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Artificial Intelligence and Smart Logistics Systems in Industry 4.0

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Abstract

AI applications are essential to smart logistics sector for industrial enterprises and for the fourth industrial revolution (Industry 4.0). The aim of this study is to analyze the variables that affect smart logistics and assess the efficiency of artificial intelligence applications on smart logistics. Further, the applications technology and AI has studied and the variables that influence on the adoption of AI are still unknown in this study. Moreover, the main investigation of this study is to find the impact of efficient factors on AI through integrating technology. The finding indicates the large-scale smart logistics system has a substantial impact on industrial organizations and businesses by utilizing AI applications of communication and information technology. Additionally, AI is able to offer supply chain logistics with technological assistance that combine big data, IoT, and cloud computing.

Keywords
Artificial Intelligence, Smart Logistics, Supply Chain Management Industry 4.0.

1. Introduction

Incorporating the ideas of interconnection, digitization, and automation, the 4th industrial revolution (Industry 4) consists of a group of definitions and technologies that industrial businesses should adopt to increase their competitiveness. In this context, the effective development of lean supply chains & intelligent based on adaptable and collaborative networks and networked companies is the aim of smart logistics. Additionally, the use of data networks, automatic identification, material tracking, technologies, actors, and sensors, as well as contemporary information and communication technologies (ICT), establishes information interchange. Additionally, transition, automated transport, and storage systems must allow for partial or full system self-control, assisted by autonomous transport vehicles (Dallasega et al. 2020).

Additionally, the technical concepts of internet of things (IoT), cyberphysical systems (CPS), as well as the industrial IoT (IIoT) as well as the physical internet (PI), can be used to create smart logistics (Zsifkovits, et al. 2019). One of the greatest crucial success factors in the digital transformation process, in addition to the application of technology principles, is the use of deep learning, artificial intelligence, machine learning. (Cioffi et al. 2020). In this sense, (AI) might be characterized as the study and development of smart machines, with a particular emphasis on intelligent computer programmes (Carthy et al. 2006). The automatic discovery of significant patterns in datasets is referred to as machine learning (ML), which is regarded as a key component of artificial intelligence (AI). By ensuring that algorithms have the capacity to adapt and learn depending on big-data analysis, ML tools strive to boost the efficacy of algorithms (Shwartz et al. 2014).

Additionally, a lot of businesses and organizations use (AI) for a variety of tasks since it is now a much potent tool that may help these businesses stand out from their rivals and lower the likelihood of making errors. The system can now carry out duties and make sensible decisions on its own thanks to artificial intelligence (AI). Many sectors are in a time of manned to unmanned transition due to the advent of AI and big data, and the logistics sector is also going through this shift from fully manned to totally automated. More logistics organizations are attempting to apply

artificial technology to modify logistics operations in order to improve their performance in current years due to the economy's rapid growth and the expanding application space for AI (Yuen & Wu 2022).

Since this is one of the key chances to improve the logistics performance and/or lower the logistics costs of both large businesses and small and medium-sized businesses current sector 4.0-related study initiatives are focusing primarily on the inquiry of the integration of intelligent AI systems in industrial logistics.

2. Literature Review

2.1 Smart Logistics

The improvement of the supply chain's distribution component through cutting-edge, intelligent technology is known as smart logistics. Smart logistics technologies seek to increase effectiveness as well as lessen the environmental influence of international trade. Intelligent software designed specifically for the logistics sector will automate numerous levels or steps of the chain and indicate any possible problems through the use of predictive analytics. In order to provide super reliable and automated procedures, like as initial work schedule and path planning of a shipment, distribution of accessible vehicles and vessels, when to dispatch the shipment and under what situations, and figuring out the cost of a specific journey relying on these variations and more, smart logistics software makes use of actual-time data floating from a massive wide range of information thanks to the IoT. By considering external factors, forecasting analytics can forecast whether a ship will be delayed in reaching a port because of a storm at sea, such as weather patterns (Yuen & Wu 2022).

