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iJIM International Journal of Interactive Mobile Technologies

iJIM | eISSN: 1865-7923 | Vol. 18 No. 23 (2024) | OPEN ACCESS

https://doi.org/10.3991/ijim.v18i23.51219

PAPER

Designing Smart Supply Chains Based on Digital AI Instruments and Mobile Technologies

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ABSTRACT

Academic and industrial research on digital technology has been quite thorough. Nevertheless, scant information exists regarding the supply chain implementation of digital technology in industrial companies. To better understand supply chains, this article will look at why and how manufacturing companies are implementing digital technology. The goal of this paper's literature analysis is to pinpoint current studies and perspectives on how these technologies could help digital supply chains (DSCs) operate better, faster, and more efficiently. The investigation looks at the technologies' directions and challenges in improving the efficiency of digital help confinement, in addition to underlining their significance for supply chains and logistics. It investigates the managerial and practical issues in developing a new integrated paradigm for digital supply chains. Also, possible obstacles to DSCs and procurement will be examined, along with solutions. Consequently, this study pinpoints multiple opportunities for adding value when implementing Internet of Things (IoT) in the supply chain using mobile technology. Additionally, it suggests a method for creating business models for supply chain algorithms.

KEYWORDS

digital supply chains (DSCs), supply chain, digital technology, mobile technologies, Internet of Things (IoT)

1 INTRODUCTION

In the contemporary, current global business environment, electronic use in manufacturing has grown significantly. For the past 10 years, factories have been researching the use of new digital technologies in supply chain management (SCM) and production, including artificial intelligence (AI), big data analytics (BDA), and the Internet of Things (IoT). SCM involves managing, controlling, and enhancing data and the original vendors and final customers; material passes through a network of interconnected organizations [1]. Planning, scheduling, travel, and buying functions within the supply chain are all expected to be improved by these technologies. IoT is frequently utilized in factories and *shipping* facilities to monitor and trace

Zemlyak, S., Khromenkova, G., Gusarova, O. (2024). Designing Smart Supply Chains Based on Digital AI Instruments and Mobile Technologies. *International Journal of Interactive Mobile Technologies (iJIM)*, 18(23), pp. 72–84. https://doi.org/10.3991/ijim.v18i23.51219

Article submitted 2024-07-18. Revision uploaded 2024-08-29. Final acceptance 2024-09-05.

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warehousing and logistical activities as well as production processes. Current information from IoT gadgets and information from other supply chain processes can yield significant commercial value with the application of BDA and AI. It might help companies discover inventory problems, allocate resources more efficiently, estimate customer wants more precisely, and manage their supplier relationships. These new technological advances are changing value chains, business designs, and factory architecture in addition to products and processes.

The use of digital technologies at the supply chain level in manufacturing companies is attracting increasing amounts of study interest. Research to date has largely shown that digital technology may help companies reduce supply chain hazards and unpredictability while also enhancing the effectiveness, accessibility, robustness, and durability of their supply networks. The digitization of supply networks generates a lot of data, and these data are thought to be a new kind of resource with the ability to boost competitiveness and add value. This could affect business structures and change how businesses create and extract revenue. Additionally, studies have demonstrated how digital technologies have changed SCM from old methods to more data-driven ones. Manufacturing companies are putting more focus on using supply chain information for logistic and production optimization, predictive maintenance, and demand forecasting. This requires a considerably higher level of information-analytical abilities and skills than the normal supply chain management.

The specific needs of each company, the resources at hand, and the industrial setting can all influence how AI is used in the supply chain. However, a supplier of supply chain AI solutions would typically take the following steps to effectively implement AI in the supply chain: in Figure 1.

