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Research Article

The Integration Model of Agricultural Products E-Commerce and Supermarket Based on the Internet of Things

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As a new technology that is driving the transformation of third-party industry and continuing to grow, Internet of Things (LOT) technology has been widely used in social and socioeconomic life and has had a profound impact on human creativity and life. The integration of agricultural products e-commerce and supermarkets based on the Internet of Things is slowly rising like a bright star. As the foundation of a national economy, after years of growth, agriculture is facing challenges such as reduced economic opportunities, lack of resources, and excessive production models, and there is an urgent need for a healthy new generation of information technology in agriculture. This thesis discusses the LOT and the circulation model of agricultural products and studies the integration model of agricultural products e-commerce and supermarkets based on the LOT. This article proposes the system framework of this model and conducts an empirical analysis of the system through experiments to demonstrate the feasibility and effectiveness of this model in practical applications. Experimental results show that the average total profit of offline supermarkets is 684,000, and the average total cost is 4.149 million. The average total profit of online platforms is 902,000, and the average total cost is 7 million. The average total profit of the online and offline integration model is 828,000, and the average total cost is 6.527 million. Compared with traditional supermarket sales, the online and offline integration model has higher profits. Although the total profit is not as good as the online model, the quality of agricultural product distribution is far better than the online model, and consumer satisfaction is higher.

1. Introduction

The LOT came from the Automated Identification Center of the Massachusetts Institute of Technology in the United States. Its purpose is to use radio frequency detection, infrared, laser scanners, global positioning system, and other smart tools to connect objects to the Internet to transmit object information, understand object information in real time, and achieve the purpose of recognition and understanding. *Application Management*. In 2005, the ITU (International Telecommunication Union) proposed the LOT and expanded its capabilities. Collaboration indicates that the LOT is the "Age of LOT Communication" that comes, through the Internet, from people-to-people communication and the interaction between people and things, objects, and things. You know the unification of all objects in the world and the exchange of information. In 2008, the world's first LOT 2008 conference was held in Zurich. The conference discussed the many advanced technologies available from the LOT and the expectations for their implementation. That same year, IBM proposed the Smart Earth development plan. The LOT, as an integral part of Smart Earth, has attracted worldwide attention. In 2011, the "White Paper on the LOT" proposed that the LOT is the promotion and advancement of communications and the Internet. It uses optical technology and smart devices to identify and recognize the physical world and uses the network system to process my data and data, to achieve the purpose of real-time management, accurate management, and scientific decision-making. The Internet of Things is more complex than the

Internet technology, has a wider range of industrial radiation, has a wider range of applications, and has a stronger driving force and influence on economic and social development. The Internet focuses on the interconnection and sharing of information and solves the problem of information communication between people.

In the field of production and life, more and more sensors are widely installed and applied. It ranges from government public management such as national security, public health, and convenient transportation, to the daily lives of the common people such as smart homes, health inspection, and convenient payment. And it is connected by the Internet and communication network, and the physical world is freed from the constraints of time and space through electronic information technology. It can be presented to us more accurately, providing us with a safer and more comfortable life.

With the advent of the LOT era, the application of the LOT covers many areas. It includes smart grid, mobile payment, traffic management, smart campus, smart environmental protection, smart medical care, vehicle and ship monitoring and dispatching, police personnel monitoring, logistics management, and other fields. However, there is not much theoretical research on the LOT in the circulation and marketing of agricultural products. The theoretical research on online and offline integrated business models, especially how to integrate the actual market conditions to promote and develop agricultural products operations, and how to integrate with existing business models, is particularly important. This paper discusses the integration model of agricultural product e-commerce and supermarket based on the LOT, extends the application of LOT technology in the field of agricultural distribution, and further strengthens scientific research in the field of LOT technology applications. At the same time, in the field of agricultural research, the introduction of ingredients on the Internet is also a new issue. LOT technology in agricultural product models can further develop scientific research into the distribution of agricultural products.

2. Related Work

In terms of theoretical research, experts and scholars at home and abroad have discussed the definition, technical direction, application, and development prospects of the LOT in various fields and have done relevant research on each link and application of the LOT industry chain. Razzaque MA is based on the latest IoT interfaces found only in wireless sensor networks (WSNs). It does not take into account other important factors such as radio frequency identification (RFID), machine-to-machine communication (M2M), and data management and retrieval (SCADA), describes the requirements for IoT intermediate software, examines a comprehensive set of intermediate solutions based on these requirements, and finally learns the technical requirements of IoT intermediate software [1]. Stojkoska et al. [2] proposed an overall framework that combines the LOT and smart homes. Based on the overall framework, a set of smart home management models are constructed to effectively integrate smart homes into the LOT. Through data processing, they discussed the operability of the framework system and the challenges that may be encountered in real-life applications. They aim to bridge the gap between existing smart home applications and their prospects for integration into the LOT environment [2]. Based on the Medical LOT, Mostafa et al. [3] researched medical applications that came in two categories: scientific papers and business results. It is evidenced by the architecture defined by the Medical LOT, including hardware and software that handles portable devices, sensors, smartphones, medical devices, and medical station analysts. It performs further diagnosis and data storage for health monitoring and disease prevention. The results show that these wearable devices have been greatly developed under the Medical LOT technology, which can better monitor the health indicators of various parts of the human body [3]. Lin et al. [4] explored the integration and application of ear computing and the LOT and developed a LOT platform based on ear computing. They provide a comprehensive overview of the LOT in terms of system architecture, operating technology, security, and privacy issues. They researched the relationship between the LOT and ear counting and discussed many issues on the Internet based on ear counting and how to use the LOT based on ear counting in practice [4]. Singh et al. [5] aim to support multiple data connections and data sharing, deliver LOT-backed computing, and integrate the LOT with cloud support. It pays attention to the security of the LOT from the point of view of cloud renters, end-users, and cloud providers. In the context of large web object applications, it analyzes the current state of the LOT supported by the cloud to determine the security needs that require the most work [5]. Gsangaya et al. [6] have developed wireless Internet sensors based on the LOT used in normal agriculture and introduced the development of a portable wireless sensor network system for remote monitoring of environmental conditions in the agricultural sector, such as temperature, humidity, light intensity, and soil moisture content. Using LOT technology, the information received from the sensors is transmitted to the cloud server wirelessly and users around the world can view it through network devices. It aims to increase agricultural productivity by streamlining the soil and managing the crop to suit the unique conditions of each location while maintaining environmental quality [6]. Gavrilovi [7] and Mishra analyzed the types of software architectures currently available in the fields of IoT systems, smart cities, healthcare, and agriculture. According to different types of software architectures, they identify the available functions in the IoT system and provide solutions and improvement suggestions for different types of software architectures [7].

