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Research Article

Smart Logistic System for Enhancing the Farmer-Customer Corridor in Smart Agriculture Sector Using Artificial Intelligence

Edwin Ramirez-Asis,[1] **Astha Bhanot**,[2] **Vishal Jagota**,[3] **B. Chandra**,[4] **Md Shamim Hossain**,[5] **Kumud Pant**,[6] **and Hashem Ali Almashaqbeh**[7]

[1]*Universidad Señor de Sipán, Chiclayo, Peru*
[2]*College of Business Adminsitration, Princess Nourah Bint Abdulrahman University, Riyadh-KSA, Saudi Arabia*
[3]*Department of Mechanical Engineering, Madanapalle Institute of Technology & Science, Madanapalle, AP, India*
[4]*Vignan's Institute of Information Technology, Visakhapatnam, Andhra Pradesh, India*
[5]*Department of Marketing, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh*
[6]*Department of Biotechnology, Graphic Era Deemed to Be University, Dehradun, Uttarakhand, India*
[7]*Abu Dhabi University, Abu Dhabi, UAE*

Correspondence should be addressed to Vishal Jagota; vishaljagota@mits.ac.in and Md Shamim Hossain; shamim.mkt@hstu.ac.bd

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In an agriculture sector, the quality of several raw crops depends upon the time factor. After harvesting, it is necessary to bring the crops either to cold storage or directly to customer though wholesale dealers. Keeping crops in cold storage decrease the nutrition value and also increase the overall cost of the crop leading to price hike. So, it will be best if the crops are put in the market as soon as possible. This can only be possible if the logistic system is updated and can handle the real-time requirement of agriculture product transport. This study investigates and highlights the possible IoT-based logistic support using artificial intelligence for the farmers such that a fast corridor is created between farmers' lands to end-user customers. This will benefit the farmers in two-fold; first, it will increase the revenue of farmers by decreasing the time span avoiding cold storage fees, and second, it will maintain the quality of crops.

1. Introduction

With increase in Internet of Things (IoT), advance artificial intelligence system, the demand of e-commerce and digital buying is risen by 4 folds. This improves the logistic platform used by the different industrial sector to improve the services related to supply chain management [1, 2]. Now, it is important to focus on farmer-customer corridor to improve the food quality delivered to the end-users.

Agriculture is one of the most important sectors on the planet. Agriculture contributes for around 15% of GDP in developing nations, such as India, and is a significant source of revenue for the Indian economy. Sierra Leone (60% of GDP), the Central African Republic (39.6%), and so on are among the few countries whose GDP is substantially based on agriculture [3, 4]. In the early ninety century, the farmers were facing lots of difficulty to maintain the crops and vegetable quality before selling to the market. Due to this, the quality of food products used to get affected and farmers bear overall losses. By investing a huge amount towards farming and getting only 60–70% as return make the living of the farmers very difficult [5]. With the introduction of smart farming, food-agribusiness has increased rapidly. With respect to global trend, modern smart logistics have attracted many big agricultural industry-based players to invest more [6]. This necessitates agricultural industrialization and the application of new technology to modernize the agricultural process. The agricultural process is split into various subprocesses, beginning with crop production and ending with the transfer of completed commodities to clients

[7, 8]. The basic phase involved in the logistics consists of transporting from base to storage, storage phase, loading and unloading phase, packaging phase, and last is distribution phase. Now, when dealing with farms product like crops and vegetables, it is considered to decrease the time span of the storage phase [9]. The aim of the logistic system is to increase the food safety, productivity, and most important, the quality of farm products. The widespread use of synthetic fertilizers, herbicides, and insecticides has significantly reduced soil fertility. Soil quality has deteriorated, resulting in lower growth rates for all crops. As a result, more chemical fertilizers, herbicides, and insecticides are required. Farmers in smart agriculture confront a number of challenges, including timely delivery of their product to the market, low wastage, and product quality, comparable to that of harvesting. Another key issue is unequal distribution of farm products, which causes a demand-supply mismatch [10].

