Smart Logistic Approach in Healthcare

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Abstract **– The business world today is faced with new and rapid changes in basic customer demands and needs as a result of global competition. State institutions and private hospitals have also started reviewing their costs and supply rates and are looking for solutions to market demands and costs in order to remain competitive. One of the most important ways to efficiently use and track the devices owned by hospitals, the utilization of Industry 4.0 technologies, including the Internet of Things, Artificial Intelligence, and cyber-physical systems. The desire for a more flexible supply process that adapts to market conditions and aligns with customer and patients' needs has sparked interest in these technologies. This research aims to investigate the advantages of smart logistics applications using industry 4.0 technologies for businesses and hospitals, reveals the differences between traditional methods, and contributes to the literature through a literature review. The comprehensive literature review concluded that smart logistics technologies positively affect the productivity of hospital staff and the quality of service provided. Most of the literature on smart logistics focuses on theoretical and conceptual studies, which support the idea that smart logistics is a very new field.**

Keywords **– Industry 4.0, smart logistic, Artificial Intelligence, smart production, smart healthcare logistic.**

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1. Introduction

Organizations can achieve a sustainable life cycle by adapting new production and logistics methods to their organizations in order to avoid the disadvantages of increasing individuality in demand, increasing costs and competition in the global market [1], [2]. The advent of novel methodologies has been propelled by the fourth industrial revolution, otherwise referred to as" Industry 4.0" and the profound metamorphosis afflicting the manufacturing and supply chain sectors. The advent of mechanization, electricity and computerization has precipitated a paradigm shift in the realm of production, ushering in a new era of digitalization and automation. This transformation has given rise to a digital value chain that facilitates seamless communication between products, machinery and laborers, thereby streamlining and enhancing the overall operational efficiency of industrial processes [3]. This digital value chain approach has also had an impact on healthcare. The fact that the overall share of logistics costs in hospital services is very high, offers important opportunities to reduce these costs by creating an application area for new technologies in these activities. The presence of high-tech equipment with very high investment costs in hospitals and the monitoring of the movement and efficient use of this equipment within the hospital are of great importance. Applications such as tracking the movement of these devices between certain departments and limiting their return are possible with Radio Frequency Identification (RFID) technology and applications that can be tracked via smartphones. These technologies allow medical professionals to access these devices and expedite the flow of information, as well as reserve operating theater and rooms. These applications and technologies also help reduce administrative overhead and transform hospitals into more successful workplaces [4]. Within the domain of industrial production and logistics, the evolution of costumer demands has precipitated a paradigm shift in production methodologies.

In the preceding decade, the employment of information and communication technologies in industrial contexts has undergone a transformative evolution, rendering it an indispensable facet of modern industry. A recent article in The Economist magazine posited that the world's most valuable resource has transitioned from oil to data [5]. In the pursuit of enhancing their operational effectiveness within the parameters of demand and supply, businesses have embarked on a multifaceted journey. This endeavour has encompassed the adaptation of advanced technologies and the adoption of standardized manufacture methodologies into existing systems. These measures have been undertaken with the objective of augmenting productivity. Concurrently, businesses have expressed a desire for a system that facilitates the timely fulfilment of customer demands and requests, aligning with stringent criteria. The heightened value of data has caused a considerable shift in the market, empowering businesses and healthcare organizations to offer the right product and service at the optimal time and price. This, in turn, has resulted in heightened competition within the market. The technological level that has been achieved has given rise to a number of challenges, as well as the emergence of novel technologies, including heightened transparency and integrity control. The latter refers to the availability of the correct product or service at the optimal time and cost, as well as the precise quantity, a necessity in the context of Supply Chain and Logistics [6]. Consequently, these technologies have facilitated a distinctive experience for all actors in the supply chain, enabling access to the requisite information. The utilization of these technologies in the domain of logistics, otherwise referred to as Logistics 4.0, signifies the adaptation of logistics with the new technologies and methods inherent to Cyber Physical Systems. Smart Logistics provides businesses with a framework that fosters increased flexibility, seamless integration with market dynamics, and enhanced proximity to customer needs [7]. The advent of information and communication technologies has been identified as a pivotal factor in enhancing supply chain performance [8]. Warehouse inventory management, a critical component of logistics processes within supply chain management, has been shown to offer businesses substantial cost savings when evaluated in terms of inventory expenses. In the context of the objective to circumvent these expenses, smart and automated warehouses, created by leveraging Industry 4.0 technologies, are gaining prominence and favor, particularly within commercial enterprises.