3. Basic Research on the LOT and the Circulation of Agricultural Products

3.1. Basic Research on the LOT

3.1.1. IoT System Architecture. The LOT is divided into three levels in the system architecture: the lower level, the middle level, and the upper level. The lower level is the optical level, which means object recognition and information observation, the middle level is the network level that performs the data transfer functions, and the upper level is the application level that supports the actual application functions, as shown in Figure 1 [8, 9]. The usage scenarios of the Internet of Things are mainly reflected in these steps: collection, transmission, calculation, and display.

(1) Perception Layer. The perception layer is composed of various sensors and sensor gateways, including carbon dioxide concentration sensors, temperature sensors, humidity sensors, two-dimensional code tags, RFID tags and readers, cameras, GPS, and other sensing terminals. The function of the perception layer is to collect object information and realize object recognition. This layer is composed of a large number of various modules for sensing and identifying objects. Related modules include EPC tags, readers, RFID readers, sensors and sensor networks, and short-distance wireless communication [10]. These modules recognize objects, collect various information and perform intelligent identification, and then transmit the object information to the network layer through network transmission technology to realize the transmission of data information [11].

(2) Network Layer. The network layer is the information transmission link between the perception layer and the application layer and is an intermediate link in the operation of the LOT. The main function is to realize the transmission and processing of data information and transmit the information data obtained by the perception layer to the application layer after processing. It guarantees the overall effective operation of the LOT and reliable transmission of information. At this time, a network with strong bearing capacity is needed to support its information transmission function. The networks that can be used to transmit sensing data mainly include the following three categories, as shown in Table 1 [12].

(3) Application Layer. The application layer includes the supporting technology layer and the application service layer. The supporting technology layer is responsible for receiving data from the network layer and performing data collection, analysis, and conversion according to user needs, such as mass storage, high-performance computing, and cloud computing technology. The application service layer presents the processed information to users in the form of services and provides users with services in various industries, such as smart homes, telemedicine, environmental monitoring, urban management, and green agriculture, according to user needs.

3.1.2. Radio Frequency Identification (RFID) Technology. As the core technology of the LOT, RFID technology is supported by microelectronics technology, microwave technology, and computer software. RFID technology is an automatic detection technology that does not require direct physical contact and is based on the transmission of radio frequency signals only for automatic signal recognition [13]. Radio frequency identification technology is applied to the application layer of the Internet of Things. Its application is very wide, and it has played an important role in the field of research and development of the LOT. RFID identification technology can identify multiple targets at the same time, will not be affected by the number of identified targets and the speed of movement, and will not be easily disturbed by the surrounding environment and human factors. Therefore, it has strong practicability and maneuverability [14]. RFID identification technology has the functions of noncontact, all-weather, strong penetrating ability, identifying high-speed moving objects, and being able to identify different types of target objects at the same time. It mainly perceives the characteristics of the target through the radio frequency signal, thereby confirming the target and achieving data acquisition and information transmission. It does not require manual intervention, is convenient and quick to operate, and is widely used in various industries [15]. In recent years, RFID technology has developed rapidly and has been gradually applied to various fields, for example, in the field of intelligent transportation, such as ETC, bus card swiping, and railway, to achieve efficient management and make people travel more convenient.

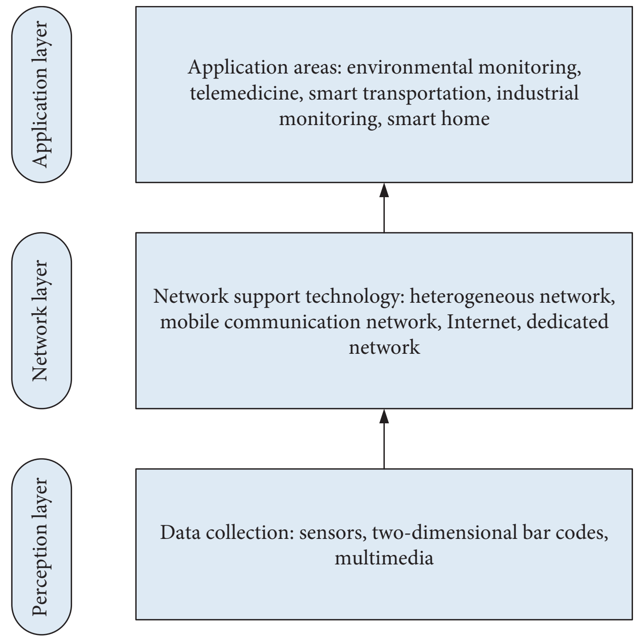

Figure 1: LOT technology architecture diagram.