Several publications in the literature have dealt with the issue with today's farming systems. For example, one of the most critical requirements for producing healthy crops is an appropriate and timely supply of nutritious and water content in agricultural areas. The ability of solutions configured with sensing devices to monitor throughout real-time has made this possible [11, 12]. Most of the horticulture products like vegetables are perishable products, where quality start decreasing after harvesting, so these farm products must be made available to end customer as soon as possible. Nowadays, customers are health conscious and believe in fresh item buying, so to make it possible, a fast trackable timely handling of product is required. Logistic is a way of planning to process the raw material from the farm land to the industry or end-user while maintaining the quality of the product [13–15]. To make the system sustainable and economical, the present logistic system should be upgraded to the "Smart Logistic System". In 21st century, the development of IoT, cloud, and artificial intelligence has helped the agricultural business logistic more efficient and reliable [16].

Another major operation in the agricultural world is the sale of farmed commodities on the market. The supply chain, as it is commonly referred to, consists of a variety of firms that act as intermediaries between the farmer and the ultimate consumer [17, 18]. Due to revolution in digital platform and easy accessibility of the android phone to farmers, the smart logistic system can be implemented [19]. With improvement in digital era, farmers can now get information regarding the year weather pattern, soil details, demand of fertilizer for specific crops, and much more. This leads to high quality and quantity production of horticulture commodities. In last few decades, the researchers have focused on traceability of the commodity. Using the barcode and RFID system to get the real-time information have increased the system efficiency [20–22]. Now, the most advance system like GIS is also been used by big players in the industry. Also, some important parts like extremely rural place and location, where population is very low, need a good logistics system, so that horticulture products can reach easily and on time-to-time basis [23, 24]. As per the current study collected [25, 26], employing workforce analytics more effectively may help managers and executives achieve their strategic and operational goals more efficiently. Food processing and handling is the country's most significant manufacturing sector, with more job opportunities. Human workers are essential for the successful manufacture and packaging of food products [11, 27]. It also makes a substantial contribution to national and global economic prosperity. Therefore, in the food industry, product safety and also effective delivery are critical. Newly created technology, such as artificial intelligence (AI), has demonstrated promising outcomes in achieving desired goals in recent decades [28].

People often take their food production for lightly, but they ignore that a single break in the network might result in shortfalls, illness, or price increases. This disproportionately impacts the most vulnerable people in society, such as limited users and private grocery restaurants and stores. The food supply system has a number of faults according to farmers. Most farmers sell their crops to local merchants at a very low profit margin because they lack the necessary infrastructure for storing and transporting them [29, 30]. In general, the aim of the smart logistic is to provide logics to the time and cost-efficient platform. In horticulture product, time play a vital role and cost play an important role in deciding the cost of the commodity [31]. If the cost is higher, then it impacts the sales of that commodity which directly affect the farmer' life. The future logistic for smart agriculture must have the following qualities:

(i) Faster: the logistic should deliver the product on timely basis without delay

(ii) Cost: the overall cost of the transportation must be low

(iii) Traceability: the logistic should be traceable and show its exact location

(iv) Availability: it should be available on demand

These qualities not only improve the logistic system based on smart agriculture product deliver but also improve the logistic business. Artificial intelligence will, undoubtedly, boost system performance and allow it to become more versatile. With the rise in demand, AI will assist to upgrade the system with the most up-to-date technology and to merge the old with the new [32]. A small number of researchers have employed the ANN system to improve the logistic system. However, as the ANN's input grows, the system becomes more complicated and slow. Fuzzy-based logistic control is employed in few studies. There are drawbacks to fuzzy-based logistic control and monitoring.

This part finishes by stating that the agri-based logistic system still need change in order to improve quality, quantity, and farmer revenue. The usage of an IoT-based platform necessitates innovative techniques for integrating the IoT system, so that overall system performance is improved [33]. Artificial intelligence is a unique and trustworthy approach that can be applied to the logistics industry.

This study aims to analyze use of the artificial intelligence-based IoT system for farmer logistic support. The possibilities to improve the present supply system and

improve the smart agriculture sector are by enhancing product quality and quantity through the smart logistic system and providing a better farmer-customer corridor.

2. Artificial Intelligence-Based IoT System for Logistic

AI was introduced around 50 years ago, but the impact and advance nature are upgraded in the 21st century. AI is a modern technology which includes a brief advance theory, deals with different types of devices, growth according to needs, and real-time applications. It has the quality like

(i) Human intelligence through visual image processing

(ii) It can recognize different voice in real-time environment

(iii) It can be used in computerized robots

(iv) It can handle natural language processing.