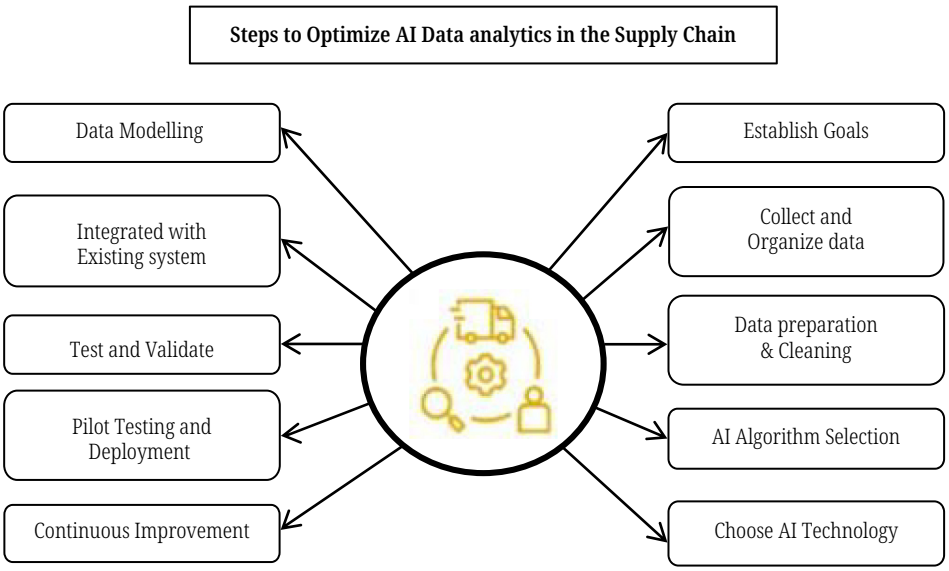

Fig. 1. Steps to optimize AI data analytics' place in supply chain management

Digital supply chains (DSCs) and the transition to a more automated and self-sufficient industrial sector have been the subject of recent research. Every step of the supply chain, from the creation of product orders or mass production to the manufacturing processes and payment methods, can be digitalized for maximum efficiency and, when compared to the outcomes before digitalization, higher financial growth. A DSC structure's main objective is to remove human error from each stage of the procedure and use software and hardware that are more intelligent than humans to automatically decide what will maximize the efficiency and minimize production costs of the smart factory.

The DSCs will be enabled by several cutting-edge technologies, including online computing, big data and evaluation, virtual reality, machine learning, AI, autonomous machines, cyber-physical systems, the web of things, smart contracts, and blockchain [2].

Among the many different kinds of industries are those in manufacturing, technology, finance, services, and healthcare [3]. Every kind has different difficulties and distinctive qualities of its own. The manufacturing sector has a more complex organizational structure and a higher human presence than many other sectors, which makes it more difficult to design for adaptation and thus taking a lot longer.

The structure of this document is as follows: Background information on the IoT is given in Section 2, along with definitions, enabling technologies, and historical context. In Section 3, we offer an overview of our review process along with a summary of the bibliometric analysis. Section 4 presents a comprehensive overview of the literature. Lastly, Section 5 offers suggestions for future study directions and findings.

2 RELATED WORKS

As the term implies, AI is the capacity of a computer to independently solve issues that it hasn't been specifically taught to manage. When John McCarthy sponsored a workshop in 1956, the area of AI was established [4]. The pioneering work of individuals such as Ray Solomonoff, Allen Newell, Herbert Simon, Claude Shannon, McCarthy, Marvin Minsky, Nathaniel Rochester, Claude Shannon, Arthur Samuel, Oliver Selfridge, and others energized the area of "artificial intelligence" in the years that followed. Alan Turing suggested that computers might be designed with automatic learning capabilities in his paper "Computing Machinery and Intelligence." Following the progress of "Shakey," a wheeled robot at SRI, mobile robotics became a globally recognized area.

Blockchain innovation and 5G networks together have a lot of possible to unleash a wave of economic value. The increased capacity, high speeds, and decreased latency of 5G coverage will also enable the widespread usage of IoT devices [5]. The "Communications Service Providers (CSPs)" must understand the many access ways and varied types of access nodes that the 5G technology promises, which allow universal access across various networking settings. For each node, the fastest route node will be chosen, and as a result, continuing to be a major challenge in the future. Therefore, the latest wave of access decision-making procedures that are necessary for 5G networks are made possible by blockchain technology.

Even with the abundance of readily accessible simulation software tools that make it possible to analyze manufacturing and distribution processes, off-the-shelf solutions frequently offer little flexibility when it comes to capturing unique working conditions and matching IAVs. Additionally, built-in libraries in commercial software packages may be old or have a limited variety of IAVs covered [6]. Consequently, a lot of unrealistic assumptions are usually made while modeling IAVs using commercial software, especially in light of current developments in the automation sector. Specifically, commercially available simulation techniques are unable to simulate how an autonomous system would react to the dynamics of the real world.

