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A Preliminary Study of Role and Challenges of IOT in Supply Chain Management

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Abstract: ***This paper delves into research on the Internet of Things (IoT) within the context of supply chain management (SCM). It comprehensively addresses the definition of IoT, key technology enablers, various SCM processes, and applications. The Internet of Things has the potential to address limitations in certain aspects of SCM, such as monitoring, production management, logistics operations efficiency, information exchange and communication, supply chain modeling, intelligent information collection, and security. The advent of IoT technology has ushered in a new era in logistics. The paper examines the current application areas and future prospects of this technology. Challenges encountered in implementation underscore the need for further refinement of IoT technology. Despite these obstacles, experts contend that the crux lies not in issues of costs, standards, and techniques, but in the establishment of a viable business model in the SCM and logistics industries.***
Keywords: Supply Chain Management(SCM), Internet of Things(IOT),logistics, security, privacy, industry 4.0; supply chain processes

I. INTRODUCTION

The Internet of Things (IoT) refers to the network of physical objects or 'things' embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet [2]. IoT is a paradigm where everyday objects are connected to the internet and can identify themselves to other devices in order to exchange data for improved efficiency and convenience [12].

In recent times, there have been significant shifts in the landscape of supply chain management (SCM) and logistics. The escalating interest in these areas is a response to competitive pressures, leading to their pivotal role in company operations and strategy. Consequently, the importance of these organizational functions has grown, compelling companies to adeptly oversee their supply chain and logistics operations to maintain a competitive edge in a dynamic business environment. Continuous enhancements of SCM and logistics systems are imperative for organizations to ensure timely delivery of the right product to the right customer. Traditionally, logistics was viewed as a necessary but costly aspect of business rather than a strategic source of competitive advantage. However, the advent of new technologies has enabled organizations to leverage innovative opportunities and gain a competitive edge. The integration of these technologies holds the potential to enhance information exchange and streamline the monitoring of physical goods throughout the supply chain [1].

Advancements in information technology (IT) have significantly influenced the planning, implementation, and control of the movement and storage of goods, services, and information from the origin to the consumption point, all aimed at elevating customer satisfaction [3]. Coined by the German economic development agency (GTAI), Industry 4.0 represents the integration, progression, and convergence of diverse technologies that establish an almost instantaneous connection between the physical and digital realms [4]. Consequently, technology, particularly Industry 4.0, has proven to be a vital facilitator for effective supply chain management (SCM). Its pivotal role lies in coordinating stakeholders, enhancing communication, and facilitating the acquisition and transmission of data, thereby supporting informed decision-making and improving overall supply chain performance [5, 6]. The Internet of Things (IoT) stands out as one of the latest IT developments in SCM, offering the potential to furnish more precise information for more effective decision-making.

II. EMERGENCE OF IOT

The Internet has been part and parcel of the social animal's life. It's a huge space of information and people. The internet first evolved as the "internet of computers" [7]. Several social websites emerged, keeping people connected constantly and resulting in the internet becoming more populated with individuals rather than information. Simultaneously, technology has been progressing, marking the onset of the "MobiComp" era, emphasizing mobile computing. Mobile devices enable constant internet connectivity on the go.

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Presently, 3G and 4G mobile internet connections offer faster access and improved quality in video calls. Wireless technologies and mobile computing have become more affordable and gained increased popularity [7]. Consequently, a new form of computing, known as Ubiquitous computing, has surfaced. This type of computing centres around creating smart, intelligent spaces with minimal user involvement [8].