Logistics in the health sector encompasses a range of activities, including planning, procurement, storage, timely delivery of medical consumables, medicines, and equipment utilized from the initial stage of medical operations to the final processing point in the provision of health services. It also involves the disposal of medical waste in accordance with established standards [9]. In the domain of healthcare logistics, the implementation of these technologies is regarded as an efficacious strategy for the organization of working time. This is due to the fact that such technologies provide organizations with the opportunity to prioritize the core activities of staff as well as patient care, thereby leading to the enhancement of patient care conditions [10]. Smart logistics applications leverage these new advanced technologies to achieve two primary objectives. First, they aim to increase operational efficiency. Second, they seek to improve patient care. Additionally, these applications strive to streamline resource management. Hospitals that integrate the IoT, Radio Frequency Identification (RFID), and Smart Network models into their work culture can optimize their logistics processes, ensuring timely delivery of medical supplies and efficient patient transport. The health sector has recently encountered substantial challenges due to various issues, including but not limited to inadequate human resources, budgetary constraints, and shortages of equipment and medications. In the health sector, the delivery of medicines to hospital pharmacies and the resulting delays, inconvenient transportation conditions, and quality-related disruptions, as well as the many problems faced by the health supply chain, can be mitigated through the implementation of Industry 4.0 technologies. The utilization of these technologies will facilitate the avoidance of superfluous expenditures stemming from errors and waste [11]. A multitude of studies have demonstrated that logistics activities, particularly those associated with procurement, represent a substantial proportion of operational expenditures within healthcare facilities [10]. The incorporation of intelligent technologies into healthcare organisations has been demonstrated to possess the capability of enhancing the efficiency and cost-effectiveness of logistics activities related to procurement. Implementation of the Internet of Things (IoT) based Hospital Management System in a healthcare organization has been shown to significantly improve operational efficiency by facilitating real-time information processing and task management [12]. Research has also been conducted on real-time monitoring and data-driven shipping methods. This research focused on the implementation of smart logistics applications in healthcare facilities using beacon delivery [13].

This approach has been demonstrated to markedly curtail delays in patient transportation resulting from overtime, thereby enhancing operational efficiency and optimizing patient care within the context of intelligent hospital environments.
Consequently, the researchers determined that the implementation of the Beacon method led to a significant reduction in overtime delays, from 41% to 26.5%, in comparison with conventional methodologies [13]. Additionally, a study concluded that implementing an Internet of Things (IoT)-based Hospital Logistics Management System for transportation, cleaning, and engineering maintenance would increase operational efficiency by facilitating real-time information processing and encouraging employee collaboration. It is anticipated that this approach will engender cost savings in healthcare facilities [14]. The integration of smart logistics technologies within the context of hospitals has been demonstrated to engender a dual effect, namely the reduction of waste costs in addition to the enhancement of the efficiency of hospital supply chain management. The implementation of certain Fourth Industrial Revolution technologies within the domain of supply chain management, automation, control, security, and decision-making processes for materials and medications has been shown to engender a series of attendant benefits. Furthermore, the utilisation of these technologies has been demonstrated to engender patient safety and minimise waste [15]. The present study utilizes a literature review method to investigate the impact of Industry 4.0 technologies on costs and efficiency in the contexts of hospital and business logistics. The findings of the present study are corroborated by the information obtained from the literature review. The integration of Industry 4.0 into hospital logistics operations has the potential to enhance efficiency and optimize resource allocation, thereby allowing healthcare professionals to concentrate more extensively on patient care services. Consequently, patients will receive enhanced service quality, and employees will be able to contribute more efficiently to the organizations they work for. In order to comprehend the significance of investigating the application of Industry 4.0 technologies in logistics with regard to cost-benefit, it is imperative to be cognizant of the magnitude of logistics activities in global trade [16]. The findings of this study indicate that logistics management is a research topic that warrants further attention due to its substantial levels of efficient sustainability and its potential to benefit stakeholders. While China and the Asia-Pacific region dominate the global logistics market, with the highest demand and largest market share, the increasing demands in retail and e-commerce pose a significant challenge for the global logistics industry.

In addition to the aforementioned economic indicators, a multitude of studies have demonstrated that logistics networks collectively influence business success or failure by contributing to customer satisfaction or dissatisfaction, high or low productivity, and even location utility.

2. Literature

This section of the study focuses on industrial revolutions, analyzing the industrial revolutions brought about by new technological developments and the inequalities between these developments. The following text is intended to provide a comprehensive overview of the subject matter. This analysis is conducted through a literature review. Moreover, the findings from a comprehensive review of extant literature reveal the benefits of new technologies for businesses and hospitals.

