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Use of AI and IoT to improve transport and logistics in agriculture

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Abstract. The logistics and supply chain industry is undergoing significant changes due to advancements in artificial intelligence and IoT technologies. These innovations are transforming logistics and supply chain companies, and products of the intelligent era are gradually replacing traditional logistics practices. This article focuses on how supply chain logistics enterprises are improving and transforming their logistics infrastructure and agricultural processes using these technologies. The latest trend in intelligent logistics is moving towards a sharing economy, automation, increased service efficiency, and cost reduction. The development of smart logistics will involve the integration of various technologies such as AI, IoT, visual information technologies in agriculture, smart robot operations, vehicle planning, and cargo tracking.

Keywords: *logistics; artificial intelligence; agriculture; IoT; supply chain; transport*

1. INTRODUCTION

In general, the use of AI in the transport and logistics sector of agriculture holds the possibility of transforming the industry by improving efficiency, reducing expenses, and increasing sustainability. Numerous research studies and projects have been conducted investigating the use of artificial intelligence to improve transportation and logistics in agriculture.

Logistics plays a crucial role in agricultural organizations and cooperatives, as it involves the movement of physical goods and related information from the producer to the consumer in order to fulfill consumer demand. The logistics process is essential at every stage presenting its unique challenges in maintaining product integrity, efficiency, and quality. Agricultural products are susceptible to several conditions that can compromise their quality before reaching the consumer. Thus, the need for a traceability system has become increasingly important due to inadequate temperature and humidity control, incorrect physical handling and delays, food security threats, and the rising issue of food loss and waste. Traceability systems are essential quality control mechanisms that ensure the safety of agricultural products from farm to consumption. [1]

2. TRANSPORTATION AND LOGISTICS IN AGRICULTURE USING AI AND IOT

Artificial intelligence offers diverse methods to enhance transportation and logistics in agriculture. These methods include:

- Optimization of Routes: Artificial intelligence can analyze delivery schedules, weather conditions, and vehicle information to optimize the delivery routes of agricultural products, leading to reduced delivery times and increased efficiency.
- Management of Inventory: Real-time monitoring of inventory levels, forecasting of demand for agricultural products, and optimization of stock levels can be achieved using AI to ensure timely delivery of products in the required quantity.

- Predictive Maintenance: AI can be used to track the status of agricultural machinery and vehicles, predict maintenance requirements, and schedule repairs proactively, minimizing downtime and enhancing productivity.
- Automated Delivery: Self-driving trucks or drones can be deployed with the help of AI for the automated delivery of agricultural products, resulting in decreased labor costs and enhanced delivery times.
- Management of Supply Chain: AI can be used to monitor products from their farm origins to the consumer, providing real-time updates about their location and status, resulting in improved traceability, transparency, food safety, and waste reduction.

The modern logistics industry heavily relies on internet technology. Given the insufficient level of informatization in rural logistics development, rural areas should accelerate the construction of logistics information platforms. This will allow agricultural product sellers to access market information and sales channels in a timely manner, making production more marketable. The informatization of logistics development can also improve quality and enable rural e commerce logistics practitioners to effectively supervise logistics transportation, warehousing, distribution, and other processes through the information platform terminal. This can enhance logistics efficiency and reduce the rate of cargo damage, significantly improving the service level of rural logistics. Ultimately, the accelerated construction of a rural logistics information platform can help to overcome existing challenges and promote the development of rural logistics. [2]

It is acknowledged that the supply chain in the "farm to fork" process holds a vast amount of data that is not currently being utilized to extract insights. With comprehensive data about the supply chain, there are opportunities to provide traceability from the farm to the consumer and furnish consumers with information on various aspects, such as the number of times an apple was sprayed, its age, and transportation history. Access to complete supply chain data also paves the way for new classes of AI-powered predictive and optimization applications. [18]

The broader agricultural ecosystem could benefit from identifying areas where AI can be utilized to gain efficiencies. One such example is the transportation of fertilizers, where AI can be deployed to streamline traffic flow on the roads. This approach can also be extended to all heavy-duty vehicles that service the rural sector. Furthermore, fourth-party logistics (4PL) presents an opportunity for point-to-point fleet optimization, reducing empty stock truck movements on our roads. The key to achieving these integrated efficiencies is collaboration across sectors. [18]