Table 1: Network for transmitting sensing data.

Communication network type	Specific classification
PAN network	ZigBee, UWB, wifi, bluetooth
LAN network	Ethernet, Wigax, WLA
WAN network	G PRS, CDMA, 3G, 4G, 5G

The RFID system has all four components: reader, electronic label, RFID intermediate software, and application software, as shown in Figure 2. The reader is the

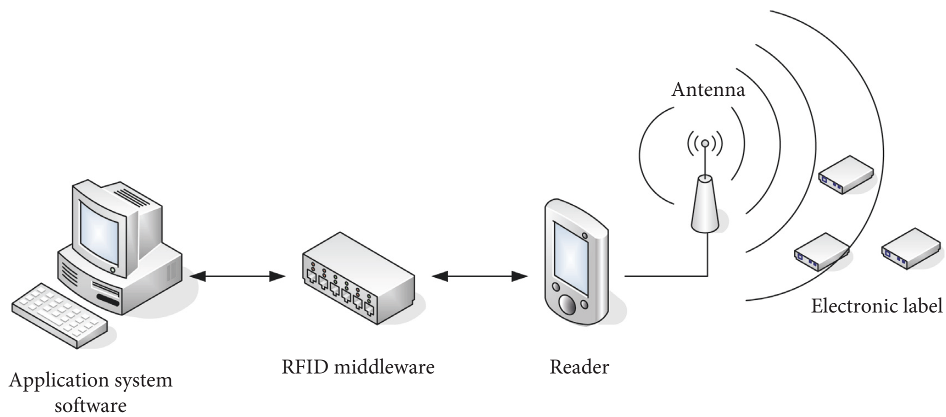

Figure 2: RFID system composition.

information management and processing center of the RFID system, and its function is important for data exchange knowledge between electronic labels under the control of the host server. The electronic signal is the data borrower of the RFID system. Each tag has a different e-mail code to store the information it needs to identify and distribute and then paste it into the item, so you need a bulletin board to have a unique ID [16]. RFID middleware is the interface between RFID hardware components and application software. The middleware can ensure the functional control of the hardware components by the application software. Since the application system software must be developed for specific needs, it is generally necessary to integrate the application system software into the corresponding business software platform.

The item information is sent out, and the radio uses radio frequency identification technology to automatically identify the item information [17]. After reading the information by the reader and decoding the data, the RFID middleware transmits these information data to the application information system through the network and further processes the data information therein. Electronic tags can be divided into passive tags and active tags according to the power supply mode. There is no battery inside the passive tag, and it can work normally only with the energy provided by the reader [18]. The active tag is equipped with a power source and relies on its own power source to provide energy, which can actively transmit signals and transmit item information without the need for a reader to send out radio frequency signals. The working sequence of electronic tags and readers is also divided into two types: reader-first mode and electronic tag-first mode. The reader first means that the reader sends out signals first and then accepts instructions after electronic tags. This method is generally applied to passive tags [19]. Electronic tag advance means that the electronic tag sends out a signal first, and the reader reads the information before issuing an instruction, which is suitable for active tags.

When the RFID system is working, when there are multiple tags in the radio frequency area of the reader, and more than one tag responds to the reader at the same time and reflects signal data, the reader will not be able to recognize the tag. This phenomenon is called label collision. In the design of an RFID system, in order to effectively deal with the collision of tags, the anticollision ALOHA algorithm is commonly used to deal with such problems, so as to achieve an accurate and fast reading of tags [20]. ALOHA algorithm is a kind of random access algorithm. When a tag wants to send data information, it can send it randomly at any time period, which is called the pure ALOHA algorithm.

(1) Pure ALOHA Algorithm. The pure ALOHA algorithm is the most basic and easiest to implement random label anticollision algorithm in the ALOHA class of algorithms. In the communication system, the arrival process of unrelated users is generally processed by the Poisson process, so the number of tags that responded per second obeys the Poisson distribution, so the probability of n tags responding in the data frame transmission time period t is

$$P(n) = \frac{(\lambda t)^n e^{-\lambda t}}{n!}. \tag{1}$$

At this time, the average data packet exchange volume is

$$G = \lambda \cdot t. \tag{2}$$

Then, the probability of successful communication without collision in the time period of $2T$, that is, the probability of no other tag responding in the time period of $2T$, is

$$\begin{aligned} P_e &= \frac{p(n=0)}{t=2\tau} \\ &= e^{-\lambda \cdot 2\tau} \\ &= e^{-2g}. \end{aligned} \tag{3}$$

The throughput rate S under this algorithm is

$$\begin{aligned} S &= GP_e \\ &= Ge^{-2G}. \end{aligned} \tag{4}$$

Because the cycle of tag conflicts is too long, at any time within this time period, as long as multiple tags transmit information to the reader at the same time, conflicts will be caused, so the collision probability is high. In view of the fact that the pure ALOHA algorithm has high randomness, high collision rate, low system throughput rate, low recognition success rate, and few applications.

