movements throughout your manufacturing plant.

4. Keep an eye on fragile items to prevent loss or damage.

Certain manufacturers frequently receive shipments of delicate or perishable commodities that must be kept under particular environmental conditions in order to remain fresh for a little period of time (Halstead, 2018).

You may tag a barrel of milk or a box of eggs and use an IoT logistics application to track the temperature, shock, and vibration levels these goods endure throughout transportation, as well as the humidity in the storage space. With this information, you can send a replacement cargo on its way and alert truck drivers to damaged shipments well before they reach your plant (Halstead, 2018).

Chapter-2

2. Methodology

2.1 Research Aim:

What are the applications of 4th industrial revolution (4IR) in developing countries' supply chains?

2.2 Research Objectives:

1. Reviewing the scholars' work regarding this issue.
2. Identifying the future scopes of research within this issue.

2.3 Literature Review:

In a thesis that is based on the literature, the entire document is a literature review. A literature-based project is a complete literature review. Whereby students autonomously establish a subject and research question, test and implement a search strategy, and then sort, evaluate, and summarize a variety of secondary information. Actually, this type of work has particular benefits over actual research. It enables students to study subjects that would not otherwise be possible, as it has less ethical challenges as it has reduced the logistical, chronological, and geographical restrictions. However, there are a number of distinct limitations to this support. The different groups like students or supervisors participating in literature-based studies have particular challenges that must be addressed if such projects are to be successful. It should not be implied or stated that literature-based research is simpler or less time-consuming than traditional research methods. These projects can be difficult, unpredictable, and time-consuming to accomplish, even when they fall short of a comprehensive systematic review. They also ask for the acquisition of new skills that are not often tried throughout the course of a standard undergraduate degree. Furthermore, relying solely on published literature can severely restrict the types of research questions that can be posed and the ways in which they can be addressed (Flynn, 2022).

The ability to use resources like search engines, citation, special collections items, and other resources is referred to as your research abilities. Where and how to get answers for the research questions is what research methodologies are all about. Typically, research on literature combines many techniques, including archive research, primary research and secondary research techniques.

Archival research involves finding and gathering evidence from archive records. Secondary research is done at a library or online and entails locating and reviewing secondary sources related to the research topic. Archival research may be contrasted to other types of primary research and experimental study, such as fieldwork and experiment. There are difficulties in discovering, obtaining, and understanding relevant information while conducting archival research, which is typically more difficult and time-consuming than secondary research (Mauer & Venecek, 2021).

The two primary types of data sources in the research domain are primary and secondary. In primary research, new data is collected directly from sources or persons; in secondary research, information already gathered by another researcher is analyzed. Typically sources for this kind of study include published documents and research papers. These materials are commonly accessible in public libraries and

online. Additionally, a number of public and private organizations maintain sizable data archives that are accessible for study. Data that has already been gathered is used in the research method known as secondary research. Data that already exists is gathered and compiled to increase the research's overall effectiveness. (Bhat, 2023).

Looking through the literature is an essential step in doing high-quality, authentic research. It supports the formulation of a research question and a study plan. Because there is so much published material accessible, it takes expertise to choose the articles that are relevant to the issue at hand. If not carried out methodically, it can be tiresome, time-consuming, and even lead to boredom or the decision to give up midway through the search. Literature searches can be done from several accessible databases. Literature review type research can serve as a strong final project by integrating several strands and competencies acquired during an academic degree into a single project (Grewal, Kataria, & Dhawan, 2016).

Doing a literature review has several advantages, such as being accessible, improving understanding of the subject matter, identifying pertinent experts and new findings, and offering solutions to significant questions pertaining to ongoing study (University of Derby Library, 2023). Determining the methods used in earlier studies on the same or similar topics. Assessing the kinds of studies that previous researchers have carried out is often helpful in determining which approaches may be most beneficial in furthering a topic. Similarly, examining past results might inspire researchers to develop a novel strategy for their present area of study. (University of North Florida, 2022).

That's why here literature-based research was selected. The researchers have taken articles of last 5 years for providing the latest information. In this research the articles were selected based on some common ingredients. First of all, the articles have to be about supply chain management. Secondly, those will mention about the applications, impacts, barriers etc. of digital technologies particularly artificial intelligence, machine learning, and internet of things in supply chain management. Last but most important that have to be about developing country's supply chain. Here the articles were first analyzed and divided in sections like applications, features, effects, barriers etc. After that all the information was summarized based on importance of mentioned digital technologies in developing countries and the obstacles in adoption of these technologies.

Chapter-3

3. Finding & analysis:

Contents	Literature (Articles)
Operation	(Desingh & Baskaran , 2021), (Joshi, Sharma , & Barve, 2022), (Kshetri , 2021), (Khalifa, Elghany, & Elgha , 2021), (Ali, et al., 2022), (Khan, Singh, Khan, & Ngah, 2023)
Coordination & Customer Relation	(Desingh & Baskaran , 2021), (Kshetri , 2021), (Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021), (Khalifa, Elghany, & Elgha , 2021)
Wastage & Environmental Management	(Luthra, Mangla, Garg, & Kumar, 2018), (Joshi, Sharma , & Barve, 2022)
Demand Management	(Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021), (Joshi, Sharma , & Barve, 2022)

3.1 Operation:

Here, the goal was to pinpoint the obstacles of adopting Internet of Things in India's healthcare supply chain, a developing nation. Besides, the benefits that can be gained from IoT are also mentioned. As India is a developing economy so it can be considered, the mentioned benefits are also similar to other developing economies. This research was conducted through an ISM fuzzy MICMAC approach. ISM is modeling technique that is being used for illustrating a specific relationship and structure of digraph model. Using this method, a panel of specialists ascertains if and how the variables are connected to one another. Then, Multiplication Appliquéan Classement, or MICMAC, is a matrix multiplication-based approach used to evaluate the impact and reliance of adoption obstacles for the Internet of Things. The connection between barriers is represented by binary numbers (0 or 1). Standard MICMAC analysis, however, is unable to adequately convey the strength of these connections. Fuzzy scales, which include no relation, weak, medium, strong, and complete relation, are used to characterize the various degrees of interaction between barriers in order to overcome this constraint. Researchers commonly use this fuzzy MICMAC analysis because it provides a more accurate classification of obstacles and is accurate in capturing correlations based on expert judgments.