2.1.1 Smart Systems Integration

The present literature generally lacks a precise definition of SSI. According to the theoretical framework used through the "European Technology Platform on Smart Systems Integration (EPoSS) in 2017", which describes intelligent systems as techniques that seeks to integrate cognitive features with detecting, data communication, power and actuation, management, the authors of this study have derived a definition. Additionally, according to this conceptual framework, the application domains for smart systems are broken down into seven categories: well-being, health, energy, natural resources, manufacturing/factory, automation, security, mobility and transportation, and the internet of things (EPoSS 2017). All of the aforementioned application areas, however, may be connected, either directly or indirectly, to the study of industrial logistics in producing companies. Therefore, the majority of the EPoSS study's results and conclusions are pertinent to industrial logistics study (Woschank et al. 2022).

2.1.2 The Crucial of Digital Transformation in Smart Logistics

The governments of Hong Kong. China, and Mainland are motivating businesses to improve their product R&D abilities as well as production techniques while implementing cutting-edge supply chain administration strategies in light of the fierce competition in the market and the requirement for industrial transformation and upgrade. In October 2017, the State Council released its Leading Beliefs on Actively Expanding Supply Chain Innovations and Application. New technology and business approaches for supply chain development will benefit all of China's major industrial segments, and access to intelligent supply chain systems as a result of this programme by the year 2020. (HKTDC 2021).

2.1.3 Smart Logistics Benefits

Like other smart efforts, the major advantage and motivating factor is enhanced efficiency, which leads to better service supply and lower total costs. Regardless of the corporation 's size, smart logistics capability has a number of advantages, according to a report by Yuen & Wu published in 2022:

- It is feasible to reduce the amount of jobs performed by individuals by automating some of the supply chain's processes using the technology that is now available. This can aid in lowering monthly expenses like wages, which sometimes cripple SMEs.
- Increased operational effectiveness as an outcome of automated logistics chain segments, which will also result in reduced waste and lower total expenditures.
- End customers will receive a better service thanks to enhanced communication and the movement of items through the supply chain.
- Better recurring business will result from better customer service and experience, with the goal of raising it.

Because there weren't many findings, the authors changed their search criteria and discovered that the terms "logistics" as well as "smart systems" work best together to achieve the paper's main objective, which is to evaluate the most recent advances in the domain of smart systems combination for the specific purpose of industrial logistics in production companies. The authors concentrated on the recommendations made by Hokka et al. in 2014 for systematic literature reviews in order to assess the status of the art in scientific publications (Woschank et ai. 2022).

2.2 Artificial Intelligence (AI)

AI is defined by The Dartmouth Research Project as the challenge of programming a machine to behave in a manner that may be regarded as smart if a person did the same thing (McCarthy et al. 1955). The intelligence expressed by computers is known as artificial intelligence (AI), it stands in opposition to the inherent intellect displayed by people and other animals (Abdullayeva 2019). From different meaning, this is a branch of computer science that places a strong emphasis on building machines with intelligence that behave and act much like people (Abdullayeva 2019).

According to Coccia (2019), who defines AI as having the same capacity as humans to carry out specific roles and duties that people would typically carry out in public and in social settings, this is a more true definition of artificial intelligence. And this skill, which is similar to human capability and, in some situations, is even greater than human capability, is still developing. Based on to Haenlein & Kaplan (2019), (AI) is the system's capacity to accurately understand external data, ability to draw lessons from such data, and the capacity to accomplish certain targets and tasks through adjusting nimbly to the application of such learning.

In order to get ready for the 4th industrial revolution, a number of companies and industrials have boosted them acknowledge of and advancement of (AI) and automation from the early 2000s. Whereas in the past businesses with many employees produced outputs that were comparable in size, AI and automation enable few groups to produce outputs that are more than was before achievable. Medium, small and micro-sized businesses have incorporated this techno to boost their markets' competitiveness and profitability. Many firms that employ automation have now substituted monotonous jobs that were previously carried out by humans in order to achieve this goal. Since its creation, awareness of and utilize of automation and AI has consistently increased in both our personal and professional lives (Marshalee et al. 2020).