Cloud computing, the IoT, big data, blockchain, robotics, and AI are just a few examples of recent innovations that make it possible to combine hitherto unconnected development lines into intelligent network systems of system. Thanks to these technologies, agriculture will be able to develop into a data-driven, intelligent, flexible, and self-sufficient network system of systems. Semantically active technology will automate the integration of every agricultural process into the food chain, all the way up to the final consumer. Agriculture is currently being affected by the fourth industrial revolution [7]. The idea of a digital platform (DP) was born out of the

integration of several, mostly open-source software solutions to create ecosystems. The EU encourages the development of digital platforms for a variety of application areas, including manufacturing.

The current distributed ledger technology (DLT) comes with built-in transaction automation features that let users create complicated applications with smart contract languages such as eSourcing Markup Language. This software shares the same properties as the DLT, such as being immutable or self-enforcing [8]. As a result, smart contracts are computer programmers that, when certain predetermined criteria are met, perform trades on a blockchain. You can think of them as virtual individuals with accounts.

To maximize the utilization of these technologies for supply chain network efficiency, people are still required. It takes knowledge management, which is the process of producing, disseminating, applying, and overseeing information and knowledge inside an organization, to make these enormous volumes of data into knowledge. Although machine learning and other aspects of digitization aim to automate "learning" in businesses [9], a SCM strategy is not yet feasible with the widespread use of these innovations. However, with all the data at our disposal, it is becoming increasingly important to understand how to extract, distribute, and use information.

Supply chain managers can share lifetime behavioral data on items and respond almost instantly through creative processing modes as information transmission across the supply chain network becomes more regular and swifter. COVID-19 pandemic has highlighted the importance of being able to act swiftly, as multiple decisions need to be made in emergencies [10]. As an illustration, IoT-based operation systems that include BDA, AI, and time were saved by alternative communication methods such as satellites and 5G monitoring more extensive human activity and forecasting the availability of essential resources within intricate supply networks.

3 METHODS AND MATERIALS

3.1 Mapping the supply chain

In order to understand the functioning of the fish supply chain and the associated substance, facts, and information flows, we conducted a primary as well as secondary analysis of the current state of the Thai fish environment. To monitor and understand supply chain activities in the sector, we conducted in-person walkthroughs and interviews. Understanding the current state of operations is crucial to drawing a future state that arises from the combined use of AI and business-centric technology (BCT) [11]. An appropriate method for capturing the actions and substance, information, and knowledge exchanges in the Thai fish environment of operations was supply chain mapping. Using the related business activities as building blocks, the produced supply chain mapping drawings are theoretically built.

We chose the BPMN as a method to notate operations and the related material flows because, given the extent of research on AI and BCT, there was an intrinsic necessity to maintain compatibility with established computer technology-based reference frames. Specifically, the OMG BPMN 2.0 was chosen, which is commonly utilized for modeling company procedures to guide their execution.

3.2 Supply chain organization

Globalization has been primarily propelled by supply chain networks that traverse national boundaries. As a result, distribution systems have had to become

more robust, intricate, and costly. Supply chains are crucial in enabling the seamless manufacturing of goods and services from the acquisition of initial supplies to the final distribution of produced commodities to global consumers. They also present numerous opportunities for increased sustainability, from better strategic purchasing to the adoption of more environmentally friendly transportation.

Furthermore, supply chains are changing the way companies collaborate, communicate, and share information. Because of this, every step that supply chains take towards more digitalization has the potential to bring about significant change. The acceptance of new technology is often a driving force behind digitalization. Numerous supply chain activities are impacted by this, including production, inventory control and storage, sales, and vendor and consumer relationships. Adopting digital technology is becoming more and more crucial in today's environment, where supply chains must compete with one another to be competitive [12]. As a result, SCM has entered a new phase were utilizing cutting-edge I4.0 technological advances is essential to facilitating data-driven decision-making, revolutionizing corporate procedures, and assisting with creative modifications in warehousing, transportation, and production. Enterprises have acknowledged the noteworthy effects of inventive digital technologies in facilitating sustainable endeavors and enhancing supply chain efficiency.