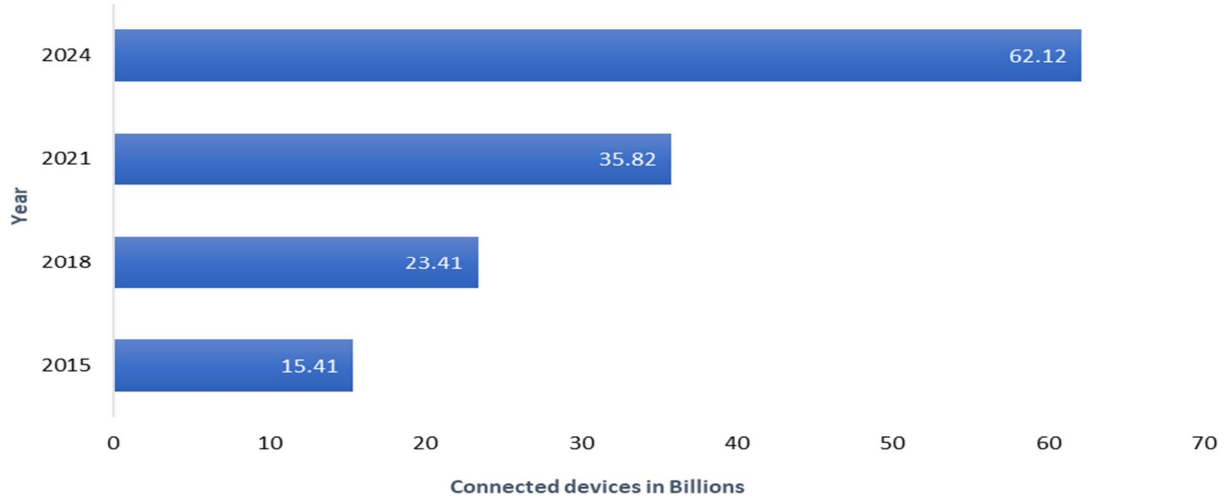

Fig 1. Depicting growth of IOT

III.ROLE OF IOT IN SCM

Supply Chain Management (SCM) is a comprehensive and integrated approach to planning, implementing, and controlling the flow of materials, information, and services from the point of origin to the point of consumption. The primary goal of supply chain management is to optimize the overall process to maximize customer value and achieve a sustainable competitive advantage.

With the increasing intelligence and technology integration in supply chains, research on the Internet of Things (IoT) has swiftly expanded, particularly concerning innovative applications within Supply Chain Management (SCM) and logistics. Scholars have increasingly turned to bibliometric techniques to analyse and comprehend the trends in IoT-related studies.

For instance, Nobre and Tavares [9] conducted a bibliometric review, delving into the literature on big data and IoT applications within the circular economy. Their study, which encompassed a substantial number of documents related to the circular economy and big data/IoT, extended beyond the realm of SCM and logistics. Sakhnini et al. [10] conducted a bibliometric survey that focused on the security aspects of IoT in smart grids.

These bibliometric approaches underscore the growing interest in studying the application of IoT across various domains, including but not limited to the circular economy, smart grids, and food safety. This highlights the expanding landscape of IoT research beyond the conventional realms of SCM and logistics[1].

The conventional supply chain management (SCM) process faces various challenges such as excess inventory, insufficient stock, delivery delays, and difficulties in transmitting real-time information. Implementing efficient and clearly outlined SCM procedures can significantly enhance operational efficiency and profitability. In response to technological progress, companies are increasingly integrating the latest technologies into their SCM processes. The advent of the Internet of Things (IoT) has particularly enabled the development of smart SCM processes, further enhancing efficiency in supply chain operations [13].

IV. CHALLENGES AND RISKS INVOLVED

The integration of Internet of Things (IoT) technologies in Supply Chain Management (SCM) brings forth a myriad of risks that organizations must navigate. One prominent concern is the increased susceptibility to cyber threats, as the interconnected devices and sensors within the supply chain provide potential entry points for malicious actors. Data privacy is another critical issue, as the massive amounts of sensitive information generated by IoT devices may be vulnerable to unauthorized access. Additionally, the reliance on IoT introduces operational risks, such as system failures or malfunctions. According to [11], major challenges faced by IOT in the field of supply chain management are-

A. Absence of Strategy and Scenario Planning

In IoT Numerous companies have not yet established clear strategies for the Internet of Things (IoT), and they lack a comprehensive understanding of how the generated information can effectively contribute to supply chain control.

B. Challenges in Predicting Outcomes

IoT stands as a transformative technology, and its potential applications are not precisely defined. Consequently, forecasting the consequences of its utilization remains uncertain.

C. Storage Challenges

They arise due to the escalating volume of data generated by smart devices, posing difficulties in determining the types of information to be stored and the duration of storage. This surge in data storage requirements also contributes to heightened energy demands.

D. Privacy Deficiencies

The Internet of Things (IoT) introduces distinctive challenges that extend beyond mere data privacy concerns, encompassing features like voice recognition or visual aspects of customer interactions.

E. Financial Challenges

They emerge in the implementation of IoT in supply chains, particularly concerning cost-sharing. It can be difficult as the value derived from IoT deployment, in terms of data or services, may not always sufficiently cover the associated expenses.

F. Need of Open Standards in IOT

The necessity for open standards is apparent in IoT, which is often constructed using open-source software. Nevertheless, the establishment of universal standards and protocols lags behind the rapid development of smart technology.

G. Establishing a Legal Framework for IoT

Establishing a legal framework for IoT governance is crucial, yet there appears to be a deficiency in the analysis of governance issues such as legitimacy, transparency, and accountability. This oversight poses a challenge in addressing the governance aspects of IoT effectively.

H. Electronic Waste

The proliferation of IoT devices contributes to an increase in electronic waste (e-waste), involving the disposal of computers, phones, and peripherals. This expansion in the use of IoT devices raises concerns about the growing volume of electronic waste.

I. User Acceptance Policies

Establishing trust and gaining user acceptance is a challenge in IoT, as it involves frequent interactions between various entities under uncertain conditions. Building trust among stakeholders can be challenging, particularly for individuals unfamiliar with IoT operations who need to develop confidence in its functionality.

V. CONCLUSIONS

This paper's primary objective is to offer a comprehensive and systematically organized review of IoT research within the realm of Supply Chain Management (SCM) and logistics. To achieve this goal, a thorough review was conducted. A total of 13 Journals were selected for the final review. We explored the domain of IOT and SCM. I studied the application of IOT in various supply chain processes and areas of supply chain management. I explored IoT in an SCM context, presented its main technology enablers, and provided an IoT definition in an SCM context. I conclude this paper by stating the research implications.