2.2.1 Advantages of AI and Automation for the Shipping and Logistics Industry

Since logistics industry and shipping and has been using the same technologies for a long time, automation and artificial intelligence are advantageous to the industry because they provide the chance for change, assisting the industry to being more dynamic. Initial adopters in the sector already have found that their supply chain & logistics operations have been simplified. According to studies, companies in the mobility and logistics industry that implemented AI systems early on in their procedures saw a gain in revenue of at minimum 5% compared with those who did not (Camhi 2018).

In addition, AI & automation techniques are now designed to recognize potential issues and offer solutions in the quickest period feasible without impeding the flow of products and services. There are certain shipping businesses that have expanded their use of automation and artificial intelligence. For instance, the Birkeland, a completely electric and self-driving container ship, is anticipated to be ready to execute full autonomy in operations by 2020, according to Winter (2018) in Norway. Organizations typically look for strategies to minimize intralogistics costs while increasing resources because they are so high.

According to Stephen (2017), "AI and automation are expected to have a larger influence than ever before, as warehouse owners attempt to optimize their intralogistics operations over the next 5 years." A sizable volume of information generated by the logistics industry is needed to help with decision-making for the storage and transportation of products and services. By offering real data, forecasting, and projections, as well as by assessing current issues like errors, repetitions, and redundant effort, automation and AI techniques can be utilized to help with data analysis and support the process of decision-making. The supply chain and logistics industry would also be able to plan and forecast with much more precise results during the busiest seasons of the year thanks to developments in automation and AI in connection to the collection and data interpretation (Coles 2018).

2.2.2 Artificial Intelligence in Manufacturing and Logistics Systems

Powerful and pervasive computing networks underpin modern industrial and logistics systems. Oceans of data are always being produced within these networks by smart devices, systems, machines, and sensors, and humans. This Big Data is being processed quicker, more thoroughly, and with greater computational power than ever before. These developments have changed how Artificial Intelligence (AI) technologies are valued and ushered in the Industry 4.0 or "Smart Factory" era. Otherwise, manufacturing systems are starting to use deep learning and advanced cognitive computing techniques for automated visual inspections, defect diagnosis, and maintenance. The use of reinforcement learning techniques in production scheduling and material handling systems is now under investigation. Industries looking to merge AI methodologies with conventional operational research procedures, the ideas and technology of the Internet of Things (IoT), and cyber-physical systems are looking for chances to transform real-time information into action decisions (Fu Chien et al. 2020).

From other hand, the growth of the logistics business differs from location to location and is influenced by elements including environment, geography, and history (Geetha, Subramanim 2020). Traditional logistics firms are generally small in size and manage a variety of minor locations. They are unable to link the whole logistical map. Therefore, a critical problem that has to be handled in the current business is how to achieve the enhancement of smart logistics integration abilities and investigate a new model of logistical development under the "Internet Plus." Additionally, the Internet of Things will have a significant influence on logistics. The era of smart logistics is represented by the revolutionary advancement of logistics information technology, the dynamic and intelligent transformation of the supply chain, the real-time tracking product allocation network, the detectable source of food and medication, and so on (Wang 2021).

A new phase of the technological and scientific revolution has started in the "Internet +" age. It has encouraged the logistics sector's thorough integration with the Internet. Smart logistics has also pushed for the informatization and standardization of logistics networks to encourage interrelated communication and information sharing. The introduction of information systems has altered the transportation, logistics, and warehousing connections from no exchange of information to communicative (Wang, Yang 2018).

3. Designing a Logistics System using AI and Big Data

The logistics system is primarily made in support of extensive logistical transportation. It is segmented into three main parts based on the requirements the first part addresses the necessity to alter the mobility environment as showed through fresh food; The 2nd section discusses written contracts; and the third part addresses other issues. The third component is the delivery to representatives of raw materials, whose transportation distance must be reduced to the greatest extent possible. Both of these components involve the need to minimize travel time. These three different kinds of criteria can be resolved using the procedures displayed in Figure 1. Establishing the necessary parameters utilized in the aforementioned algorithm is one of them, and it derives from the fundamental technical support offered via large-scale data algorithm as well as the platform for cloud computing: the road transportation condition is extracted from the vast volume of data information dynamic received each convey the items circulation & memory of the terminal are gathered on the cloud-based computing system. and function statistics are being utilized to determine Through extending the data search range, the system should be able to somewhat cover a wider service region (Bai 2021). The supply chain system described in this article uses a classification approach to account for the various transportation needs of various items, which means that various algorithms are created to address the various transportation needs (Le et al. 2013). The system's primary design functions are grouped into three categories among them, as indicated in Figure 1:

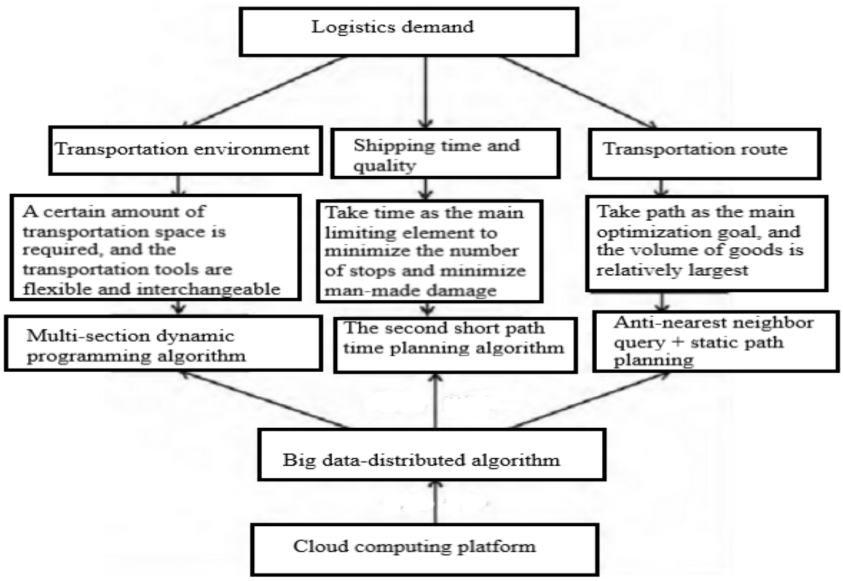

Figure 1. System Design Block Diagram for Logistics

1. The transportation environment has to adapt for the first category. Utilize the static route planning system to create an initial path order, and then, in accordance with the items' environmental prerequisites (such as those for temperatures and humidity), utilize a platform for cloud computing. to recover the pertinent environmental variables of the region along on the route and segment the original route in accordance with these parameters. The suitable transportation instrument for several sub-section is chosen Depending on each sub-environmental section's characteristics (Bai 2021).

2. The demands for travel time are greater for the second classification. The system resolves this issue using the subsequent short route planning technique. A static planning technique is used in the algorithm to determine the shortest path and the 2ed-shortest path, and it makes use of a platform for cloud computing to recover information on the convey processing times of each logistics station, the amount of goods backlogged at each station, and other factors. A less time-consuming transportation strategy is chosen by comparing the predicted times of the two routes (Lingbin et al. 2015).
3. The quickest transit route is needed for the third category. This kind of transport is primarily intended for the movement of goods and raw materials. To address these issues, the system combining the static algorithm for route planning along with the anti-nearest neighbor inquiry technique. In order to build the final transportation plan, the route planning algorithm is utilized to identify the shortest path after the technique of anti-nearest neighbor inquiry has been used to look for raw material sources with generally suitable conditions in many aspects (Bai 2021).

4. Conclusion

In conclusion, the large-scale system of smart logistics has a significant impact on industrial enterprises and companies by using the AI applications of recent innovations in communication and information technologies, for instance IoT, CPS, & PI. Logistics systems impact the planning outcomes of the path by consuming time as a constraint path as well as AI and automation technology used to analyze the data which helps in the decision-making procedure by giving current information, expectations based on forecasting, and predictions. Moreover, with technical resources in the 21st century, Supply chain logistics can be provided by AI with technical assistance that combines cloud computing, big data, and IoT. Therefore, AI is a significant factor behind the transformation of the logistics sector.

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