2.1. Historical Development of Industry and Overview of Industry 4.0

The advent of the First Industrial Revolution, akin to other such revolutionary periods, signaled the genesis of novel advancements that subsequently engendered the emergence of subsequent developments or fostered the integration of prevailing technologies into the fabric of society and the business realm [17]. Technological innovations have been shown to exert a significant impact on business entities and the market structures within which they operate [18], [19], [20]. Towards the conclusion of the 18th century, the initial innovation, which materialized in England and was designated as a revolution, was the invention of the steam engine by James Watt in 1712 [17]. During this period, which commenced in the 1760s and concluded in 1830, a transition from manual and physical labor to mechanization occurred [21]. The period known as Industry 2.0 is characterized by a series of industrial revolutions that commenced in 1870 and persisted until 1989 [22]. This process, initiated with the advent of electricity and perpetuated by its subsequent integration into industry and daily life, has facilitated the adoption of electricity in various applications, including motors. The integration of electricity has enhanced the ergonomics and efficiency of machinery, while concurrently introducing innovations that have elevated the quality of life and augmented comfort levels. In addition to these developments, countries that have gained power through electricity have also experienced significant advancements in the chemical, petroleum, plastics, and steel sectors [17]. Renewable energy sources represent a fundamental component of the third industrial revolution.

The technologies that are currently influencing this era include information technology, biotechnology, nanotechnology, and communication technologies [23], [17]. In addition, this the driving forces in the third industrial revolution, which is comprised of the following subsectors: computer, digital products, solutions, and internet [24]. The evolution in logistics during the specified period is regarded as the advancement of the logistics management system. The beginning of widely used software and information systems such as transportation management systems, now known as Warehouse Management Systems, is considered to be this period. The utilization of information technologies and computers is of paramount importance in the control and management of all these processes and logistics activities.

The third industrial revolution, which emerged subsequent to the two preceding revolutions, differed from the other two revolutions in that it incorporated automation in production and its concomitant digitization. During this period, the widespread production and use of technologies such as computers, lasers, and fiber optics resulted in the emergence of differences in the structure of production processes. The third industrial revolution, which emerged in the 1970s, was spearheaded by the United States and East Asia. This novel approach, which emerged in Germany in 2011 and to which people are exposed in some way in every area of their lives today, began with steam and water machines and has evolved into smart manufacturing and service applications [24], [25]. The genesis of this technology has been described as a combination of the strengths of optimized industrial production and the latest internet technologies. A comparison of this revolution with other revolutions reveals the most obvious difference between them to be the interaction of virtual and real worlds.

It has been predicted that a structural transformation in business models will emerge with the help of digitalization of production, automation, and robotics technologies [26]. Industry 4.0 is defined as a structure that includes smart devices and systems that detect potential needs that may arise in the production site or business partners through sensors and connect with other remote production vehicles via the Internet.

These systems then retrieve the necessary production information from large data sets in cloud systems [27]. A distinguishing feature of Industry 4.0 is the integration of smart systems with autonomous features, which manage manufacturing areas. These systems possess the capacity for self-development, self-construction, self-observation, self-control, and self-adaptation.

This innovative methodology will facilitate the development of novel types of advanced manufacturing and industrial processes through machine-human collaboration, with a substantial enhancement in operational efficiency and productivity acceleration [22]. The concept of Smart Logistics, also known as Logistics 4.0, can be comprehended by examining the role of Industry 4.0 technologies at the core of this concept and the global context of a technological revolution. In this context, it is imperative to examine the technologies known as Industry 4.0 technologies and the fundamental components that constitute the conceptual framework of this era. The following section will provide a detailed exposition of these technologies. The industrial revolutions described above emerged as a result of a triggering force from their starting point. The following Figure 1 provides a synopsis of the temporal emergence of these revolutions, alongside the underlying factors that precipitated their occurrence.