(Desingh & Baskaran , 2021) Stated that the Internet of Things is anticipated to be a bright future technological platform with a significant influence on the healthcare supply chain. Internet of things adoption is inevitable because it comes with several benefits and value addition through integrating new technologies to its systems in healthcare supply chain. IOT is comparable to an eco-system for businesses in which a number of digitally integrated sensors and other sensors exchange data via an internet connection. (Desingh & Baskaran , 2021). Feasible advantages in healthcare supply chain of developing countries may be achieved through this technological platform. The benefits provided by IoT are real-time

data, accurate clinical decisions, cost reduction, and smooth operations. Here it can be seen that with the help of IoT real time data can be generated for which any kinds of predictions and health monitoring data can be generated more accurately. For instance, through this blood glucose levels, blood pressure, heart rate etc. can be supervised with more ease and accuracy. Moreover because of the different devices of IoT operation gets smoother. Still developing countries like India are facing difficulties in adopting IoT in their healthcare system because of some barriers. As mentioned, in this paper those barriers are identified an by removing obstacles to realizing the advantages, the study's conclusions offer crucial recommendations to decision-makers for the effective use of IoT in the healthcare supply chain. (Desingh & Baskaran , 2021).

The digital revolution has led to increased innovation and cost reductions in electronic equipment, resulting in a significant global demand for electronic devices by 2020-21, estimated between 42 and 55 billion units (Talapatra, 2022). While Waste Electrical and Electronic Equipment (WEEE) recycling contributes to circularity and reduces obsolescence, it also generates electronic waste (e-waste). Closed-loop supply chain (CLSC) practices, incorporating IoT and Blockchain technology (BCT), have proven effective in managing WEEE, particularly in developed countries (Joshi, Sharma , & Barve, 2022). However, implementing these digital technologies faces challenges such as data integrity, accessibility, and resistance to alter particularly in developing countries (Joshi, Sharma , & Barve, 2022). This study used a systematic literature review and the Best Worst Method (BWM) to identify important obstacles to adopting BCT in WEEE management in order to solve these problems and add to the body of current literature. The study addresses important obstacles such as the need for legislative backing, difficulties with database administration, a lack of knowledge of cognitive technologies, and worries about privacy and information security that are connected to IoT empowered blockchain technology adoption in closed-loop WEEE management. The study's overall goal is to aid emerging economies in their shift to circular waste management techniques. The Best Worst Method (BWM) is utilized in this study to pinpoint important implementation roadblocks in a closed-loop supply chain. BWM is appropriate for this investigation as it has a reputation for being accurate when comparing criteria and evaluating alternatives pairwise. Experts from a range of disciplines, including supply chain management, waste management, and blockchain, who hold diverse roles in North Indian companies are involved in the study. January 2022 saw the gathering of data by specialists from companies employing 50 to 200 people. Those working as logistics executives, shipping and transportation managers, waste management information system managers, legal counsels/environmental law experts, remanufacturers, environmental activists/NGO representatives, members of the Environment and Pollution Control Authority, and experts in the treatment of hazardous materials were among those who received the questionnaire. Each of these specialists has over seven years of expertise. Ten of the twenty-five specialists that were contacted provided comprehensive responses. The criterion and sub-criteria were then ranked using the BWM solver according to their replies.

The advent of digital technology in recent times has improved the efficiency of supply networks that are already in place and assisted developing nations in digitizing their supply chains. (Joshi, Sharma , & Barve, 2022). (Joshi, Sharma , & Barve, 2022) suggested that the objectives of these technologies are anticipating real time data, supply enhancement, better demand forecast, establishment of smart warehouses and improve transportation cost both forward and reverse supply chain. It also integrates supply chains' upstream and downstream. Moreover (Joshi, Sharma , & Barve, 2022) identified that, a closed loop supply chain with digital capabilities may be a worthwhile strategy to improve information sharing, cost reduction, and productivity among supply chain participants. Withe help of digital technologies including IoT and blockchain real time information can be generated and smart warehouses be developed. Because of this

8

productivity will increase. On top of that blockchain and IoT technologies can bring a range of benefits such as accessibility, scalability, transparency, traceability, optimization of response time, enhanced end to end operational efficiency for smoother operation and increasing productivity. Along with these improved forecasts and optimizing transportation cost will be reduced.

The goal of this research is to ascertain how blockchain technology contributes to supply chain sustainability. This study is focused on developing nations specifically. Because there are greater disruptions of sustainability principles in developing nations than in wealthy nations. It is said here that the features of blockchain technology are more important when it comes to enforcing sustainability requirements in developing nations.

The researchers have stated that undoubtedly blockchain has the technical ability for addressing the problems regarding feasibility in supply chain in developing nations (Kshetri , 2021). There four sectors were determined in which blockchain has positive impacts. Those are smoother operations, increasing productivity and quality, cost efficiency and safety. Blockchain can tackle inefficient regulatory standards, enrich monitoring and implement it in real time for addressing sustainability standards in supply chains for developing countries. (Kshetri , 2021) Said that real-time monitoring and enforcement take place in the world of blockchain. That's why the operation gets smoother because real time generated data are more accurate and it gives more precise information for decision making. Even monitoring is enriched so errors can be solved expeditiously. It not only eases operation but also increase productivity. Furthermore, blockchain has the ability to remove certain intermediary tasks which also increases productivity. Also, it reduces paperwork and physical inspection related cost (Kshetri , 2021). On the other hand, blockchain enhance the safety purposes related to consumers. Because sustainability related information can be verified by the consumers which in turn increases trust and stimulate the consumption of these kinds of products. Through blockchain certification frauds get more difficult (Kshetri , 2021). As a result, it guides to positive social outcome, improve living standards and quality of life for the individuals in low-income areas.