Figure 1 shows the evolution of AI. In real-time application, AI came into existence from 20th century and the maximum use was after 2010. Each stage indicates the evolution of AI from small applications with no memory to large applications with more intelligent memory processes [34, 35]. AI is an integrated part of software engineering whose main aim is to develop a framework, which can think and work like intelligent people.

Nowadays, the need for the smart logistic system is huge and in demand in the smart agricultural business. The details of the smart logistic system are explained in the subsections.

2.1. Smart Logistic for Smart Agriculture Sector. Connect the logistic with help of information and communication technologies like the sensor, GPS, and data analytics system. These technologies gather all types of data needed for the AI system.

Then, the AI system learns from the historical data to mimic the mind strategy of human behavior and help the system to make its own decision. Instead of calculating all the details manually, the AI systems calculate all the possible risk, cost, best route, and best situation to deliver the commodity from the farmer to the end-users [36, 37]. The AI-based platform for the smart agriculture logistic can help as mentioned in the following:

(i) Best route prediction: the AI-based logistic can predict the best shortest route from the farm land to the customer or industry to save the time and cost of the fuel

(ii) Time prediction: using the historical data and real-time input from farmers, one can predict the waiting time of a farmer-customer corridor which can reduce the overall time in packaging

(iii) Details of commodity: using the AI system details of commodity, its packing size, weight, and quantity helps the receivers to know the details, so it can arrange the equipment/labor and storage room.

(iv) Breakdown monitoring and tracking: we all know that a machine without proper maintenance can lead to blockage of supply; so, using the AI-based logistic, it can be tracked and proper information can be shared to the nearby logistic system to take the command of the breakdown supply. It will help the supply system to maintain the quality of the commodity.

Using the AI system in the different stage of the smart agriculture logistic system (Figure 2) can help to develop system architecture. Machine learning is a subset of AI, which help the AI system to achieve the requirements in best possible ways [38, 39]. Figure 2 shows different machine learning-based AI subsets and in which the part of logistic architecture can be implemented. People often take their businesses to increase revenue and save costs. Businesses employ a range of apps in their everyday operations. Chatbots have been shown to be incredibly effective in procurement. The AI system then uses previous data to emulate human behavior's thought strategy and assist the system in making its own conclusion. Instead of manually calculating all of the information, AI systems evaluate all of the possible risks, costs, best routes, and optimal situations for delivering the product from the farmer to the end customers.

2.2. Architecture of Smart Logistic for Farmer-Customer Corridor. AI enhances the logistic supply to a smarter model. So, using AI, the possible architecture obtained is shown in Figure 3. It consists of total six stages. The first stage is farmer side. In this stage, the details of farmer, location, type of commodity they deal, and required time need for service are taken into consideration. Stage 2 consists of computation of the data collected from the farmer side. These data are made available to the website and cloud for proper information to all the stages of the architecture.

Stage 3 and stage 4 consist of data storage at the local level and at the overall level. The local data are useful for the local vendors and customers. The overall data are required by the company and logistic team to find problem within the systems. It is also used to enhance the system coordination. Stage 5 consists of customer side details. Here, the customer may be end-user or it may be a business industry and the details regarding time of delivery, delivery networks, and quality inspection of the commodity. Stage 6 is for feedback. Feedback is always necessary to improve the service quality. Through feedback, the system can easily identify the deterioration stage and can help to improve the system.

Using all the six stages of new architecture, the possibility of attending high quality with high satisfaction can be guaranteed. Now, we are going to identify the details using the statistic available on the Internet to prove that including all these stages, the logistic system can perform well and can create a good amount of revenue. Also, we will do the comparison of the non-AI-based system with the AI system in terms of time, quality, and cost.