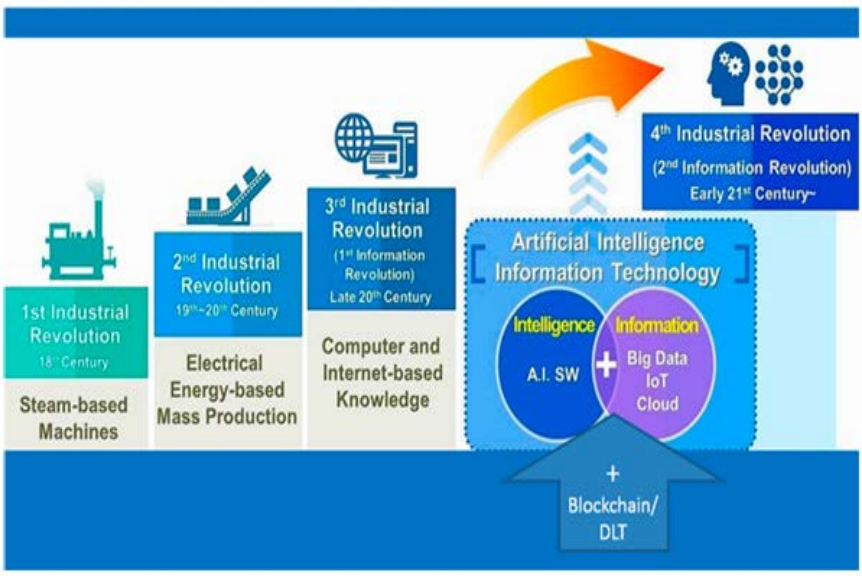

Figure 1. Fourth industrial revolution

2.1.1. Industry 4.0 Technologies

Industry 4.0 is an ecosystem of structure and life that is too extensive to be confined within the conceptual framework of the Internet of Things or smart factories alone. This groundbreaking event transcends the confines of the Internet, given its global reach and impact on all stakeholders. This paradigm encompasses not merely the integration of production systems and the objects they yield, but also the migration of physical data into the digital domain. The technologies that comprise this formation are an ecosystem that interactively communicates with each other, reasons, and transfers this information to the flowing world in order to sustain smart actions, thereby enabling the transition from physical to digital and from digital to physical. The intensive interactive use of the Internet within the industrial value chain, in conjunction with the rise in the level of Internet necessity, constituted the inception of the foundations of this novel revolution, Industry 4.0 [28]. This increase offers real-time transparency from start to finish, facilitating decision-making within a very short timeframe and providing a competitive advantage to achieve success in highly competitive global markets [29]. In order to leverage these technologies, three essential features must be considered: The concept of integration in business operations encompasses a variety of approaches, including horizontal integration through value networks, vertical integration, and production system networks. In addition, end-to-end digital integration of engineering along the entire value chain is a critical aspect of modern business strategy [30]. In addition to these positive attributes, in this industrial revolution has the potential to introduce new global risks and exacerbate existing risks associated with the convergence of digital, biological, and physical technologies [31].

This section is based on the findings of the research in the literature.

The section will explain the definitions and characteristics of the technologies used in Industry 4.0.

It is evident that the advent of the Internet of Things, which commenced with the implementation of a coffee machine, has culminated in its evolution into a pivotal element of this industrial revolution. A team of researchers at the University of Cambridge developed a system to ascertain the current quantity of coffee remaining in the coffee machine. They recorded data at regular intervals to determine the amount of coffee in the coffee machine utilized by the group in the area where they work. The data collection process is designed as a system that captures three images of the coffee machine in less than three minutes and transfers them to the computers used for analysis [32].

This data marks the inaugural instance of communication between an object and an external entity via the internet. Despite its initial conception to address a rudimentary necessity, the Internet of Everything, a novel technological system, has endowed machines and devices with the capacity to interact with one another within a network, thereby facilitating the procurement of information essential to the industrial sector [33].

In the contemporary epoch, technological development has facilitated the interactive monitoring of goods and services in real time during the ordering process via smartphone applications. This technological advancement has also enabled individuals to track their order's location within the production and delivery logistics network. From a supply-side perspective, businesses that prioritize customer demands and requests from a corporate perspective stand to benefit from the ability to obtain customer feedback on valuable data, goods, and services instantaneously. In this context, the Internet of Things (IoT) plays a pivotal role in facilitating seamless information exchange, thus enabling effective operations in production and logistics (Figure 2).