The transformative potential of AI is the driving force behind this study. The study adopts an exploratory methodology to investigate digital transformation practices in supply chain management topic. Mainly it gives emphasis on developing countries, specifically Egypt in the MENA region. Using case studies as a methodology, this study seeks to clarify how AI algorithms are really implemented in the production cycle and production process monitoring. It also provides insightful information on technical decision-making, both tactically and strategically. At present, a global Fourth Industrial Revolution is underway, and artificial intelligence (AI) is reshaping the lives of individuals in both advanced and emerging economies (Khalifa, Elghany, & Elgha , 2021). Most people believe that these changes will have a big effect on the economy in a number of ways, such as growth rate, employment, and total productivity. The amalgamation of artificial intelligence (AI) technology and machine learning (ML) holds the capability to transform many facets, such as supply chain management logistics, warehousing, and cooperation. This invention has the power to change perceptions and practices in all of these fields.

AI has a significant impact on improving operational efficiency and productivity in supply chain management. With minimal human intervention, AI can streamline demand, inventory, and supply processes, ensuring precise planning and dependable operations (Khalifa, Elghany, & Elgha , 2021). AI plays a vital role in logistics, enabling faster transportation and cost savings through autonomous vehicles. Real-time and multi-source data provided by AI empowers businesses to transform their supply chain

management (Khalifa, Elghany, & Elgha , 2021). Process automation and optimization are facilitated by the correct IT infrastructure, aiming to reduce the time of decision-making and support decision-making in supply chain tasks. While computers can pre-screen orders, predict sales, and plan manufacturing, the final decisions are still made by humans. However, AI enhances planning, allowing individuals to manage numerous cases efficiently, resulting in quicker responses and higher throughput (Khalifa, Elghany, & Elgha , 2021). This reduces the need for human resources in repetitive tasks, impacting back-office work and overall efficiency. AI is evolving supply chain management towards autonomy, self-awareness, self-governance, and self-optimization (Khalifa, Elghany, & Elgha , 2021). Recent research has explored real-world examples of AI adoption in supply chain management, contributing to both theory and practical techniques. The study suggests potential growth opportunities for AI in SCM, including the study of organizational and cultural factors influencing AI adoption. While AI holds great promise in supply chain management, there is still progress to be made before it realizes its full potential.

Agile production processes are now required due to rising consumer demand brought on by technological improvements. The industry 4.0 revolution is being ushered in by major technological advancements including cloud computing, blockchain, IoT, and big data analytics that are revolutionizing international company processes (Khan, Singh, Khan, & Ngah, 2023). Industry 4.0 relies heavily on the Internet of Things (IoT) and associated technologies like big data and wireless technology to facilitate real-time data transmission and analysis among physical items (Khan, Singh, Khan, & Ngah, 2023). Smart technologies such as the Internet of Things (IoT) can assist the food sector, it has a crucial part in the economy; overcome its issues related to food safety and traceability. Nevertheless, there are a number of obstacles that prevent IoT implementation in the food supply chain (FSC), especially in underdeveloped nations. This study finds and examines fourteen of these barriers, using the fuzzy Delphi approach to reduce the number of hurdles to twelve major ones. These obstacles include difficult-to-understand frameworks, excessive expenses, inadequate IT infrastructure, unsatisfactory IT infrastructure, regulatory requirements, low awareness, a lack of qualified staff, problems with trust, heterogeneous data, knowledge management gaps, and a scarcity of suppliers (Khan, Singh, Khan, & Ngah, 2023). The study's conclusions can help policymakers get ready for the introduction of IoT and help FSC managers digitize their supply chains.

The food supply chain (FSC) includes distributors, wholesalers and merchants, farmers, transportation businesses, and supermarket shops (Khan, Singh, Khan, & Ngah, 2023). Since these FSC components are dispersed around the world, the related multi-actor should cooperate to optimize value production. The supply chain partners may benefit from the cooperative effort by receiving accurate information at the appropriate moment. IoT, a recently created technology, may be utilized to manage the relevant data. Several aspects of food supply chain management can be made easier by the use of IoT, including managing the machinery and devices used for framing and transporting, estimating production and demand, tracking the movement of products and equipment, and keeping an eye on the weather, environment, water management, crop, fertilizer, water efficiency, etc. (Khan, Singh, Khan, & Ngah, 2023) Because of these the operation of food supply chain becomes smoother. IoT makes it possible to link everything, no matter where they are, which streamlines information flow across the FSC.

Nevertheless, a recent study found twelve important obstacles to IoT technology adoption in the food supply chain (FSC), including challenges such as the absence of established criteria and reference frameworks for IoT architecture, cost concerns, poor IT infrastructure, the lack of regulatory standards, low awareness about IoT benefits, a shortage of skilled personnel, trust issues, inadequate knowledge management, data

heterogeneity, high investment and maintenance costs, a scarcity of reliable IoT vendors, and security and privacy risks (Khan, Singh, Khan, & Ngah, 2023). Addressing these barriers is essential for achieving sustainability and operational efficiency in the food supply chain through IoT adoption.

This research analyses the use of machine learning techniques in fusion-based supply chain collaboration. The supply chain involves organized movement of components to minimize inventory errors, with support from simulation and business intelligence tools (Ali, et al., 2022). These methods are used to solve complex systems and optimization problems in a variety of industries and areas, including as the military, banking, construction, and health. Product, information, and financial flow efficiency are all improved by the integration of machine learning. Leaders must make decisions every day and strive for continual improvement in order to manage supply chains effectively. In order to achieve success in the supply chain, organizations must collaborate through integration and communication while balancing objectives such as robustness, risk reduction, and cost-efficiency. Operations may be improved with the use of data analytics, including data science and predictive analytics. Analysis of real-world processes and enhanced decision-making depend heavily on simulation, modeling, and fused machine learning.