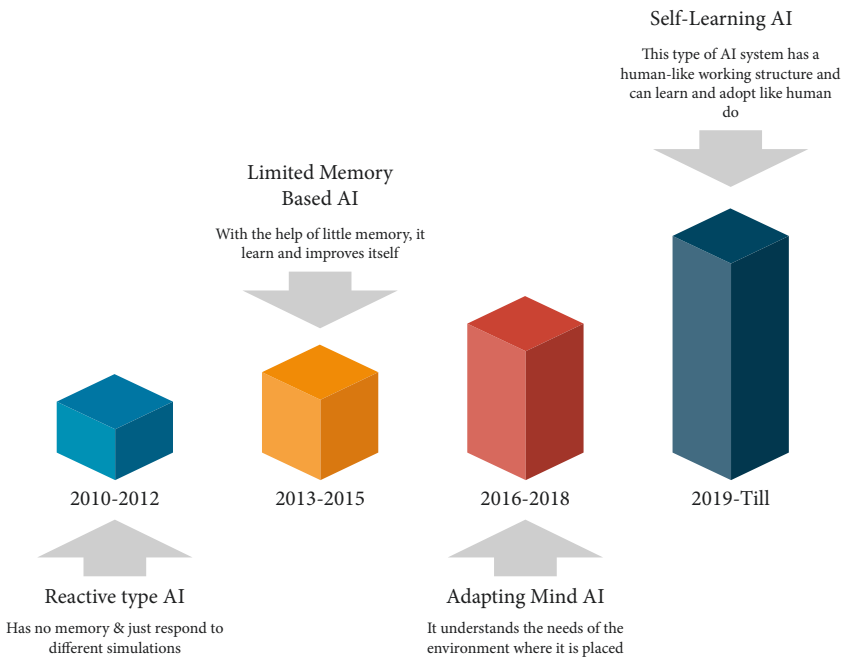

Figure 1: Evolution of AI.