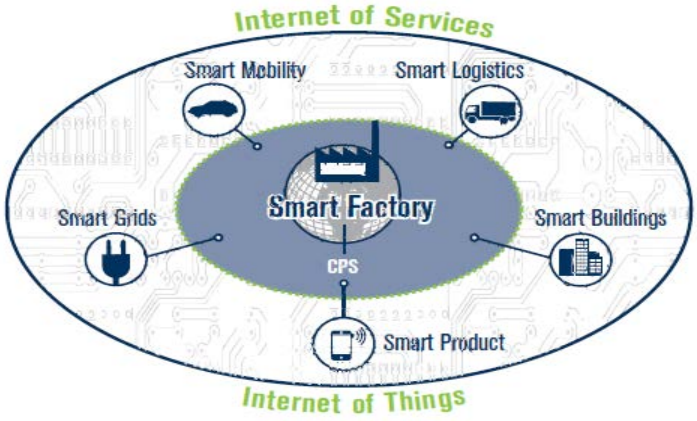

Figure 2. Internet of Things

Cyber-physical systems are defined as a process of exponential computing, as well as an exponential increase in transmission and storage capacity. This is due to the continuous development of information and communication technology, which leads to the emergence of new interconnected technological systems that evolve on a daily basis. Therefore, it can be concluded that all structures, including the interaction and integration between the physical world and the cyber world, are defined as cyber-physical systems [34]. The most critical feature of cyber-physical systems is their ability to address the agile and dynamic needs of production or organizations, thereby enhancing the efficiency and effectiveness of the entire industry. The integration of physical processes and computation is known as "cyber-physical systems." Another feature is the completely new and different evaluation of control, observation, accessibility, and efficiency in production processes [2]. In addition of those tech the argument that artificial intelligence can be defined as a field of study within cognitive science that involves the research and development of systems capable of performing tasks that traditionally required human intelligence. Such systems are designed to process images, interpret natural language, and navigate complex environments autonomously, etc., with many variants [33]. The advanced level of robotics and sensor technology has the potential to further increase individuality, as well as the capacity for fragmentation and flexibility it supports [35]. A primary focal point of artificial intelligence is the concept of learning, which can be defined as the ability to simulate learned knowledge and experience [24].

From the perspectives of the producer and the operator, machine learning methods and artificial intelligence algorithms will empower them to oversee the system's operation in its entirety. This will enable them to discern numerous unfavourable possibilities that might diminish the quality of the final product and various other adverse scenarios that could potentially compromise the interests of the consumer and the brand [36].

A review of the advantages provided by big data from Industry 4.0 technologies in terms of its application in the production and business area reveals that information and data produced by machines and devices in the production area are stored in cloud infrastructure systems [37].

This data can be accessed by business managers and consumers with ease and at their discretion. The sheer volume of data present within networks is expected to have far-reaching implications, extending well beyond the mere act of purchasing a product in the coming years. Therefore, it can be concluded that big data is a critical factor for Industry 4.0 [38], [39]. This system, integrated with the world via the Internet of Things (IoT), is vulnerable to cyber attacks. This ecosystem is protected by cybersecurity technology. The primary objective of cyber security systems is to safeguard the integrity of companies and to facilitate the maintenance of optimal physical communication conditions [40].

2.2. Development Chronology of Logistics

In the contemporary business world, the market, personalized customer demands, flexibility, and the demand for expeditious solutions exert pressure on manufacturers to establish a system that enables them to coordinate their logistics network with all stakeholders of the supply chain. This system should encompass both internal and external logistics processes as well as decision-making processes [3]. The tracking and monitoring of commercial goods, facilities, and process movements is widely regarded as a foundational activity in the domains of planning, monitoring, and tracking logistics systems. Consequently, it is imperative to comprehensively monitor all pertinent entities, processes, and activities, extending from the supply of raw materials to the end customer [41]. Industrial revolutions and subsequent developments have had a profound impact on the logistics sector, leading to its transformation in tandem with these advancements. Figure 3 provides a chronological overview of the development and evolution of logistics activities in relation to industrial development and its concomitant changes.