The finding of this study is machine learning plays significant role in supply chain for smoothing production, increase productivity and reducing cost. Machine learning, a subset of artificial intelligence, involves the use of computer algorithms and is essential for data analysis and program development. It contributes to increased process efficiency within companies and supply chain partnerships through automation (Ali, et al., 2022). In the context of today's dynamic market environment, supply chain collaboration relies heavily on information (Ali, et al., 2022). Professionals and researchers are focused on managing data effectively to make informed decisions. Manufacturers face challenges in reducing production lead times. To address these challenges, they must adopt new tools and technologies to offer quality products and services globally. Factors like global competitiveness, adaptability, and industry entry timing impact supply chain management volatility (Ali, et al., 2022). Technological advancements, such as the Internet of Things (IoT), are poised to disrupt the supply chain market by enabling real-time tracking of shipments and remote appliance monitoring. Supply chain collaboration often encounters difficulties due to information gaps, leading to the "bullwhip effect" and complex planning for each entity involved in the flow of products and services (Ali, et al., 2022). In summary, machine learning, data management, and emerging technologies are crucial in addressing the challenges and complexities of modern supply chain management.

3.2 Coordination:

Here, the goal was to find out the difficulties associated with adapting Internet of Things (IoT) in India's healthcare supply chain. The paper also covers benefits that can be obtained from IoT

implementation. It is sense to infer that the advantages listed also apply to other emerging economies, as India is a developing economy. In this study, an ISM fuzzy MICMAC method was used. ISM, which stands for Interpretive Structural Modeling, is a technique used for modeling utilized to visually represent particular relationships and the structure of a digraph model (Desingh & Baskaran , 2021). A group of specialists evaluates the presence and degree of interdependence between variables in this process. The MICMAC approach was then applied. The MICMAC, or Matrice d'Impacts Croisés Multiplication Appliquée au Classement, is a methodology that relies on matrix multiplication to evaluate the influence and interdependence of barriers to IoT adoption (Desingh & Baskaran , 2021). It uses binary numbers (0 or 1) to show how these barriers relate to one another. Nevertheless, there are restrictions on how well the typical MICMAC analysis can represent the strength of these associations. Fuzzy scales—which include categories like no relation, weak, medium, strong, and full relation—are used to characterize the different levels of interaction across barriers in order to get around this restriction. Researchers often like this fuzzy MICMAC analysis because it accurately captures linkages based on expert judgements and provides a more exact identification of obstacles (Desingh & Baskaran , 2021).

Researchers have found that real time data exchange and high-quality patient care are the major goals of utilizing IoT in healthcare supply chain (Desingh & Baskaran , 2021). That facilitates the coordination and customer relations. The researchers have compared internet of things with an eco-system because it contains several sensors and digitally embedded sensors which can be used for data exchange with internet facility. Through, Auto-ID a communication and identification technology of IoT, different types of physical objects and things can be tracked during motion (Desingh & Baskaran , 2021). Additionally, it points to the physical object network includes wireless networks, electronic devices, software, internet connection and sensors for communicating and exchanging information with human, products and/or other physical things (Desingh & Baskaran , 2021). IoT solutions generally involve different types of wearable wireless devices that are connected to internet (Desingh & Baskaran , 2021). It creates a massive network of cyber physical systems for exchanging real time information with more accuracy that makes the coordination among the stakeholders of supply chain smooth. As customers are also included in the stakeholders, the relationship with customers becomes healthy.

This study aims to explore the potential benefits of blockchain technology for supply chains in terms of sustainability, with a focus on developing nations. The premise of this research is that underdeveloped countries have more obstacles than industrialized ones when it comes to maintaining sustainability ideals. As a result, the study emphasizes how crucial blockchain's features are for upholding sustainability norms, particularly when considering these emerging nations.

This study determined several amenities that can be received because of blockchain. Among those most important ones are better monitoring, real time information exchange and safety which positively impacts coordination in supply chain and customer relation. (Kshetri , 2021) Stated that in the world of blockchain monitoring and enforcement occur in real time. Also, after studying cases the researchers have concluded that it acts as shield for certification fraud. The level of details and verifiability increase the quality of information with the help of blockchain (Kshetri , 2021). Moreover, it possesses the capacity of avoiding unjust and morally questionable behaviors (Kshetri , 2021). All of these create transparency and safety more visible. As a result, the consumers get more confidence regarding the authenticity of the products which builds the relationship stronger (Kshetri , 2021). Along with that the coordination and relation with the

other stakeholders of supply chain get better. Because when real time information can be generated and exchanged, there will be less chances for errors and communication will be better.

The goal of this research is to determine the effects of big data on Supply Chain 4.0 within manufacturing companies in developing nations. Its objective is to explore the role of "big data analytics" as a mediator in improving various aspects of business performance (Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021). The study uses a two-stage hybrid model to analyze data from 321 replies gathered from 40 Indian manufacturing companies. This model combines statistical analysis and artificial neural network analysis. This study advances our understanding of how Supply Chain 4.0 and big data interact in the context of Indian manufacturing companies. With regard to the use of big data analytics in supply chain management, it clarifies possible advantages and provides managerial policy recommendations. This gives insightful information on how big data might improve corporate performance in the context of Supply Chain 4.0.