(2) Slotted ALOHA Algorithm. Slotted ALOHA is a commonly used anticollision algorithm in RFID systems. It is an improvement to pure ALOHA, and its basic idea is to divide the time into several identical time slices, and all users access the network channel synchronously at the beginning of the time slice. If a conflict occurs, it must wait until the start of the next time slice before sending. The slotted ALOHA algorithm adjusts the collision period on the basis of the pure ALOHA algorithm, and the length of each slot is changed from $2T$ to T.

The probability of successful communication without collision in the time period T, that is, the probability that no other tag responds in the time period T, is

$$\begin{aligned} P_e &= \frac{P(n=0)}{t=\tau} \\ &= e^{-\lambda\cdot\tau} = e^{-G}. \end{aligned} \tag{5}$$

The throughput rate S under this algorithm is

$$\begin{aligned} S &= GP_e \\ &= Ge^{-G}. \end{aligned} \tag{6}$$

Compared with the pure ALOHA algorithm, the slotted ALOHA algorithm has a higher throughput rate and a higher recognition success rate. However, with the adjustment of the cycle, the network system will also be adjusted accordingly, and the requirements for the system will be more refined.

(3) Frame slot ALOHA Algorithm. On the basis of the slotted ALOHA algorithm, N slots are packed into a frame to form the framed slotted ALOHA algorithm.

Assuming that the frame length is N and the number of tags to be read is n, the probability of r tags appearing in a given time slot obeys the binomial distribution:

$$P(X=r) = C_n^r \cdot \left(\frac{1}{N}\right)^r \left(1-\frac{1}{N}\right)^{n-r}. \tag{7}$$

The probability that this time slot is a successful time slot is

$$P(X=1) = C_n^1 \cdot \left(\frac{1}{N}\right)^1 \left(1-\frac{1}{N}\right)^{n-1}. \tag{8}$$

The expectation of the number of successful slots in the frame is

$$E(X=1) = N\cdot C_n^1 \cdot \left(\frac{1}{N}\right)^1 \left(1-\frac{1}{N}\right)^{n-1}. \tag{9}$$

Differentiating N, we get

$$\frac{\mathrm{d}\eta}{\mathrm{d}N} = \frac{\mathrm{d}}{\mathrm{d}N}\left\{\frac{n}{N}\left(1-\frac{1}{N}\right)^{n-1}\right\} = 0. \tag{10}$$

From the formula (10), we can get

$$N_{opt} = n. \tag{11}$$

Therefore, when the reader's frame length N is equal to the number of unidentified tags n, the probability of successful tag transmission is the greatest, and the system works in the best state, and at the same time:

$$\lim_{n\longrightarrow\infty}\frac{n}{N}\left(1-\frac{1}{N}\right)^{n-1} = \lim_{n\longrightarrow\infty}\left(1-\frac{1}{n}\right)^{n-1} \approx 0.368. \tag{12}$$

(4) Dynamic Frame Time Slot ALOHA Algorithm. Suppose the frame length of the reader is L, and the number of tags in the range of the reader is n. When r tags respond in the same time slot, the probability obeys the binomial distribution:

$$P(r) = C_n^r \cdot \left(\frac{1}{L}\right)^r \left(1-\frac{1}{L}\right)^{n-r}. \tag{13}$$

Therefore, the probability of a free slot in a frame is

$$\begin{aligned} P(e) &= P(0) \\ &= \left(1-\frac{1}{L}\right)^n. \end{aligned} \tag{14}$$

The probability of successfully identifying the time slot is

$$\begin{aligned} P(s) &= P(1) \\ &= \frac{n}{L}\left(1-\frac{1}{L}\right)^n. \end{aligned} \tag{15}$$

The probability of collision time slot is

$$\begin{aligned} P(c) &= 1 - P(0) - P(1) \\ &= 1 - \left(1-\frac{1}{L}\right)^n - \frac{n}{L}\left(1-\frac{1}{L}\right)^n. \end{aligned} \tag{16}$$

Excluding communication interference, the throughput rate of the system is

$$\begin{aligned} S &= P(s) \\ &= \frac{n}{L}\left(1-\frac{1}{L}\right)^{n-1}. \end{aligned} \tag{17}$$

The throughput rate of the algorithm is equal to the probability of successfully identifying the time slot in a frame. In order to obtain the maximum throughput of the system, the two sides of the Formula are derivated with respect to n, and then,

$$\frac{dS}{dn} = \left(1-\frac{1}{L}\right)^{n-1} + n\times\left(1-\frac{1}{L}\right)^{n-1}\ln\left(1-\frac{1}{L}\right) = 0. \tag{18}$$

We can get

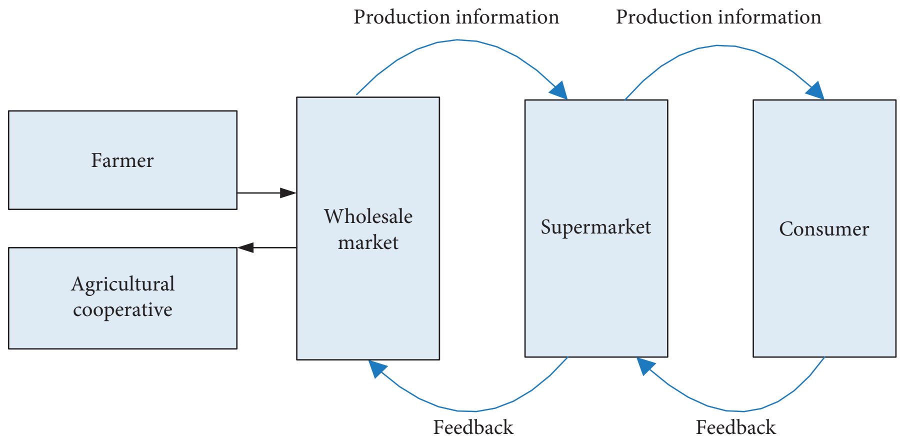

Figure 3: The supermarket circulation diagram of agricultural products.