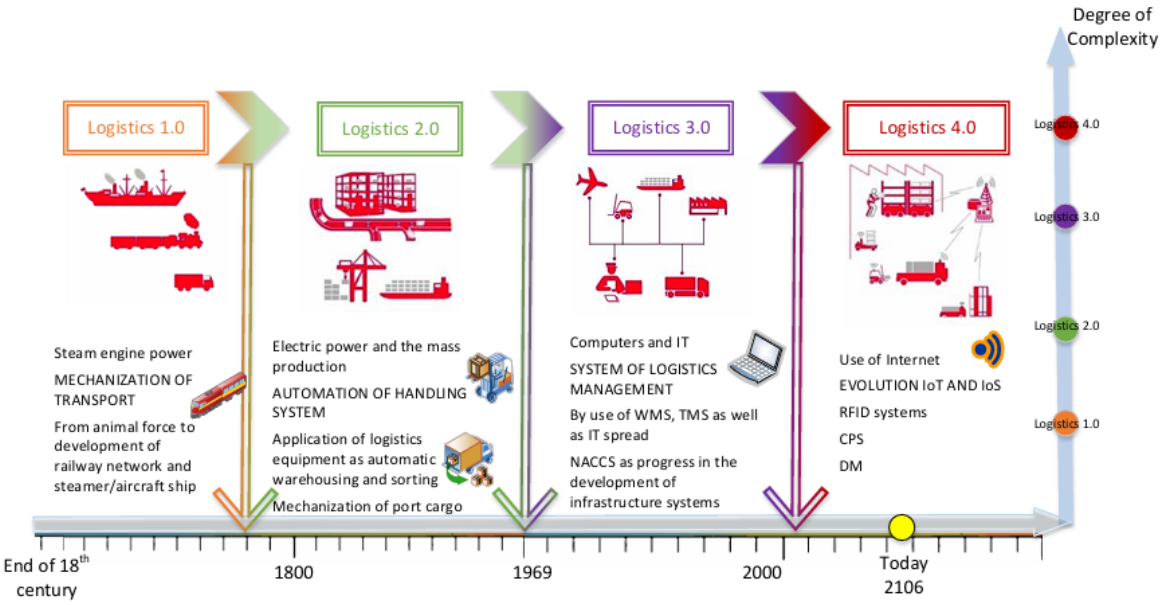

Figure 3. Evolution of logistics

The subsequent sections offer detailed explanations of these developments and changes.

2.2.1. Logistics 1.0

The transition from animal-powered production and transportation, which predates the industrial revolution, to machine-driven industrial processes marks a significant turning point in history. This period is characterized by a predominant reliance on road transportation. The advent of the steam engine, the railroad, and the airline profoundly impacted transportation, leading to a decline in the prevalence of road transportation. These technological advancements, particularly in the realm of logistics, resulted in a substantial augmentation in operational capacity during the latter half of the nineteenth century. The warehouse, in this context, denoted a facility utilized for the storage of materials or finished products. During this era, the movement of goods within the production process was primarily executed by laborers utilizing manual labor and tramways [42].

2.2.2. Logistics 2.0

The most significant development in the Second Industrial Revolution was the integration of electricity into machinery [43].

The Second Industrial Revolution commenced subsequent to the advent of the First Industrial Revolution in the slaughterhouses of Cincinnati, Ohio, and after that Ford in the United States.

These enterprises prioritized enhancing productivity by scientific principles and with this principles' contributions [44]. In consequence of the aforementioned developments, the implementation of novel machinery and production systems has engendered new advancements that have also exerted an influence on the domain of logistics. The advent of automated handling in the 1960s constitutes a particularly noteworthy development in this regard. Rail transportation and aircraft cargo operations have historically been the preferred methods of transport, and the advent of electric power has further solidified their dominance. The increasing demand for mass production has led to the development of advanced logistics equipment, such as automatic sorting and storage systems, which have become pivotal in modern supply chains. Concurrently, container ship transportation emerged as a significant innovation, marking a paradigm shift in the realm of maritime logistics [42].

2.2.3. Logistics 3.0

Information Technology, biotechnology, nanotechnology, and communication technology are collectively recognized as the technologies that will drive the Third Industrial Revolution [23], [17]. An alternative perspective characterizes the third industrial revolution as the digital revolution.

The most prominent and pioneering technologies in this period are recognized as computers, digital products, solutions, and the Internet [24]. An examination of the applications of these technologies during the period under investigation reveals the development of the logistics management system, warehouse management systems that are currently in widespread use, the Transportation Management System, and the utilization of information technologies. The advent of these technologies can be attributed, in no small part, to the advent of information technology. The use of computers is the most significant factor in the implementation of these technologies for the management of logistics processes [42].

2.2.4. Logistics 4.0 (Smart Logistics)

The fourth industrial revolution and the interaction of virtual and real worlds form the fundamental logic of this period. A revolutionary transformation in business models has occurred due to the implementation of digitalized production, automation, and robotics in manufacturing [26]. The Fourth Industrial revolution is predicated on the concept of establishing smart factories through the implementation of intelligent virtual-physical systems. The advent of Industry 4.0 has ushered in a paradigm shift in the realm of manufacturing, characterized by the emergence of production ecosystems that are meticulously orchestrated by intelligent systems endowed with autonomous capabilities. These systems possess the intrinsic capacity to self-configure, self-monitor, and self-control, while perpetually seeking to optimize their performance. The advent of this novel process will facilitate the implementation of more efficient business processes in production and logistics through human-machine collaboration [45]. The ramifications of the ongoing COVID-19 pandemic have underscored the significance of supply chain flexibility and agility for all stakeholders. The uninterrupted and seamless progression of products or services from their point of production to the final consumer is paramount for fostering sustainable relationships among stakeholders at the conclusion of the consumption or acquisition cycle. In this context, all processes are required to adhere to stringent standards of timeliness, quality, transparency, and satisfaction for all involved parties. The implementation of a smart logistics approach is instrumental in ensuring the fulfillment of these expectations.