Supply chain 4.0 and industry 4.0 should briefly be discussed, before describing how big data adoption positively influence supply chain 4.0 business performance. The fourth industrial revolution is known as "industry 4.0." (Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021). It turns technologies into digitalization, automation etc. (Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021). There are several techniques such as Internet of Things, Cloud Computing, Augmented Reality, Robotics, Cyber security etc. (Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021). When industry 4.0 is being utilized in supply chain for making the processes more efficient and increasing productivity then the supply chain is called supply chain 4.0 (Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021). So, it means a supply chain of that particular business will be technologically advanced. Now, in this type of business performance big data adoption has a positive impact. So, for these impacts there are several predictors and among them highest ranked predictor was information and product delivery performance (Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021). Along with that there are other ones as well like collaborative planning performance, operational performance, technical and knowledge capability (Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021). If these predictors are present in supply chain 4.0 businesses, then big data adoption will have a positive impact (Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021). Also, big data adoption guarantees information availability throughout the entire supply chain (Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021). In that case the coordination and customer relation will increase. Because of in time information sharing, availability, transparency and collaborative planning will increase the coordination among the stakeholders. Alongside, in time product delivery will excel the relationship with customers.

At present, the world is experiencing the Fourth Industrial Revolution, with artificial intelligence (AI) significantly altering the lives of numerous individuals in both developed and developing nations. (Khalifa, Elghany, & Elgha , 2021). It is being predicted that these changes will have a noteworthy impact of the economy's growth rate, employment rate, productivity etc. (Khalifa, Elghany, & Elgha , 2021). So, this research is based on that revolutionary purpose. It is exploratory research which aims to find out the digitalization transformation practices within supply chain management context. It is basically based on developing nations particularly Egypt in the MENA region. This paper, through investing case studies, provides information about how to apply AI algorithms in production cycle and monitor the production process. Also provides insights about strategic and tactical engineering decision making (Khalifa, Elghany,

& Elgha , 2021). If Ai technologies and machine learning (ML) are incorporated, it will create innovation perception regarding several topics incorporating logistics, warehousing, cooperation in supply chain management (Khalifa, Elghany, & Elgha , 2021).

The findings of this study suggest various aspects. Among them one is with the help AI relationship with all the stakeholders has improved. It indicates better coordination and customer relation. For instance, autonomous vehicles developed by AI makes the transportation easier so the companies can deliver even in shorter lead times. The supply chain is critical because it includes long distance transporting, interconnectivity among various stakeholders such as manufacturers, retailers, raw material suppliers, consumers etc. (Khalifa, Elghany, & Elgha , 2021). So, it is necessary to make this connection accurately, quickly and cheaply for developing an effective and efficient supply chain. That's why supply chains need to be more digitalized and technology depending in the form of IoT, AI etc. (Khalifa, Elghany, & Elgha , 2021). AI provides real time information and multi-source data which can be exploited for transforming supply chain management (Khalifa, Elghany, & Elgha , 2021). This in turn will assist to develop those connections for better coordination and relation. Furthermore, supply chain is evolving intro and autonomous thing with self-awareness, self-governing, self-determining and self-optimizing qualities for integrating AI (Khalifa, Elghany, & Elgha , 2021). In consequence it will definitely have a productive impact the relationship and cooperation with different stakeholders.

3.3 Wastage & Environmental effects:

Electronic device innovation and cost reductions have been fueled by the digital revolution, and as a result, there is a significant worldwide demand for electronic devices, which is projected to reach 42 to 55 billion units by 2020–21 (Talapatra, 2022). Recycling Waste Electrical and Electronic Equipment (WEEE) produces e-waste in addition to promoting circularity and lowering obsolescence. Closed-loop supply chain (CLSC) methods that use blockchain technology (BCT) and the Internet of Things (IoT) have been successful in managing waste electronics (WEEE), especially in industrialized countries (Joshi, Sharma , & Barve, 2022). However, there are obstacles to overcome in the implementation of these digital technologies, especially in developing nations, such as data integrity, accessibility, and resistance to change. This study used a systematic literature review and the Best Worst Method (BWM) to identify important obstacles to adopting BCT in WEEE management in order to address these issues and advance current understanding. Key challenges in implementing IoT-enabled blockchain technology in closed-loop WEEE management were identified by the research. These included the need for legislative backing, the complexity of database administration, the lack of knowledge of cognitive technologies, and privacy and information security concerns. The study's overall goal is to make it easier for poor nations to switch to circular waste management techniques. Experts with vast expertise in a variety of sectors, including supply chain management, waste management, and blockchain, participated in the study. In January 2022, experts in a range of professions and from companies with 50 to 200 people collected data. Ten of the twenty-five specialists who were contacted gave thorough answers. To ensure a precise assessment of obstacles, the BWM solver was employed to rank criteria and sub-criteria according to expert judgments.

Waste management has benefited from the transformation and digitization of supply networks brought about by digital technologies (DTs) (Joshi, Sharma , & Barve, 2022). These technologies seek to enhance

supply and demand forecasting, optimize transportation costs, provide real-time data accessibility, and create intelligent warehouses for forward and reverse supply chains. They improve overall efficiency by facilitating real-time communication between supply chain participants. Digital Closed-Loop Supply Chains (CLSCs) provide better information sharing among supply chain participants, cost reduction, and productivity increase. It enhances the management of waste. Additionally, they can lessen harm to ecosystems by assisting in the mitigation of environmental concerns related to end-of-life items. The technology known as blockchain (BCT) is particularly important for CLSCs because it provides traceability, transparency, scalability, and accessibility. Utilizing BCT has several advantages, such as disintermediation, legally binding transactions, optimized response times, end-to-end data transparency, customized contracts utilizing smart contracts, and real-time data production and availability (Joshi, Sharma , & Barve, 2022). Applications of BCT in commercial supply chains include energy supply chain management, construction supply chains, agri-food quality, traceability, transparency, supply chain integration, sustainability and healthcare systems.