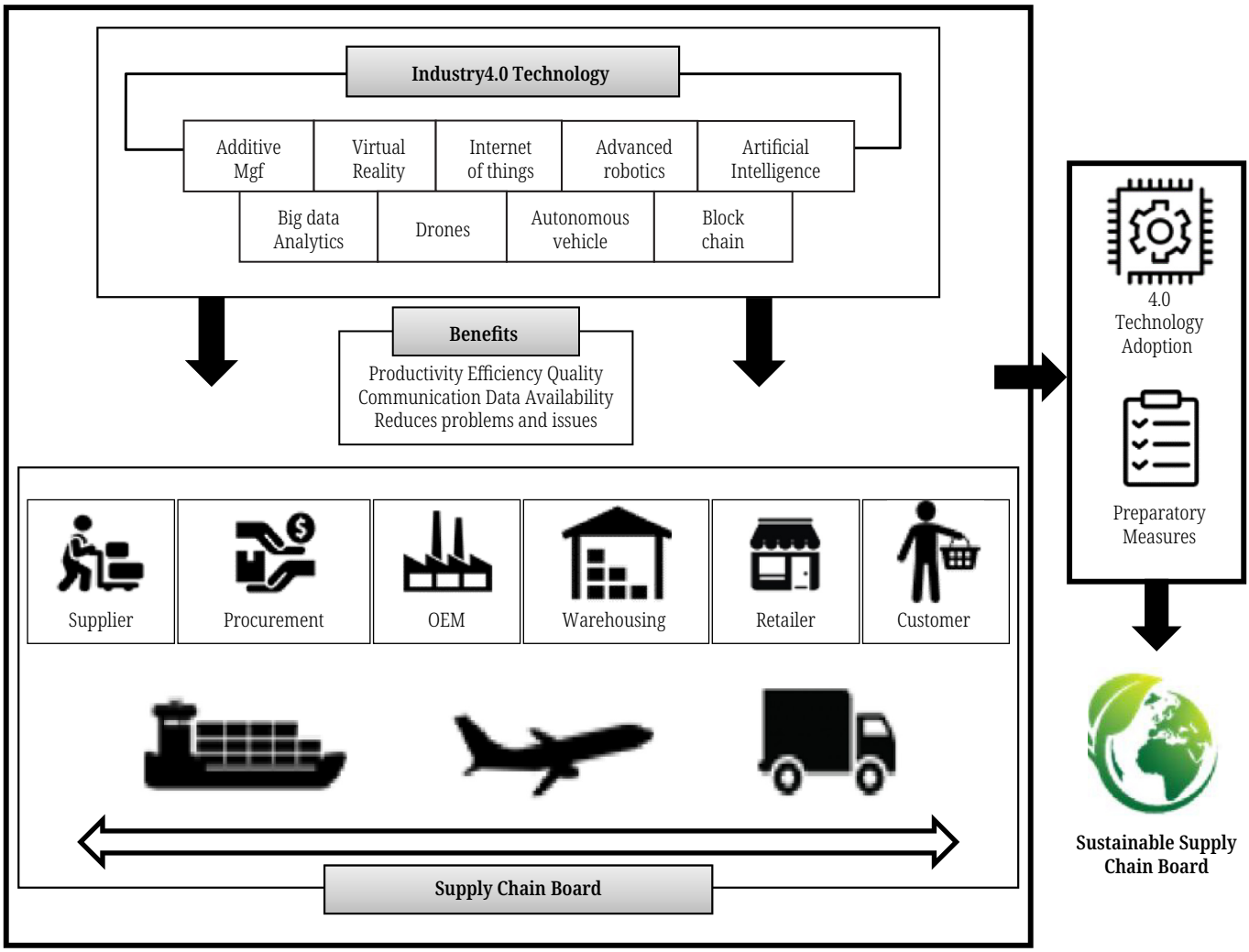

Fig. 2. Frameworks for research

The significance of Industry 4.0 technologies and their potential advantages for supply chain networks in promoting sustainability enhancements is illustrated in Figure 2. Integration of technology such as AI, big data, and the web of things can have a significant positive impact on supply chains. Supply networks in developing nations, such as Vietnam, can become more sustainable by implementing Industry 4.0 if the necessary steps are taken in advance.

They enhance supply chain resilience and agility by reducing bottlenecks, optimizing touchpoints [13], improving network architecture and delivery, and cutting cycle times.

Global awareness of how globalization affects the environment, society, and economy is expanding at the same time. The definition of sustainability is striking a balance between environmental, social, and economic factors. Therefore, supply chain managers need to be sufficiently prepared and should think about adopting sustainable methods with a higher emphasis on Cyber-Physical.