Smart logistics is a logistics system designed to adapt to market conditions, changes, and demands, thereby enhancing operational flexibility and ensuring the business's alignment with consumer needs. This system has been shown to improve service quality and contribute to maintaining optimal production and storage costs [6]. This approach enables businesses to establish a framework conducive to enhancing customer service quality, optimizing production processes, and reducing inventory and production costs [42]. This novel approach, also referred to as smart logistics or Logistics 4.0, is the smart logistics concept proposed by IBM. While this structure does not have an integrated definition, it generally plans to manage and control logistics activities in a way that is intelligent and synchronized with efficiency [6]. This novel approach is poised to play a pivotal role in the transition from manual systems to automated handling equipment within the Internet of Things (IoT) or enterprise management system. This transition is predicated on the ability of the aforementioned equipment to execute repetitive tasks with a high degree of precision and efficiency [46]. In this system, which utilizes a substantial amount of data, the question arises regarding the manner in which logistics and supply chains will employ this data to enhance the intelligence level of decision-making processes. The utilization of data in logistics is not a recent development; it has been in existence for decades. What is novel is the immense volume of data currently being generated, stored, and shared [5]. The advent of these novel technologies has given rise to novel concepts that are efficient and sustainable in myriad areas of production and services. One such technology is Artificial Intelligence. It has been ascertained that Artificial Intelligence in global logistics and supply chain management is undergoing continuous improvement and facilitates processes [47]. The most evident advantages of intelligent logistics are evident in the domains of on-time delivery and supply, supply chain agility, flexibility, and responsiveness, as well as the capacity to employ predictive analytics [48]. The implementation of smart logistics, a term used to describe the use of artificial intelligence to address logistical challenges, has been shown to yield notable benefits for both customers and businesses. These benefits include enhanced delivery times, a key advantage in today's fast-paced consumer culture.

Furthermore, intelligent logistics has the potential to significantly improve quality parameters and promote sustainability by contributing to positive environmental and social outcomes [49].

2.2.4.1. The Difference Between Traditional Logistics Approach and Smart Logistics

The evolution of smart logistics can be categorized into four distinct phases. The initial phase of intelligent logistics entails the emphasis on the optimization of each logistics function. The general processes of this phase include transportation, routing optimization, warehouse location, and operation planning based on smart algorithms. In addition, real-time data flow forecasting is a key component of this phase. The AI Fresh System, a proprietary technology developed by Codelong Company in collaboration with Walmart, serves as a paradigmatic illustration of this process. In this project, real-time product information is collected by shelf-scanning robots and RFID technology systems in all Walmart stores in China. This system, characterized by its low-intrusion nature, is capable of accurately identifying a wide range of products, even those contained within customer bags. This intelligent system facilitates the display of functions such as replenishment, classification, and inventory in a more intelligent and autonomous manner [16]. A substantial body of research has indicated that between 18% and 20% of all medical errors experienced by patients can be ascribed to inaccuracies in medication administration. From this perspective, the utilization of these technologies has the potential to minimize errors and ensure the appropriate and timely administration of medications. Technologies such as Artificial Intelligence, automation technologies, and the utilization of information and communication technologies has been demonstrated to enhance the automation level of all logistics activities and enable intelligent decision-making in common logistics management problems. The second pillar of smart logistics is flexibility. The enhanced flexibility of smart logistics stems from several factors, including more effective and predictive demand forecasting, improved inventory tracking through optimization, and more efficient transportation routing. It has been demonstrated that the provision of these features results in a substantial enhancement of customer satisfaction [16]. The present study draws from the authors' extensive experience in the field to demonstrate the critical importance of hospitals with flexible logistics in responding to systemic disruptions, such as the ongoing pandemic caused by the novel (COVID-19).

The capacity for resilience in health systems is predicated on their ability to adapt to evolving circumstances, thereby ensuring the continuity of service provision even during periods of crisis. It is imperative to acknowledge the significance of adaptability in ensuring the continued effectiveness and responsiveness of health services to patient needs [50].