In the previous several decades, agriculture supply chain management (ASCM) has encountered a number of difficulties, such as its dependence on weather patterns that are not always predictable, the engagement of numerous actors, especially in rural India, and a shortage of skills and literacy among the workforce (Luthra, Mangla, Garg, & Kumar, 2018). Information and communications technology are becoming more and more necessary to address these issues Information and communication technology (ICT). ICT is the integration of communication technologies and telecommunication networks with information technology components, such as computers and sensors (Chapman & Slaymaker, 2002). The purpose of this section is to present Internet of Things (IoT)-based technologies and their uses in the context of supply chains for agriculture, particularly in developing nations like India. Six distinct IoT-based technologies that are pertinent to ASCM have been discovered in the literature. IoT implementation in India's agri-food industry has the ability to drastically cut waste and provide sustainable user requirements (Luthra, Mangla, Garg, & Kumar, 2018). Internet of Things (IoT) technology presents significant potential for integration into several ASCM tasks in the industrial setting of emerging nations such as India.

Here the researchers have found that agricultural supply chain based on IoT is like a chain which includes production, storage, distribution and retailing facility to satisfy the demands of the client for greater originality and quality (Luthra, Mangla, Garg, & Kumar, 2018). These can be done by using different technologies of IoT such as RFID, biosensors, wireless sensors etc. These technologies allow managers to determine accurate information about the products for maintaining quality (Luthra, Mangla, Garg, & Kumar, 2018). Moreover, particularly RFID tag can record every operation of the whole supply chain of agricultural products automatically. Besides, IoT can improve continuously by adopting different types of techniques like AI, ML, high pressure processing etc. (Luthra, Mangla, Garg, & Kumar, 2018).That not only develop the quality of the products but also reduce the wastage. Because when the information is being collected in a regular basis and with more accuracy, then record keeping and decision-making regarding product gets easier. Which in turn reduce wastage of products. Also, it saves the supply chains from wastage of funds in unnecessary warehouses or labor. As result it can be stated that wastage management gets better with IoT.

3.4 Demand management:

The aim of this study is to investigate the function of big data for supply chain 4.0 in developing country manufacturing companies. It investigates how 'big data analytics' works as a mediator in enhancing business performance across various factors (Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021). The research uses a two-stage hybrid approach that combines analysis using artificial neural networks with statistical analysis. An analysis is conducted on 321 answers from 40 manufacturing organizations in India. By illuminating the possible advantages and directing management practices linked to big data analytics in supply chain management; this study advances knowledge of the interaction between big data and Supply Chain 4.0 in the context of Indian manufacturing companies. It provides insightful information on how Supply Chain 4.0 business performance may be improved by big data.

The findings reveal that several performance factors, including organizational and top management, sustainable procurement and sourcing, environmental considerations, information and product delivery, operational efficiency, technical expertise, knowledge, and collaborative planning, significantly influence the adoption of big data (Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021). Here the researchers have identified the two main predictors of big data adoption. One of those is information and product delivery, another one is sustainable sourcing and procurement. (Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021) suggested that the ANN analysis provide "information and product delivery performance" the highest ranking, it exhibit that the organization must guarantee timely product delivery and information sharing. Which will have a positive impact on big data analytics and in turn this will positively influence supply chain 4.0 business performance. Here if the information flows securely and timely then it will influence big data adoption. (Narwane , Raut , Yadav , Cheikhrouhou , Priyadarshinee, & Narkhede , 2021) Suggested that big data adoption certifies information availability over end-to-end supply chain. It will improve the decision making at demand management and other aspects of supply chain.

The advent of the digital revolution has generated a significant worldwide need for electronic devices, with projections indicating a range of 42 to 55 billion units by the year 2020-21 (Talapatra, 2022). This surge in demand has therefore fostered heightened levels of innovation and cost reductions within the realm of electronic equipment. Nevertheless, the increased utilization of electronic devices has concurrently resulted in the emergence of electronic trash (e-waste), despite the endeavors made in the recycling of trash Electrical and Electronic Equipment (WEEE) to encourage circularity and diminish obsolescence. The use of closed-loop supply chain (CLSC) practices, which integrate Internet of Things (IoT) and Blockchain technology (BCT), has demonstrated its efficacy in the management of Waste Electrical and Electronic Equipment (WEEE), notably in industrialized nations. However, the implementation of these digital technologies encounters other problems, such as ensuring data integrity, promoting accessibility, and overcoming reluctance to change, especially in poor countries (Joshi, Sharma , & Barve, 2022). In order to tackle these problems, a comprehensive evaluation of existing literature was conducted, and the Best Worst Method (BWM) was utilized to identify key obstacles in the implementation of Behavior Change Techniques (BCT) in Waste Electrical and Electronic Equipment (WEEE) management. This study identified significant problems pertaining to the deployment of Internet of Things (IoT)-enabled Block

chain Technology (BCT) in closed-loop Waste Electrical and Electronic Equipment (WEEE) management. These concerns include the necessity for legal backing, difficulties in managing databases, insufficient comprehension of cognitive technologies, and apprehensions over information security and privacy. The objective of this study is to support the adoption of circular waste management practices in developing economies. To achieve this, the Blockchain Waste Management (BWM) approach is utilized to identify key barriers to implementation. Expert opinions from diverse fields such as Blockchain, waste management, and supply chain management in North India are gathered, with a specific emphasis on respondents' substantial experience and expertise.

Digital technologies have significant impact over the entire supply chain of developing countries by enhancing the performance and making that more digitized. Since the objectives of digital technologies are providing accessibility for real time data, enhancement of supplies, improved demand forecast, development of smart warehouses and optimize transportation cost in forward and reverse supply chains (Joshi, Sharma , & Barve, 2022). As a result, especially demand management is positively impacted. Because with the help of improved demand forecast and real time information, almost actual amount of demand can be predicted then smart warehouses will help to provide the routine information about inventory. Moreover, digital technologies have integrated the upstream and downstream supply chain activities (Sharma & Joshi, 2021). It in turn will help to balance the demand and supply. Besides, among all the information technologies that are currently available, block chain technology is the most valuable technology which has the ability to solve the circularity issues in closed loop supply chain and bring synergy and transparency among supply chain partners of developing countries (Agrawal, Wankhede, Kumar, Luthra, & Huisingh, 2021). It can help in various activities ranging from accessibility, scalability, end to end data transparency, real time data generation, optimize response time, improve operational efficiency etc. All of these benefits can bring positive impact in the demand management in supply chain of developing countries.