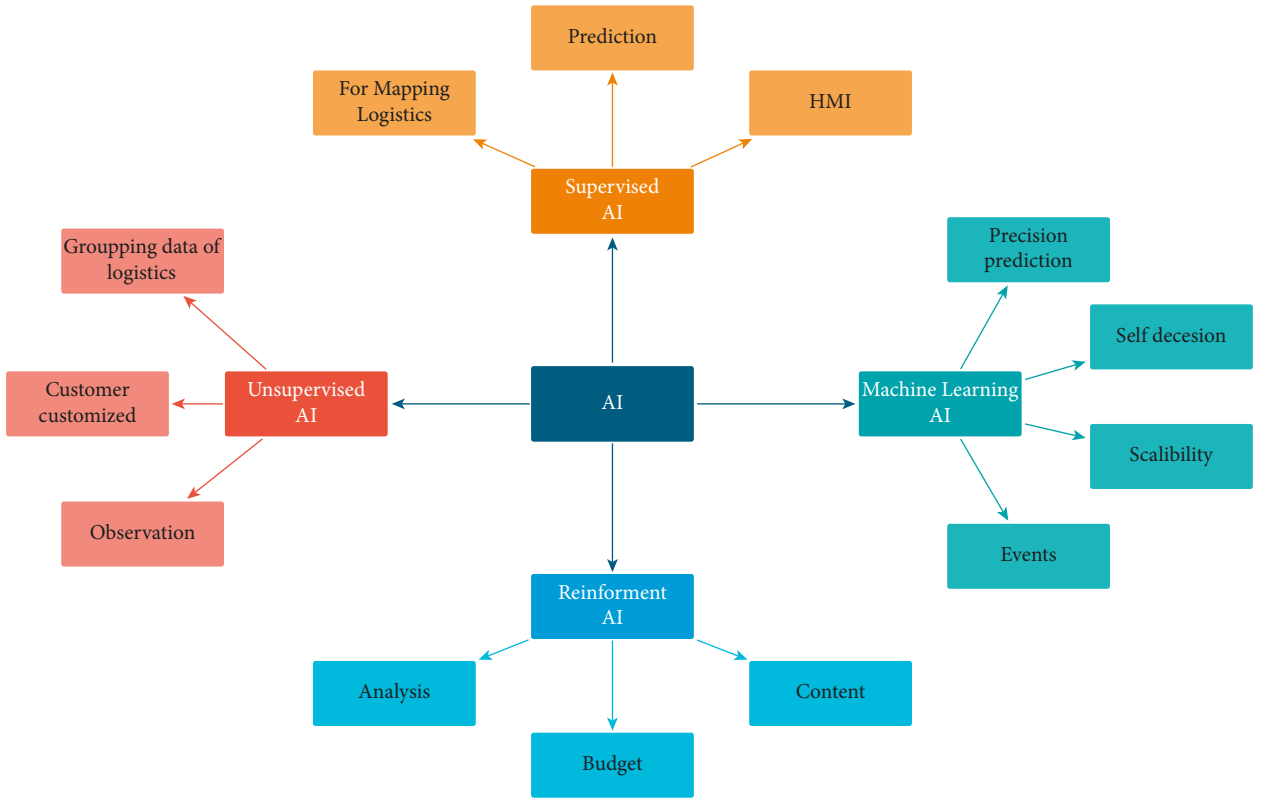

Figure 2: Use of the AI system in different parts of logistics.

3. Result and Discussion

This section deals with review results obtained from different sources available on the Internet and the discussion section.

3.1. Result. Based on the criticisms of smart logistics in food horticulture industrial products, particularly those related to food security and quality, this study proposes a new model of smart logistics in the food horticulture industry product with six AI-based stages, including forecasting

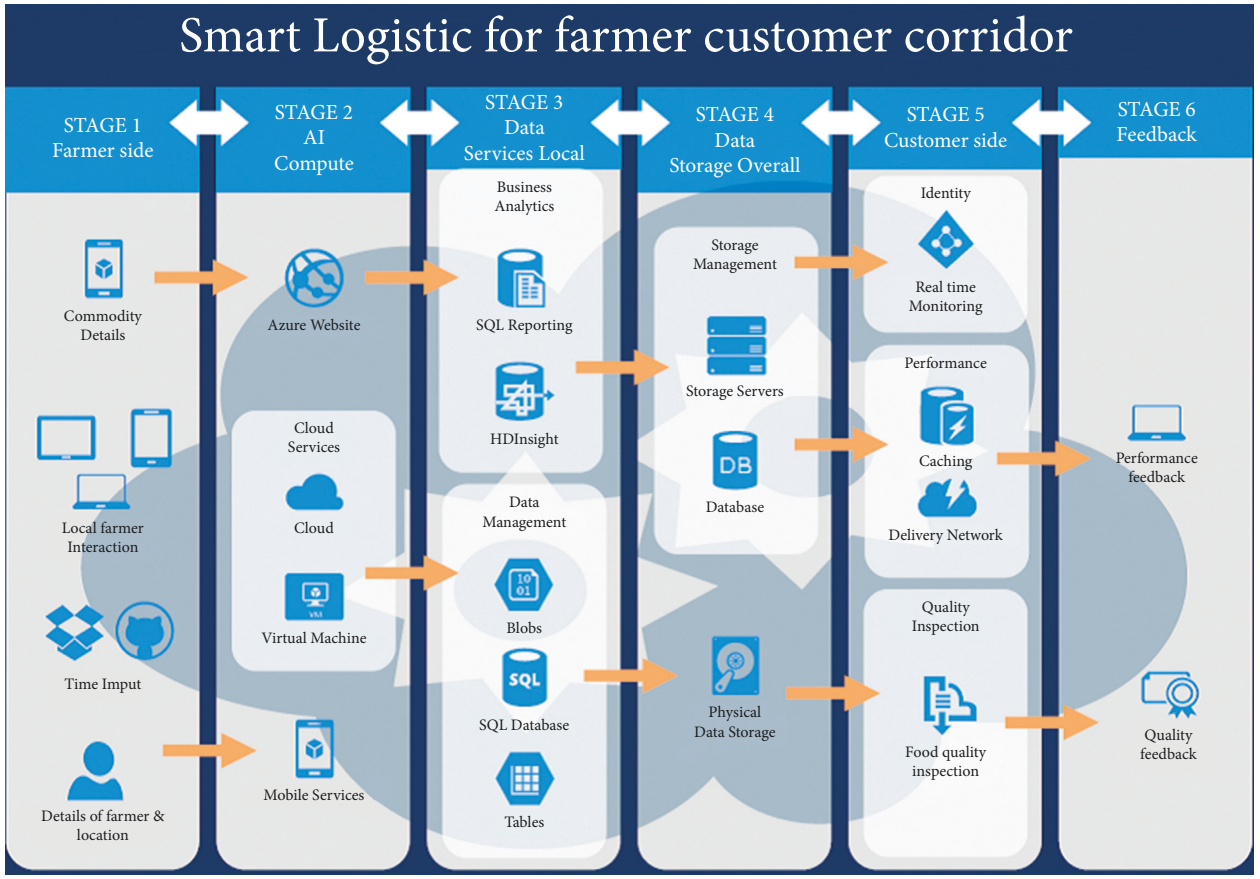

Figure 3: AI-based smart logistic architecture for farmer-customer corridor.