3.3 Smart supply chains and manufacturing

Smart manufacturing refers to the networked equipment that makes up the Cyber-Physical System, which enables a self-adjusting environment capable of adapting to changes and recommending the best path forward. But it's crucial to realize that even if one organization doesn't effectively implement the ideas of innovative production facilities, the other participants' efforts won't result in an international global optima position given the critical role that multiple entities play in shaping the journey from the initial supplies to the end consumers. The smaller, separate entities in the supply chain must function like interconnected platforms for it to function as a whole, much like the connected physical assets found in a smart environment [14]. When one variable changes for a single entity, the other related entities must respond collectively and with a countermeasure.

Numerous academics have emphasized the importance of the electronic supply chain multiple times. Previous studies have emphasized the online supply chain in the manufacturing industry in this regard.

The degree to which physical objects or procedures are interconnected with different digital platforms is known as smart technology. Investing in smart technology can significantly boost the company's performance both internally and externally, provided that the existing supply chain integrates these technologies. The reader can better grasp the key distinctions between traditional and DSCs by referring to Figure 3.

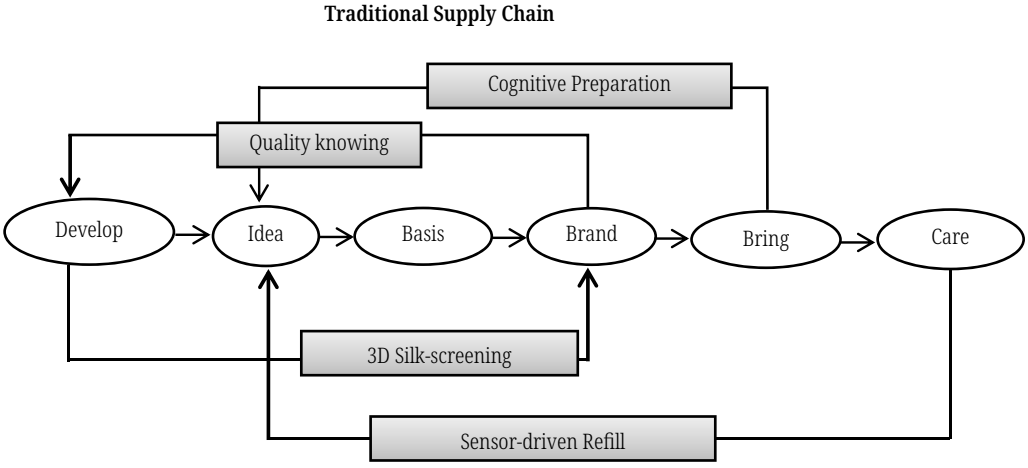

Fig. 3. *(Continued)*

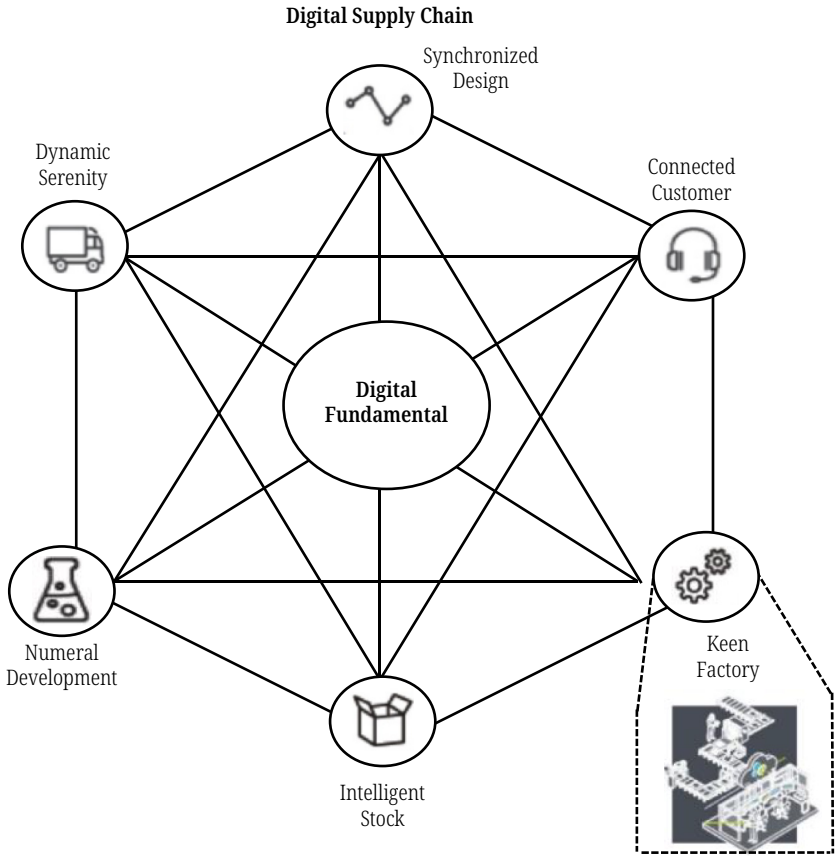

Fig. 3. Process for developing and deploying the smart factories models

It found that a decision support system aids users in making more informed decisions about organizational actions throughout the whole supply chain, through the Italian fashion sector. According to a recent research on the fourth industrialization, multi-agent deployment of technology is taking into account many supply chain operations, including supplier selection, and developed a company model with three patterns—integration, service, and expatriation—to leverage industry 4.0 in a single context. It was demonstrated that the integration adds new procedures to a current company structure and incorporates the supply chain's components in a similar way [15].