Chapter-4

4. Conclusion:

In conclusion, the examined research articles collectively illuminate the revolutionary possibilities of cutting-edge technologies in several facets of supply chain management, especially in developing nations. Supply chain operations could be greatly impacted and improved by the use of technologies like the Internet of Things (IoT), blockchain, artificial intelligence (AI), machine learning, and digitalization.

IoT implementation in healthcare supply chains has several advantages, starting with operational ones. These include real-time data interchange, cost savings, and accurate clinical decision-making. Despite these benefits, adoption of IoT is hindered in underdeveloped nations. In order to successfully integrate IoT into healthcare supply chains and realize the expected benefits, it is imperative that these impediments be addressed. Adoption of digital technologies, such as blockchain and the Internet of Things, can improve real-time information sharing, demand forecasting, and cost optimization while also improving supply chain coordination. Additionally, blockchain technology improves safety and meets regulatory criteria while promoting transparency, traceability, and quality improvement. Artificial Intelligence has a big impact on how supply chains operate, how well they coordinate, and how well they interact with stakeholders. The integration of artificial intelligence (AI) in autonomous vehicles, real-time data sharing, and process optimization enhances supply chain efficiency and logistics. Even if AI has a lot of potential, research and development are still needed to realize all of that potential in supply chain management.

Digital technologies like blockchain and IoT have the potential to greatly improve supply chains in the context of trash management. Improved productivity, lower costs, and improved information sharing are made possible by these technologies. They also help to lessen waste and damage to the environment. Specifically, blockchain provides improved certification processes, traceability, and transparency that increase consumer trust and safety. The improvement of supply chains' environmental sustainability depends on these technological developments.

Adoption of big data has a positive effect on demand management, particularly when issues like procurement, sustainable sourcing, and information and product delivery performance are taken into consideration. The performance of supply chains as a business is positively impacted by big data analytics and safe, real-time information flow. By offering real-time data, better demand forecasting, and streamlined supply chain operations, digital technologies, such as blockchain and the Internet of Things, improve demand management and ultimately aid in the balance between supply and demand.

In conclusion, supply chain management in underdeveloped nations can undergo a radical transformation with the use of cutting-edge technologies and digital solutions. These technologies provide a number of advantages, including improved stakeholder engagement, increased coordination, transparency, and real-time data interchange. Nevertheless, in order to fully utilize these technologies, obstacles and difficulties must be overcome. Developing countries can use the revolutionary potential of these technologies in supply chain management by implementing practical applications and furthering research into this area.

Now there are a number of interesting directions for future supply chain management study, especially when looking at developing nations like India. More research in the field of IoT adoption in healthcare supply chains should focus on particular tactics and case studies that effectively overcome the obstacles found. To offer insight on best practices and lessons learned, this may entail investigating how healthcare institutions in developing economies have surmounted obstacles and benefited from IoT integration.

Future studies in the area of blockchain and supply chain sustainability may concentrate on evaluating the social and environmental effects of blockchain technology in developing nations. It is crucial to comprehend how blockchain technology might help promote sustainable practices in less developed areas and lessen waste and environmental harm. Additionally, studies can look into the legal and regulatory frameworks needed to encourage the use of blockchain technology for sustainability and environmental goals.

Research on big data analytics in Supply Chain 4.0 is quite promising, especially in poor countries. Future research, while accounting for the particular difficulties these nations confront, may focus on creating frameworks and technologies that make big data analytics easier to use in supply chains. Furthermore, investigating how big data may optimize demand management and lead to increased resource efficiency could be a wise course of action.

In terms of IoT-based technology in agriculture supply chains, more study can look into how affordable and scalable IoT solutions are for local producers and small-scale farmers in developing nations. Insights from case studies and field research demonstrating the real-world application of IoT technology and their influence on waste reduction and enhanced supply chain effectiveness would be beneficial.

Future studies should examine these countries' willingness to adopt AI technology and any obstacles in the context of AI and its effects on supply chain management in emerging nations. Best practices and case studies for incorporating AI into supply chain management in various contexts would provide direction for real-world application.

It would be possible to broaden the scope of research on machine learning approaches in fusion-based supply chain collaboration by looking at how these approaches may be used to solve particular optimization problems in a variety of industries, including banking, healthcare, and military logistics. Additionally, more study might concentrate on creating useful manuals and resources for businesses wishing to successfully integrate machine learning methods into their supply chain processes.

Future studies in the field of waste management and environmental implications of digital technology might look into creative strategies for lowering the amount of electronic waste produced by the widespread use of digital devices, particularly in poor countries. It might also look into ways that digital tools like blockchain and the Internet of Things can improve waste management procedures while reducing their negative effects on the environment.

There is much to learn about how big data analytics may be used in demand management to optimize and respond to market demand. Future studies might concentrate on creating predictive models, instruments, and tactics that assist businesses in underdeveloped nations in utilizing big data analytics to enhance demand forecasting and more effectively satisfy client demands.

All things considered, these many fields of study present a variety of chances to improve resource allocation, minimize waste, and enhance supply chain management techniques in developing nations, all the while encouraging sustainability and creativity.

References

Khalifa, N., Elghany, M. A., & Elgha , M. A. (2021). Exploratory research on digitalization transformation practices within supply chain management context in developing countries specifically Egypt in the MENA region. *Cogent Business & Management*.