consumer demand, purchasing seeds, planning logistical needs, production planning, storage and inventory, and warehousing.

Figure 4 shows the statistic regarding the use of smart logistic over a time span of 5 years, i.e., from 2015 to 2020 [40, 41]. It clearly shows that the investment in smart logistic is increasing year by year. Figure 5 shows the effect of smart logistic on farmers. From 2016 to 2020, the farmer' revenue has increased due to presence of smart logistic supply channel. It also indicates that the overall logistical cost decreases in a huge amount [42, 43].

Now, as shown in Figure 6, non-AI-based logistic is compared with the AI-based logistic. The comparison is on 5 major points which are stated as follows:

(i) Cost related to time: it means if the time consumed by the logistic system is more, it means more money is involved

(ii) Cost related to waste: it means if the time is more, the horticulture commodity quality will reduce and will affect the farmer

(iii) Investment return back: it highlights the amount of returns which they can get from the logistic system during the span time of 5 years

(iv) Cost of investment for long period: this means every year, the total investment is required to improve the system efficiency.

(v) Initial investment cost: it highlights the cost at the time of starting

It can be noted that for the AI-based system, the initial investment cost is high, but with respect to other parameters, the results are better.

3.2. Discussion. The core essence of the agricultural logistics ecosystem and internal relationships between the main bodies are attempted to be explained through business practices in this study, which use typical cases to show the internal relationships between the main bodies of the agricultural logistics ecosystem.

Furthermore, through the general structure (who works with whom), the collaborative phase (how to collaborate), and the collaborative content, this study clearly demonstrates the collaborative framework of the agricultural logistics ecosystem.

Furthermore, this research integrates AI and Internet of Things technology to examine its own path of the agricultural logistics ecosystem's collaborative development mechanism. This study combines the intelligent architecture to develop the intelligent model structure after establishing the system framework and examines the system function realization process based on the actual circumstances. Finally, through research reviews, this work examines the performance of architecture from many perspectives.

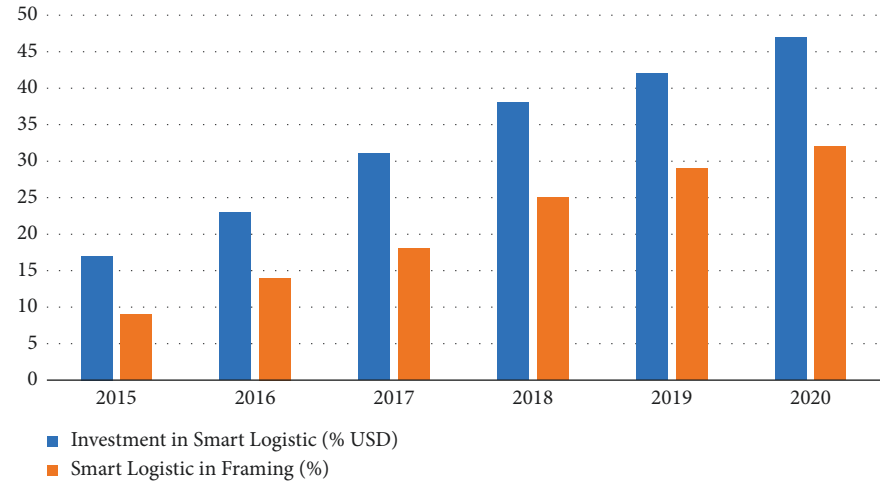

Figure 4: Statistic regarding smart logistic.