Incorporating digital innovations can assist logistics operators in enhancing efficiency and reducing costs, while also exploring new business prospects. High level data techniques such as artificial intelligence (AI), big data (BD), data mining (DM) and etc., focuses on the optimization of supply chain management, transport and logistics for real-time monitoring during transportation that increase efficiency, reduce costs, and improve product quality and safety. As more farmers and agricultural stakeholders adopt AI-powered technologies, we can expect to see further growth and innovation in the agriculture industry. Data has always been a crucial aspect of logistics, and advancements in data collection, processing, and simulation technology present an opportunity for logistics firms to enhance their operations. With the introduction of new technologies like AI and augmented reality, digital platforms have opened up new possibilities and business models, presenting a new frontier for the logistics industry. ([3-8])

The agri-food sector's logistics is notably intricate, even in comparison to other industries. Therefore, the utilization of digitization may yield exceptional results in this area. Each company's specific task generates a considerable amount of data daily along the supply chain, which can be leveraged to enhance productivity and reduce operating costs by developing dynamic and usable predictive models. Precision farming can enable farmers to achieve more with fewer resources, make more effective and immediate decisions, and eventually yield higher returns on investment by identifying key segments of the production chain. Data and simulation can also pinpoint specific areas of a business that could be better developed to provide more sustainable results. By intelligently using data, farmers can better comprehend their production practices and identify changes that can generate more value within their

structure. Consequently, virtual educational models such as business games can be implemented using these data to create new professional roles with enhanced knowledge [9-11].

Agricultural logistics has become more complex in recent years due to the increasing demand for safe and sustainable food production. Fortunately, technological progress has made it possible to combine the capabilities of artificial intelligence (AI) and the Internet of Things (IoT) to simplify and enhance the efficiency of the agricultural supply chain.

One of the benefits of AI and IoT applications in logistics is just-in-time deliveries. With real-time data and predictive analytics, farmers can better plan their crop harvest and coordinate with logistics companies for timely deliveries. This not only reduces waste and spoilage but also ensures that fresh produce reaches consumers faster. ([12-16])

Supply chain visibility and monitoring is another important aspect of agricultural logistics. Through the use of IoT sensors and AI algorithms, farmers and logistics companies can track the movement of products throughout the supply chain. This allows for better coordination and communication between different actors in the supply chain and helps to prevent delays or disruptions. ([12-16])

Vehicle tracking is a key component of agricultural logistics, especially when it comes to transporting perishable goods. With GPS tracking and real-time data, logistics companies can optimize delivery routes and ensure that products are transported in a timely and efficient manner. This also helps to reduce the carbon footprint of transportation by minimizing empty trips and reducing overall vehicle usage.

Product lifecycle transparency is becoming increasingly important in the agriculture industry, as consumers are increasingly interested in the origins and sustainability of the products they consume. By utilizing AI and IoT applications, farmers and logistics companies can provide consumers with detailed information on the production and transportation of their products, including information on farming practices, supply chain processes, and packaging materials. ([12-16])

Efficient inventory and warehouse management is also essential for agricultural logistics. With real-time data and predictive analytics, farmers and logistics companies can optimize inventory levels, reduce waste, and ensure that products are stored and transported in the most efficient way possible.

Automation of internal business processes is another area where AI and IoT can be applied to agricultural logistics. By automating tasks such as data entry, inventory management, and supply chain monitoring, logistics companies can free up time and resources for more strategic tasks, such as supply chain optimization and sustainability planning. ([12-16])

Finally, fast, safe, and efficient product delivery is the ultimate goal of agricultural logistics. By leveraging AI and IoT technologies, logistics companies can ensure that products are delivered in a timely and cost-effective manner, while also minimizing waste and reducing the environmental impact of transportation. ([12-16])

In conclusion, AI and IoT applications in agricultural logistics have the potential to revolutionize the industry by improving supply chain visibility, optimizing inventory and warehouse management, automating internal business processes, and providing consumers with greater transparency and sustainability in their food production.