$$n = \left[\frac{1}{\ln(1-(1/L))}\right]. \quad (19)$$

When the number of tags is n, the optimal frame size can be obtained as

$$\begin{aligned} L &= \frac{1}{1-e^{-1/n}} \\ &= \frac{e^{1/n}}{e^{1/n}-1} \approx \frac{1+1/n}{1+1/n-1} \\ &= n+1. \end{aligned} \quad (20)$$

After the identification of each frame, the unmarked labels are evaluated, and the size of the next frame is set equal to the number of unmarked labels. Substituting formula (20) into formula (17), we get

$$\begin{aligned} S &= \frac{n}{n+1}\left(1-\frac{1}{n+1}\right)^{n-1} \approx \left(1-\frac{1}{n}\right)^{n-1} \approx \frac{1}{e} \\ &= 0.368. \end{aligned} \quad (21)$$

3.2. Circulation Mode of Agricultural Products

3.2.1. Circulation Mode of Agricultural Products Supermarket. It refers to the production-sales docking method in which producers sell their agricultural products to wholesalers, and the wholesalers centrally supply them to large supermarkets. Farmers or agricultural cooperatives jointly established by farmer households sell agricultural products to agricultural product wholesale centers, which are purchased by wholesalers. Wholesalers sign purchase contracts with some large supermarkets to centrally supply agricultural products to large supermarkets, and finally, the supermarkets sell the agricultural products to consumers. This model mainly connects consumers and supermarket chain enterprises with agricultural product wholesale markets, farmers, and agricultural cooperatives through continuous and fixed procurement contracts. The distribution model of agricultural products supermarkets is shown in Figure 3. This model takes wholesalers and supermarkets as the core of the agricultural product circulation process. In the process of agricultural product circulation, producers and consumers cannot update the information about agricultural products in a timely manner. Supermarkets and wholesalers need to complete the matching of information together, and there will still be situations of poor information circulation. This is due to the different channels for obtaining information between supermarkets and wholesalers, which leads to poor information flow.

3.2.2. Circulation Mode of Agricultural Products E-Commerce. As a new type of agricultural product circulation method, the agricultural product e-commerce circulation model refers to the use of e-commerce in the agricultural product market circulation. It sets up a symmetrical, open, and transparent exchange channel between production and sales to promote a smooth flow of agricultural product supply and demand information. The e-commerce platform transmits the demand of the consumer's order to the supplier according to the demand of the consumer. At the same time, farmers and agricultural cooperatives uniformly sell agricultural products to wholesale markets in various regions, and wholesale markets in all regions, namely, suppliers, sell agricultural products to consumers through logistics according to the needs of consumers' orders. E-commerce has greatly improved the benefits and efficiency of traditional business activities. E-commerce provides a virtual global trading environment for enterprises, which greatly improves the level of business activities and service quality. The circulation mode is shown in Figure 4:

However, the current e-commerce circulation method still has the shortcomings of network infrastructure construction and single network marketing method. I will analyze it below.

(1) Insufficient Network Infrastructure Construction. Due to slow economic development, backward infrastructure construction, low level of farmers' own education,

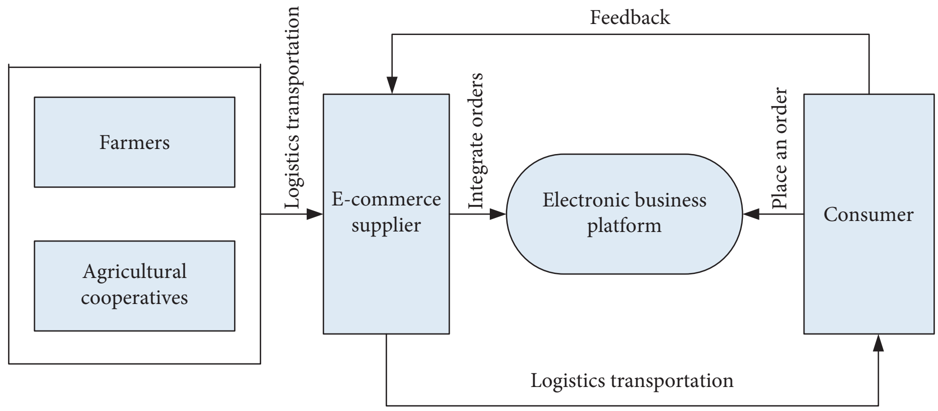

Figure 4: E-commerce circulation diagram of agricultural products.

Table 2: Rural network penetration rate in each province.

Provinces	Number of Internet users\ten thousand	Penetration rate (%)	The growth rate of netizens (%)
Guangdong	3786	66	8.5
Jiangsu	3690	60	9.2
Zhejiang	3793	68	7.2
Anhui	2758	52	12.1
Hunan	2992	55	10.9
Jiangxi	2550	48	14.2
Shanxi	2886	54	10.9
Gansu	2276	43	15.8
Guizhou	2013	38	14.6
Yunnan	2168	41	15.7

insufficient understanding of e-commerce, and weak learning ability of e-commerce, the sales of seasonal agricultural products will become very slow. Self-employed individuals cannot reach consumers through the Internet and can only sell to local distributors, who will lower the purchase price of agricultural products. Therefore, it harms the interests of producers and is not conducive to the normal circulation of agricultural products. Table 2 shows the popularization of rural basic networks in various provinces.