Subsequently, supply chain resilience could be enhanced by smart systems, particularly in light of the emergence of new skills and capabilities. The implementation of Industry 4.0 technologies that enable tends to improve the performance of the entire supply chain, particularly with regard to manufacturing, trading, automation, and digitization. Additionally, it promotes the concept of sharing data and digitalization across the supply chain, highlighting the need to integrate DSCs and enterprises through initiatives like the development and use of the term "digital culture."

- "new digital business models,"
- "optimised data management,"
- "connected devices and processes,"
- "integrated performance management,"
- "synchronised planning and inventory management,"
- "supply chain transparency,"

- "integrated value chains,"
- "connected customers and channels,"
- and "x" collaboration and data sharing are all important for the successful adoption of the idea of industry 4.0.

It demonstrated how industry 4.0 and digital change, through improved visibility regarding process uniformity, can lead to a fully digital supply chain. If the businesses don't have the right information-sharing standards, this might not be possible. It is noteworthy that, in order to improve process efficiency and effectiveness, the decision-making process is linked to information exchange throughout the supply chain. In keeping with the same framework, research has shown that the advances and innovations associated with the latest industrial revolution enable autonomous decision-making throughout the supply chain.

Furthermore, industry 4.0 can positively influence efficient marketplaces and all things linked to environmental aspects (such as healthy circular production systems) in an integrated way thanks to new technology. In this sense, increasing information sharing and synchronizing activities among supply chain participants enables flexibility, effectiveness, and overall cost savings across the board for the supply network. It was discovered that by lowering expenses and inventory levels, RFID and cloud computing improved operational effectiveness. However, this was made feasible by a greater level of visibility due to data exchange among supply chain participants.

4 IMPLEMENTATION AND EXPERIMENTAL RESULTS

4.1 For IoT-based SCM, the detection device

The primary parts of IoT systems are sensors. In sensors-based IoT SCM, a multitude of data types are gathered. Sensors support product tracking and monitoring. The list of sensors for IoT-based SCM in the literature is displayed in Figure 4. This section addresses the sensors that were employed in the review research and investigates the use domains for SCM in which they were applied. Sensors and the SCM application domains where they were used are shown in Figure 5.