For researchers seeking to gain a better understanding of IoT within SCM and logistics, the core content of IoT literature was identified using the approach of keyword frequency. To grasp a better understanding of IoT research in SCM and logistics, researchers can refer to the most influential papers in the pertinent literature, which are listed in this paper.

Being conscious of the seminal articles and their authors will help initiate further developments, encourage co-authorship collaborations, and enhance the overall quality of future research work. In addition, the analysis of the keyword co-occurrence network helps to reveal the structure of topics and themes discussed in IoT research within SCM and logistics. Future studies should also explore non-English IoT research and underline its contribution to this research domain. Even though academics and practitioners have already devoted huge attention to IoT in recent years, the integration of IoT in the supply chain is still in its infancy. Therefore, I hope this paper motivates academics to encourage the SCM and logistics communities to devote more effort to this evolving area of interest and to keep abreast of this trendsetting field of IoT research.

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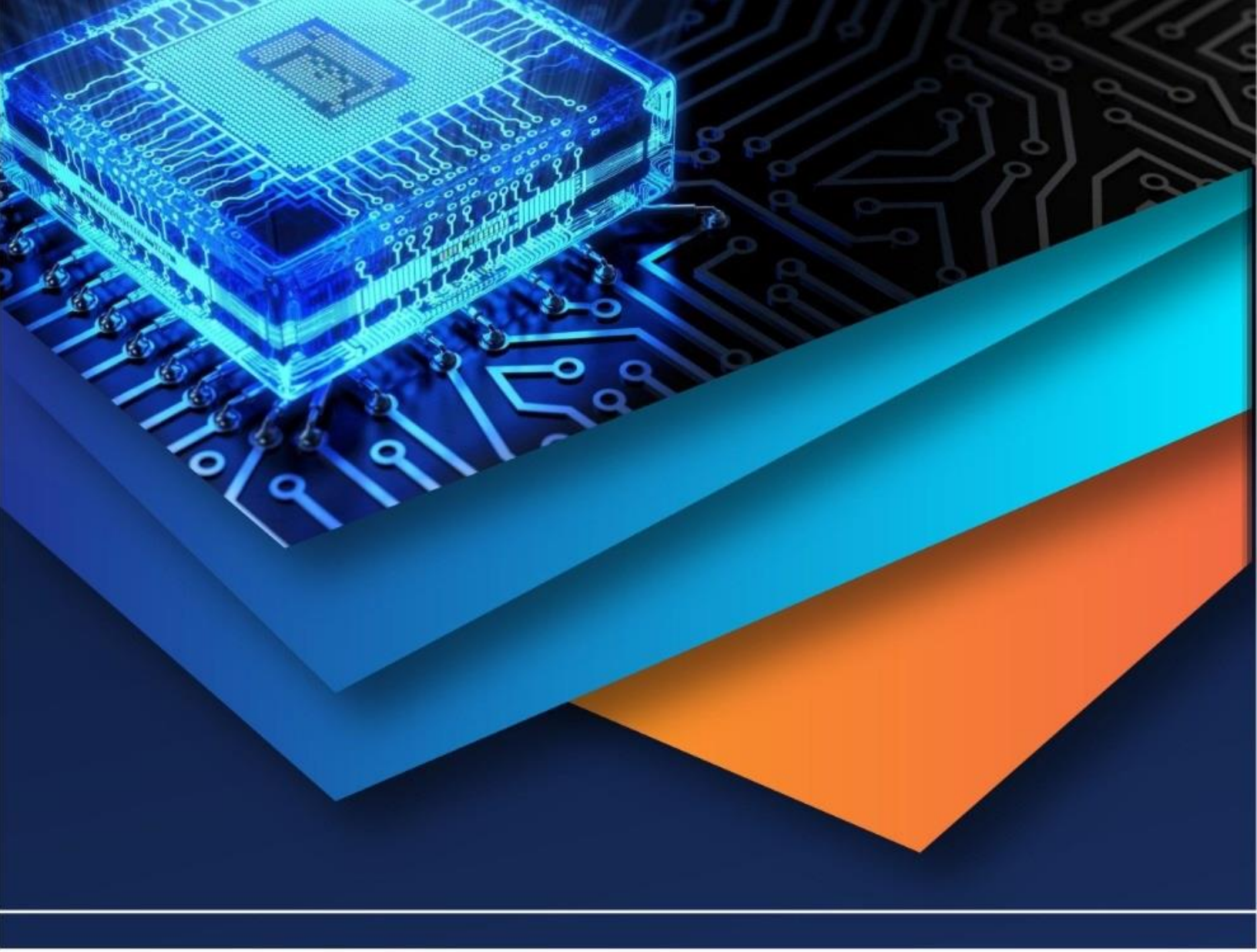

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