It can be seen from Table 2 that the rural Internet penetration rate in Jiangxi, Gansu, Guizhou, Yunnan, and other places is less than 50%, which is much lower than that of Zhejiang, Jiangsu, Guangdong, and other provinces with developed logistics. At the same time, the number of netizens in Jiangxi, Gansu, Guizhou, Yunnan, and other places is also lower than that in developed provinces such as Zhejiang, Jiangsu, and Guangdong. Therefore, the current government should also increase network infrastructure construction in rural areas in the central and western provinces.

(2) Single Network Marketing Method. For the rapidly developing agricultural products, network marketing still lacks characteristic marketing methods. Take Jiangxi's Gannan navel orange as an example. In the peak season of navel orange in autumn and winter, network marketing is still mainly through the circle of friends to promote and market the characteristics of the hometown. The consumer resources of Moments are limited, lack of innovation in Internet promotion and marketing methods, single promotion methods, and weak market influence. According to the statistical report on the development of the Internet in China in October 2020, the utilization rate of various online marketing methods is shown in Figure 5.

It can be seen from Figure 5 that the use of online chat tools for marketing promotion is the most common marketing method, accounting for 80%; the use of search engines, e-commerce platforms, and e-mail promotion is also gradually increasing, accounting for about 72%. However, Weibo marketing and online video advertising still need to increase marketing efforts to promote the diversified development of marketing methods.

4. System Research

The mode of integration of offline supermarkets and online platforms refers to a mode that combines offline supermarkets and online e-commerce platforms for product circulation and service promotion, and a mode that integrates online and offline. Through the Internet, e-commerce platforms are used to provide information on agricultural products of producers or wholesalers to Internet users through display and promotion. Potential consumers can go to offline supermarkets in the same city to pick them up or deliver them by supermarkets. Consumers outside the same city can receive agricultural products in the form of logistics. This model effectively combines offline supermarkets and online e-commerce and uses the advantages of online information dissemination to complete information

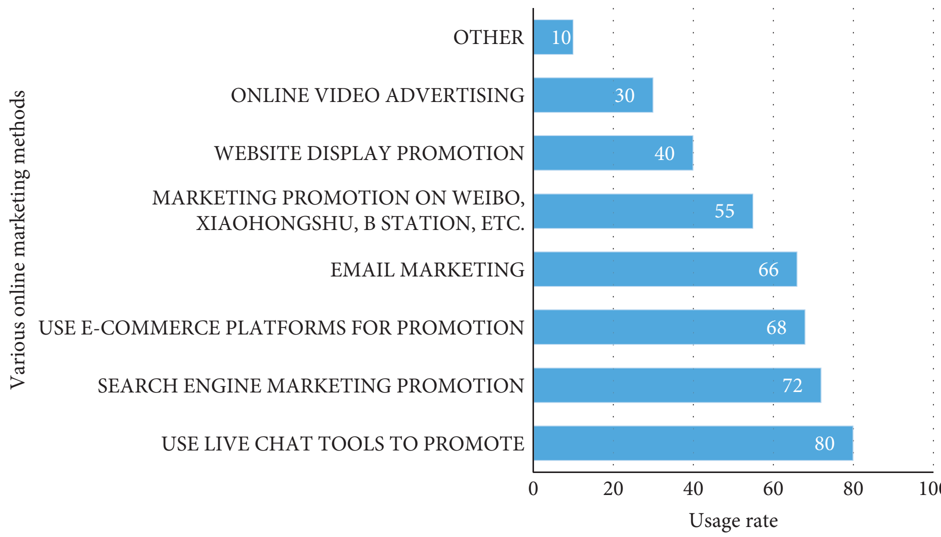

Figure 5: Utilization rate of various online marketing methods.

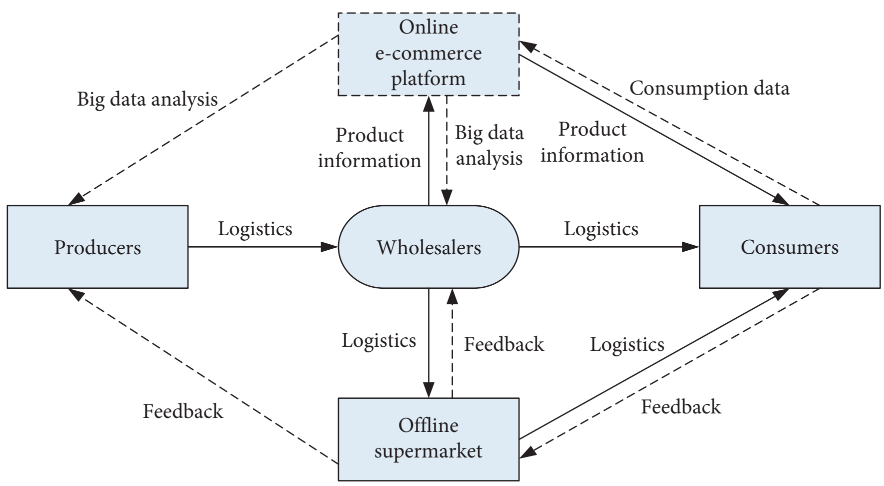

Figure 6: The framework of online and offline integration of agricultural products.

communication between producers and consumers. The overall frame diagram is shown in Figure 6.