Graphics

The initial phase of the system is the farmer stage, which collects information such as the farmer's details, location, type of commodity they deal with, and the required service time. The second stage involves the processing of the collected data, which is then made available on the website and cloud to all stages of the system's architecture. The third and fourth stages involve data storage at the local level which is beneficial for the local vendors and customers and overall levels that is necessary for the company and logistics team to identify system issues and improve system coordination.

The fifth stage of the system deals with the collection of customer-related information including details about the customer, as well as information regarding the expected delivery time, delivery networks, and etc.. The last stage of the system is focused on feedback which is crucial for improving the overall service quality, the system's performance.[17]

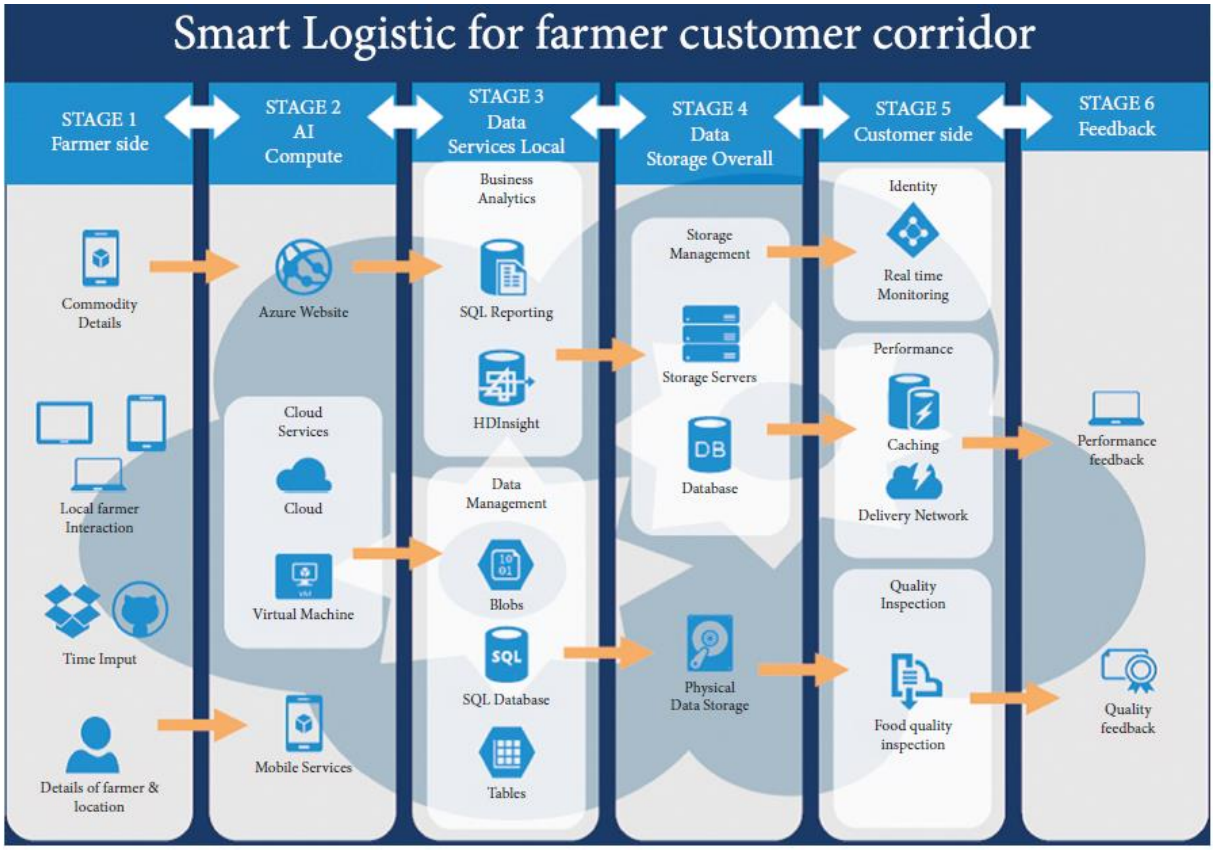

Fig. 1. Smart Logistic for farmer customer corridor

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