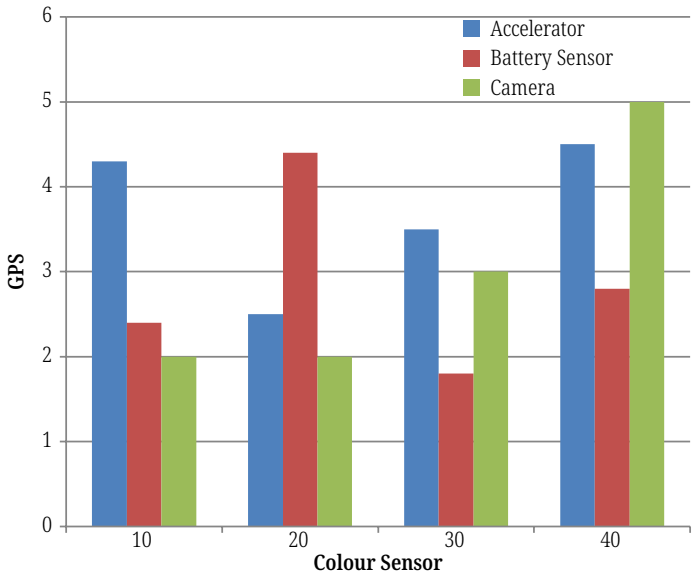

Fig. 4. IoT-based SCM employs sensors

Humidity sensors are used in the distribution of products, transportation systems, smart containers used in the reverse distribution process, and humidity sensors to measure the amount of liquid vapor. These sensors allow the agri-food supply chain to monitor its transportation conditions. To measure food moisture, perishable food storage areas have humidity sensors installed; humidity sensors in warehousing to gauge inventory humidity; humidity sensors in the medical supply area to gauge supply humidity; humidity sensors are used in food and farming supply chains to monitor the relative humidity of storage areas for food. Humidity sensors were also used to detect the temperature of the agricultural environment. The ambient parameters for logistics were measured by the authors through the use of humidity sensors.

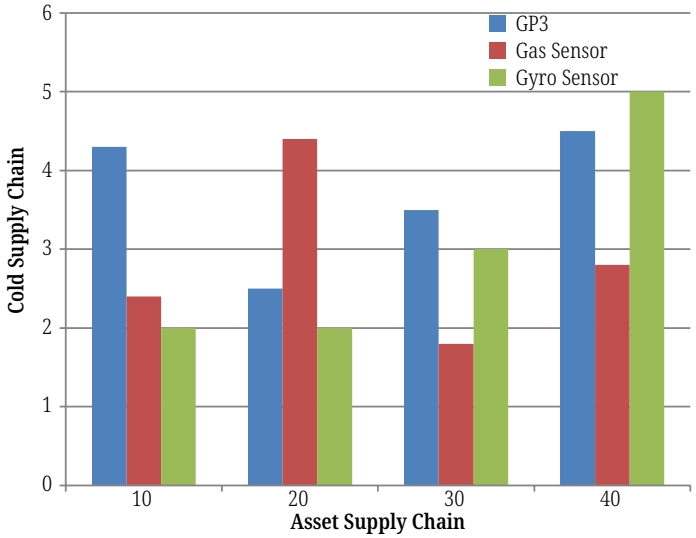

Fig. 5. IoT-based SCM uses sensors for many application domains

4.2 SCM challenges based on IoT

A number of factors, including changing customer tastes and interests as well as advancements in the internet, affect the need for items. This causes the company to experience problems with supply as well as demand for its goods. It is therefore difficult to predict product demand. Advanced technologies such as AI, neural networks, and advanced learning may be used to overcome these limitations and challenges. In order to predict customer demand for particular products, IoT-based management of supply chains historically depended on historical data from backorders. The bullwhip effect is another well-known challenging phenomenon in supply chain management.

This issue demonstrates how many phases of the supply chain can become unstable and experience variations in product and order quantities at various points due to a lack of communication and coordination. Purchases of supplies are either frequent or infrequent as a result. It causes problems with backorders and out-of-stock situations or compels businesses to lower their pricing. Proposed a multimedia platform for exchanging information and controlling inventories that was built on Internet and 5G internet protocols and employed RFID and AI to solve the issue of a shortage of goods availability.

The researchers have developed a smart agent-based forecasting engine that will recommend products to consumers according to current sales, using real-time data from item racks.