In the whole framework, offline supermarkets and online platforms operate together to promote the integrated development of online and offline. Online platforms use various network marketing methods to promote agricultural products, including e-commerce platform promotion, Weibo marketing promotion, and website advertising promotion. Using data processing technology to process consumer orders and tap potential consumers, predict user preferences, and generate a page of agricultural products that users want to buy for users to select and purchase related products, consumers browse, compare, and screen the agricultural products they want to buy on this page, and after confirming the products, they place an order for agricultural products through an online payment. The online platform selects the nearest offline supermarket based on the consumer's address. If there is no offline physical supermarket in the local area, the platform will look for a closer producer or distributor in the database to transport agricultural products to consumers in the form of logistics. After consumers receive the goods, they can evaluate the purchased agricultural products and provide feedback to the platform. Due to the openness and transparency of online platform information, manufacturers and distributors can browse consumer feedback and better improve the quality of agricultural products. Offline supermarkets store ample agricultural products, are responsible for selling agricultural products to customers offline, and complete orders distributed on the online platform, allowing online consumers to pick up or deliver them in the same city to ensure that online consumers receive agricultural products. Offline consumers can complete the feedback information on agricultural products by going to the supermarket, and then the supermarket will input the feedback information into the online platform to promote the circulation of agricultural product information. Whether it is producers, wholesalers, offline supermarkets, or consumers, they can obtain relevant information and data feedback on agricultural products through online platforms. It is conducive to the transparency

Table 3: Evaluation index system of agricultural products circulation mode.

First indicator	Secondary indicator	Third indicator
Logistic aspect	Logistics information processing time Agricultural product delivery quality	Time unit: s Quality rating
Economic aspect	Shipping costs and storage costs Costs and profits	Compare the two costs Compare total costs and profits

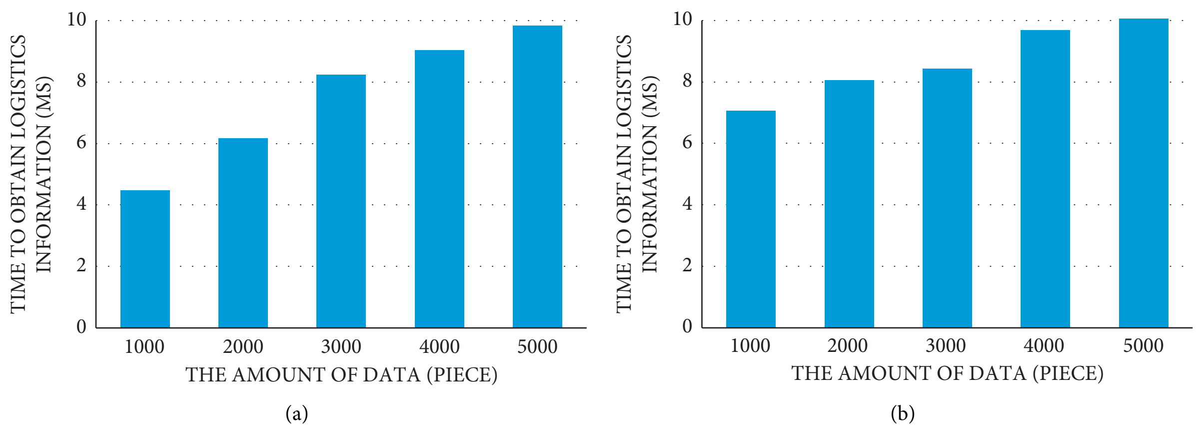

Figure 7: Time-consuming diagram of logistics information processing.

and clarity of agricultural product data and information and is conducive to the healthy circulation of agricultural product supply chains.

5. Experimental Design

In order to verify the feasibility of this mode, a series of tests were carried out through the LOT to test the performance of various working performances of the system in practical applications. The evaluation index system of agricultural product circulation efficiency is shown in Table 3.

5.1. Time-Consuming Logistics Information Processing. An important criterion for measuring the pros and cons of the agricultural product circulation model is the speed of logistics information processing. The information processing speed of agricultural products logistics is fast, and the circulation speed of agricultural products in the supply chain will be very fast. It will be faster in production, transportation, signing, and other links, speed up the circulation rate, and improve the freshness of agricultural products. We take agricultural product logistics information as the experimental object, compare the LOT technology with intelligent sensor network technology, obtain the time-consuming results of logistics information processing, and draw the logistics information processing time chart under the two technologies, as shown in Figure 7. Figure 7(a) is a time chart of logistics information processing based on the LOT, and Figure 7(b) is a time chart of logistics information processing based on smart sensor network technology.

It can be seen from the comparative analysis in Figure 7 that whether it is the LOT technology or the smart sensor network technology, as the amount of data gradually increases, the logistics information processing time is gradually increasing, and the processing speed is gradually decreasing. But on the whole, compared with smart sensor network technology, the use of LOT technology takes a shorter time in agricultural product logistics information processing. This proves that the LOT technology is faster and more efficient in the processing of agricultural product logistics information.

Table 4: Agricultural product quality score form.