Khan, S., Singh, R., Khan, S., & Ngah, A. H. (2023). Unearthing the barriers of Internet of Things adoption in food supply chain: A. *Green Technologies and Sustainability*.

Narwane , V. S., Raut , D. D., Yadav , V. S., Cheikhrouhou , D., Priyadarshinee, D., & Narkhede , D. E. (2021). The role of big data for Supply Chain 4.0 in manufacturing organisations of developing countries . *Journal of Enterprise Information Management* .

Agrawal, R., Wankhede, V. A., Kumar, A., Luthra, S., & Huisingh, D. (2021). Progress and trends in integrating Industry 4.0 within Circular Economy: A comprehensive literature review and future research propositions.

Ali, N., Ghaza, T. M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H. M., et al. (2022). Fusion-Based Supply Chain Collaboration Using Machine Learning Techniques.

Bhat, A. (2023). *Secondary Research: Definition, Methods and Examples.* Retrieved from QuestionPro: https://www.questionpro.com/blog/secondary-research/

DDC FPO Solutions. (2023). *What Is Supply Chain Digitization, and Why Does It Matter?* Retrieved from DDC FPO Solutions: https://www.ddcfpo.com/freight-process-insights/what-is-supply-chain-digitization-and-why-does-it-matter#:~:text=Supply%20chain%20digitization%20(or%20supply,external%20sources%20(e.g.%20internal%20historical

Desingh , V., & Baskaran , R. (2021). Internet of Things adoption barriers in the Indian healthcare supply chain: An ISM-fuzzy MICMAC approach. *International Journal of Health Planning and Management* .

Flynn, D. (2022). *How might literature-based studies work better for academics, students and librarians?* Retrieved from Information Literacy Group: https://infolit.org.uk/how-might-literature-based-studies-work-better-for-academics-students-and-librarians/#:~:text=Over%20recent%20years%20it's%20become,an%20entirely%20literature%2Dbased%20study.

Grewal, A., Kataria, H., & Dhawan, I. (2016). Literature search for research planning and identification of research problem. *Indian Journal of Anaesthesia* .

Halstead, J. (2018, January 05). *5 IoT Applications In Logistics & Supply Chain Management.* Retrieved from Link-labs.com: https://www.link-labs.com/blog/iot-applications-in-logistics

IBM.com. (2023). *What is machine learning?* Retrieved from IBM.com: https://www.ibm.com/topics/machine-learning

Jacobs, T. (2023, February 24). *Unlocking the Value of Artificial Intelligence (AI) in Supply Chains and Logistics.* Retrieved from Throughput.world: https://throughput.world/blog/ai-in-supply-chain-and-logistics/

Joshi, S., Sharma , M., & Barve, A. (2022). Implementation challenges of blockchain technology in closed-loop supply chain: A Waste Electrical and Electronic Equipment (WEEE) management perspective in developing countries. *Supply Chain Forum: An International Journal* .

Kshetri , N. (2021). Blockchain and sustainable supply chain management in developing countries . *International Journal of Information Management* .

Laskowski, N., & Tucci, L. (2023, November). *A guide to artificial intelligence in the enterprise.* Retrieved from TechTarget Network: https://www.techtarget.com/searchenterpriseai/definition/AI-Artificial-Intelligence

Luthra, S., Mangla, S. K., Garg, D., & Kumar, A. (2018). Internet of Things (IoT) in Agriculture Supply Chain Management: A Developing Country Perspective.

Mauer, B., & Venecek, J. (2021). *STRATEGIES FOR CONDUCTING LITERARY RESEARCH.* Retrieved from University OF Central Florida : https://pressbooks.online.ucf.edu/strategies/chapter/research-methods/#Methods

Scott, S. (2019, April 01). *Survival of the Fittest Supply Chain" and Shay Scott's Foresight On Supply Chain Excellence.* Retrieved from supplychainmanagement.utk.edu: https://supplychainmanagement.utk.edu/blog/shay-scott-strategic-logistics-summit-march-2019/

Sharma, M., & Joshi, S. (2021). Digital technologies (DT) adoption in agri-food supply chains amidst COVID-19: an approach towards food security concerns in developing countries. *Journal of Global Operations and Strategic Sourcing*.

Srivastava, S. (2023, August 28). *The role of AI-Led Analytics in optimizing supply chain management flow.* Retrieved from Appinventiv.com: https://appinventiv.com/blog/ai-in-supply-chain-analytics/

Talapatra. (2022). Impact of Changing Consumer Behaviour on Sustainability. *In Emerging Economic Models for Sustainable Businesses*, 109-127.

The University of Tennessee Knoxville. (2020, March 09). *Emerging Technologies in Supply Chain Management.* Retrieved from supplychainmanagement.utk.edu: https://supplychainmanagement.utk.edu/blog/emerging-technology-in-supply-chain-management/

Tirkolaee, E. B., Sadeghi, S., Mooseloo, F. M., Vandchali, H. R., & Aeini, S. (2021). Application of Machine Learning in Supply Chain Management: A Comprehensive Overview of the Main Areas. *Mathematical Problems in Engineering*.

University of Derby Library. (2023). *Dissertations - Skills Guide*. Retrieved from University OF Derby: https://libguides.derby.ac.uk/c.php?g=690330&p=4944394#:~:text=The%20advantages%20of%20conducting%20a,key%20questions%20about%20current%20research.

University of North Florida. (2022). *Conducting a Literature Review*. Retrieved from University of North Florida: https://libguides.unf.edu/litreview/benefits

What is IoT (Internet of Things)? (n.d.). Retrieved from aws.amazon.com: https://aws.amazon.com/what-is/iot/#:~:text=The%20term%20IoT%2C%20or%20Internet,as%20between%20the%20devices%20themselves.

Younis, H., Sundarakani, B., & Alsharairi, M. (2021). Applications of Artificial Intelligence and Machine Learning within Supply Chains: Systematic review and future research directions. *Journal of Modelling in Management*.