The third step in the implementation of smart logistics is the integration of logistics. The integration of technologies, such as the Internet of Things and information and communication technologies, has enabled the facilitation of information exchange between logistics entities. Moreover, the coordination of related business processes can be organised centrally, thus facilitating enhanced coordination of disparate logistics processes [16]. The objective of leveraging technologies such as the Internet of Things is to enhance healthcare logistics flows, augment operational efficiency, mitigate health risks, and elevate patient and staff satisfaction [51]. The final phase entails self-organization. Real-time monitoring and intelligent decision-making facilitate operations with minimal human intervention, thereby enhancing the efficiency of logistics operations [16] RFID-based systems can effectively track medical devices and kitchen operations in hospitals, while also reducing administrative burdens by enabling equipment and room reservations. The results indicate that the use of these technologies in hospitals can contribute to cost reduction. This, in turn, has the potential to enhance patient satisfaction and productivity by allocating more time to operational efficiency and patient care in the hospital environment [4]. With respect to its implementation in healthcare institutions, the RFID system has a significant impact on hospitals by facilitating the monitoring of all medications in the inventory, irrespective of their location within the warehouse or the utilization of the system [9]. From this perspective, the benefits that these new technologies will provide to hospitals and all supply chain stakeholders, as well as their classical organizations, are considerable. As illustrated in Figure 4, the Internet of Things (IoT), big data analytics, and Artificial Intelligence are distinguished from conventional logistics methodologies in smart logistics applications by four characteristics [16].

Figure 4. Smart logistics

3. Conclusion

In recent years, armed conflicts, epidemics, uncontrolled waves of migration, and population growth in different parts of the world have compelled people to exercise greater caution. It is imperative to acknowledge the necessity of accentuating the significance of saving and efficiency in the future, particularly in the context of events such as escalating competition over-limited resources and behavioural disorders. The contemporary generation, predominantly influenced by smartphones and other devices that have become an inextricable facet of daily lives, is acutely aware of the cruelty that characterizes this era. In the context of global inflationary market conditions, declining demand, and the shifting of demand to disparate regions, stakeholders within supply chains have been compelled to seek new business partners, while manufacturers and service providers have sought to minimize costs. Since the advent of the industrial revolution, the pursuit of optimal efficiency, minimal cost, and maximized profit has guided businesses and organizations in their adoption of novel technologies. The adoption of mechanization has been a perpetual aspiration. When hospital costs are taken into consideration, it becomes evident that patient transfers, particularly those involving drug supply, the utilization of patient information, and the disposal of medical waste, are activities that hospitals allocate substantial resources in the context of logistics and supply chain management. These transfers constitute a considerable proportion of the hospitals' overall expenditures. The optimization and reduction of costs associated with these activities are of paramount importance for ensuring the sustainable operation of hospitals.

The implementation of smart logistics and supply chain technologies in healthcare facilities has been demonstrated to reduce costs and error rates. This system integrates personnel, equipment, and data, thereby facilitating enhanced collaboration among departments and reducing operational expenditures. In light of shifting consumer patterns, novel consumption trends have come to the fore, propelled by the proliferation of internet-connected devices and applications. Concomitantly, supply chain management has witnessed a paradigm shift, with the advent of Industry 4.0 technologies such as artificial intelligence analysis, the Internet of Things (IoT), big data, cyber-physical technologies, and data and processes derived from internet-connected devices, robots, and computers. These advancements have engendered a new era of efficiency and effectiveness in supply chain operations. The contemporary industrial revolution presents businesses with significant opportunities, including employment opportunities, economic growth, stability, effectiveness, occupational safety, efficiency, productivity, and sustainable competitive advantage. Many businesses cannot ignore these opportunities. The results of the literature research conducted for this study indicate that the use of these technologies will increase in logistics and hospital logistics activities, thereby having an effect on these activities. The implementation of these technologies in healthcare facilities is poised to enhance operational efficiency by facilitating seamless coordination between units, streamlining the reservation process for operating rooms, and ensuring more meticulous planning of work schedules. The integration of RFID technology for the tracking of critical medications and controlled substances is anticipated to offer substantial benefits to administrative personnel, particularly in terms of enhanced management and organizational capabilities.

These technologies are of great importance in order to prevent increasing vulnerabilities in the supply chain. In addition to enhancing transparency and efficiency through the implementation of smart logistics technologies in the field, the timely and accurate dissemination of data to all stakeholders at an equivalent distance will foster significant awareness regarding cost reduction and competitive advantage. The integration of smart logistics technologies into logistics activities is a strategic initiative that aims to enhance the system's adaptability to market conditions, fluctuations, and evolving demands, thereby ensuring the business's alignment with consumer expectations. The integration of smart logistics technologies into business supply chains offers a unique opportunity to optimize inventory tracking, enhance efficiency, and facilitate real-time monitoring. This integration enables intelligent decision-making functions, leading to enhanced efficiency in business operations.

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