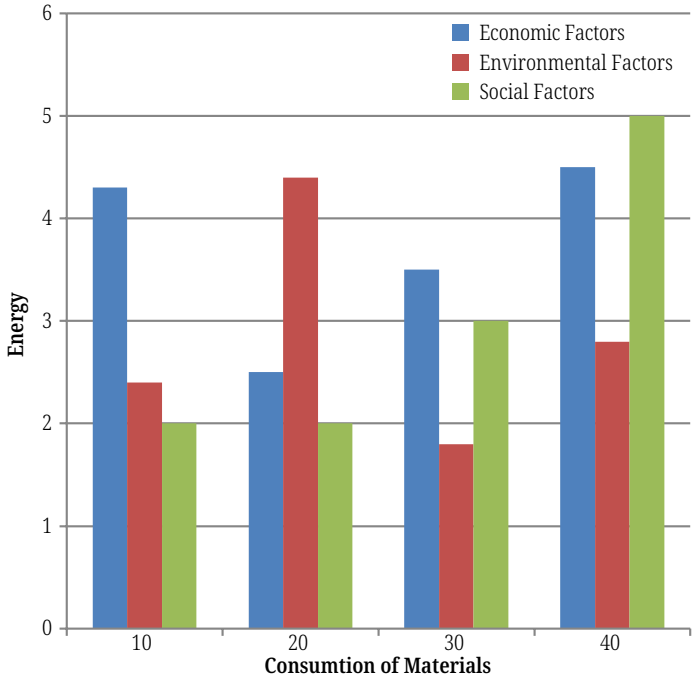

Fig. 6. A base hierarchy for the Internet of Things SSCM

Each company uses a centralized system to manage data about its supply chain operations. These centralized systems fall short in providing real-time data for global supply chain management (GSCM) and (see Figure 6) promising to maintain some discrepancies while working with different structures globally, to a certain degree. Yet, these disparities in data related to supply chain operations may provide counterfeiters with opportunities to manipulate data for their own gain.

4.3 Implications for the economy of using IoT-based SCM

Due to the fact that IoT-based SCM provides best practices for fully automating the supply chain process, businesses enjoy its benefits. As a result, the organization performs better overall to compete with other companies. Its primary objective is to advance the circular economy. Businesses can profitably use IoT-based SCM solutions, which also have the potential to generate long-term circular value. Using IoT-based SCM helps businesses save money on raw material purchases and product development.

This also holds true for customers who receive premium goods and services at reduced costs. In a number of SCM application areas, such as smart logistics, smart agriculture, wearable technology, energy, waste management, and warehouse management, IoT can lead to new business opportunities. The national economy would gain if this led to the founding of new businesses and the creation of jobs. The primary impetus behind the adoption of the circular economy (CE) is SCM powered by IoT. Concepts pertaining to advanced manufacturing, asset utilization, part repair, reuse, and cycling, current products and supplies, resources, energy, and handling waste emerged as a result of the integration of IoT into supply chain management.

4.4 Implications for business of deploying IoT-based SCM

Businesses may get up-to-date information on a variety of supply chain operations, including inventory levels, machine performance, ambient temperatures, and energy use, by utilizing sensors, devices, and smart tags. IoT has made it simple for companies to track shipments, which aids in prompt order fulfillment. Better warehouse and inventory management for firms is facilitated by this, as it also promotes openness in supply chain processes. Companies enabled by IoT can now offer individualized customer service to their clients. Companies that integrate IoT devices, detectors, and intelligent programs into their goods can obtain valuable insights about the usage habits and preferences of their customers. Customized product recommendations, targeted marketing campaigns, and enhanced consumer satisfaction are made possible by this.

Internet of things-enabled devices can further improve the overall customer experience by giving users choices for remote control and real-time monitoring. Predictive upkeep and asset management are more benefits of Internet of Things.

Businesses can monitor performance by gathering data from IoT sensors incorporated into assets and mechanical equipment, spot abnormalities, and determine which maintenance needs need to be done. Businesses can avoid unscheduled downtime by adopting preventive measures. It also lengthens the asset's lifespan and reduces repair time and expense [16]. IoT makes remote monitoring possible, allowing businesses to optimize and control their assets from several places.

5 CONCLUSION

Industry 4.0 has made smart SCM a hot study area. The tendency is supported by national policies as well as an increase in articles published. In this work, we introduce national strategies in North America and examine ongoing research projects and literature to present an integrated strategy to disclose the current major research effort, research opportunities and obstacles, and future research direction. Our evaluations demonstrate that while the need to integrate new ICTs into supply chains is widely acknowledged, research on this topic is still in its infancy, particularly about small and medium-sized businesses.

Traditional SCM faces numerous issues, including difficulties with real-time inventory tracking and opaque supply chain processes. This includes problems such as goods that are forged due to a closed supply chain. IoT-based SCM is a novel approach to using IoT to update the traditional SCM process. Since tracking products is trouble-free, modern SCM is more transparent.

There was a gap in the research, as there was no thorough SLR. Thus, IoT-based SCM would be well suited for this application domain. Additionally, companies are putting more of an emphasis on sourcing products and services in a way that lessens the negative effects they have on the environment, society, and economy. Considering the aforementioned, the notion of Sustainable Supply Chain Management, which prioritizes ethical business practices concerning the environment, society, and economy, is worth considering and has drawn the attention of business and academics. When using IoT-based SCM, research SSCM is another exciting area to pursue to achieve sustainability.

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