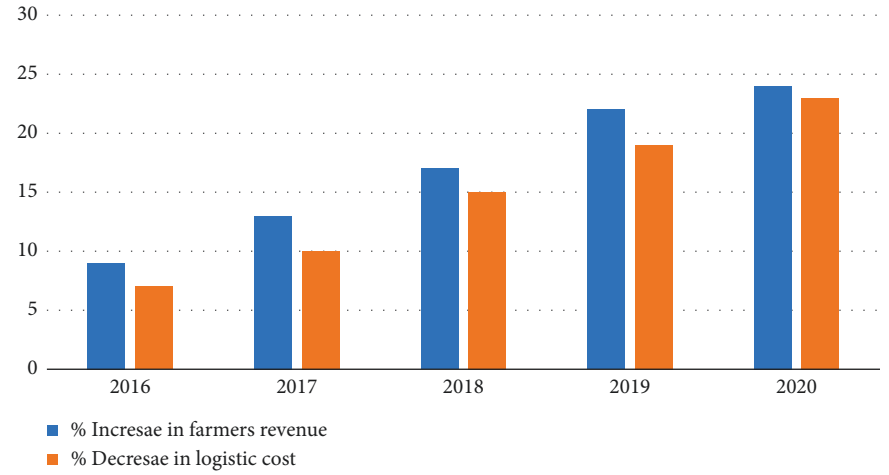

Figure 5: Effect of smart logistic.

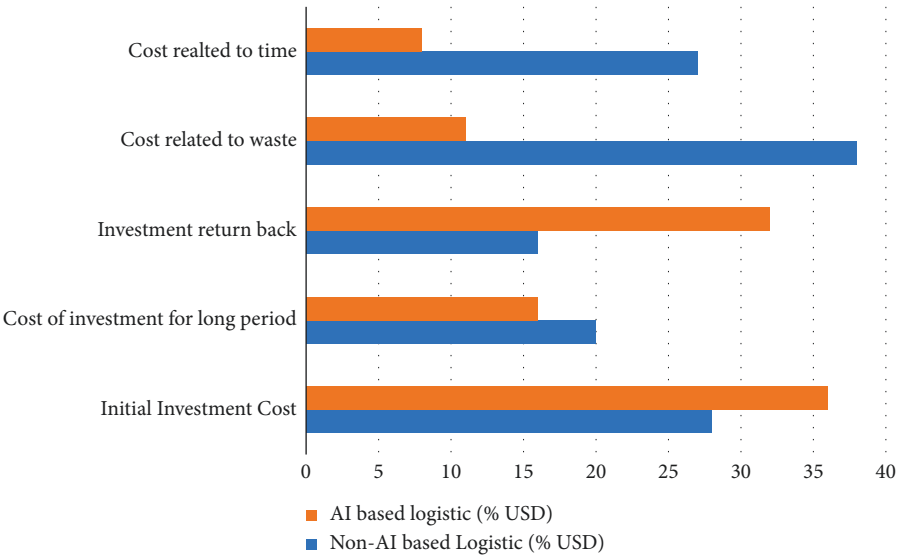

Figure 6: Comparison between AI-based and non-AI-based logistics.

4. Conclusion

The study's goal was to look into AI's impact in the current world, notably in the field of agricultural logistics. The goal of this project was to figure out how AI could be used in the farmer-customer corridor. The study employed a qualitative research method (document analysis). After harvesting, the quality of the product swiftly deteriorates. As a result, postharvest handling, distribution, and delivery of products must all be completed on time in order to maximize consumer satisfaction. The logistic strategy in food horticulture industrial product is made up of smart logistics, spatial logistics, and traceability logistics, as we learned in the previous discussion. Product quality suffers as a result of mishandling as well as product damage. As a result, a smart logistics system built with a new framework can anticipate harvest time, determine the best warehousing and distribution center, and choose the best shipping route to reduce postharvest damage. AI is influencing the commercial earning rate and expenditure reduction in today's sectors. Predictive skills are improving demand forecasting, and it also aids in the reduction of operational costs. In today's environment, smart warehouses are becoming increasingly vital for effective supply chain management. The companies' revenue is increasing as a result of automated warehousing. AI technology implementation has enhanced data collection and inventory processes. AI can help supply chain managers detect and resolve big challenges. The research shows that merging other AI technologies and machine learning offers up new insights on a wide range of problems, such as warehousing and logistics management, collaboration, and supply chain management.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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