Level	Scores
Level 1	8.5–10
Level 2	6.5–8.5
Level 3	≤6.5

5.2. Delivery Quality. The key indicators to measure the pros and cons of the agricultural product circulation model also include the comparison of the quality of agricultural product distribution. In the process of agricultural product circulation, we must try our best to ensure the freshness of agricultural products reaching consumers. The experiment uses two methods, offline and online, to sort and distribute 10 agricultural product orders and send them to consumers. Among them, the quality of agricultural products is classified into 3 levels, the first level is fresh and no rot, the second level is not too fresh but no rot, and the third level is partially decayed which affects eating. In this experiment, the delivery quality is scored, with a total score of 10 points, with 8.5 or higher being the first level, 6.5 to 8.5 being the second level, and 6.5 or less being the third level, as shown in Table 4. The quality effect comparison chart of the distribution is obtained, as shown in Figure 8. Figure 8(a) is an offline

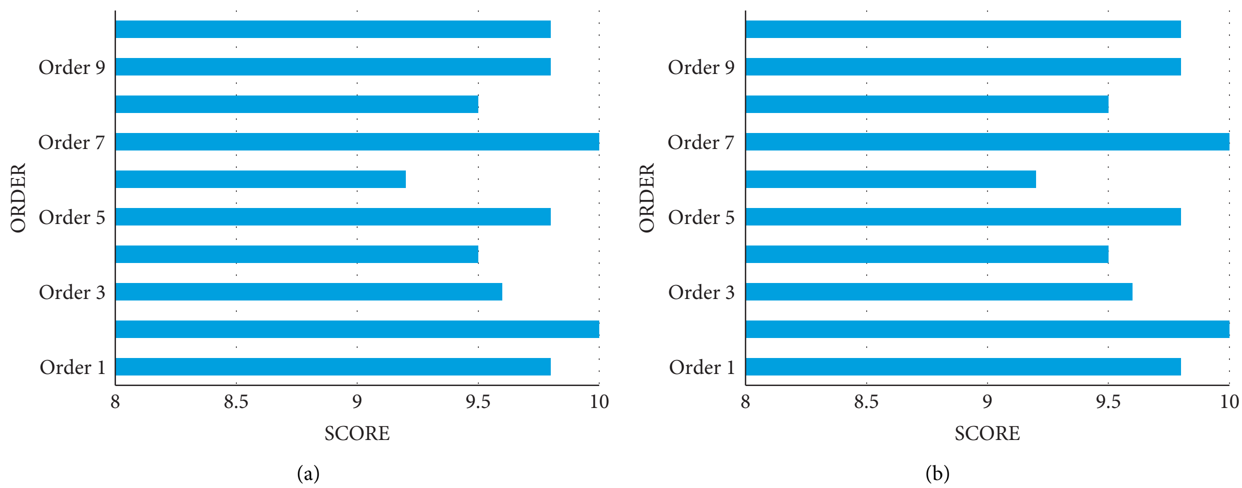

Figure 8: Graph of the evaluation results of the delivery quality of agricultural products.

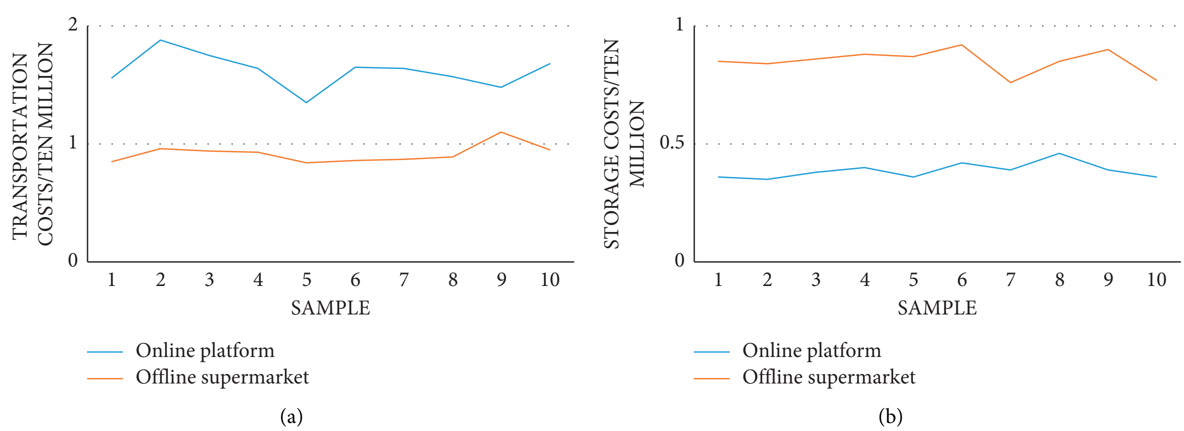

Figure 9: Comparison chart of online and offline transportation and storage costs.

supermarket delivery quality map, and Figure 8(b) is an online e-commerce delivery quality map.

From the comparative analysis in Figure 8, it can be seen that the agricultural products distributed online are not fresh. Although there is no rot, the freshness of the fruits and vegetables will directly affect the taste and affect consumer satisfaction. The quality of agricultural products delivered by offline supermarkets is all first-class, and the delivery quality is fresher. Therefore, in the same city, consumers are more willing to go to offline supermarkets to buy agricultural products.

5.3. Transportation Costs and Storage Costs. In addition to the time-consuming logistics information processing and delivery quality, the transportation and storage costs of agricultural products must also be considered. In this experiment, the combined online and offline circulation model is compared with the offline supermarket circulation model, and the average value of the transportation and storage costs of 10 e-commerce platforms and offline supermarkets for one month is calculated. It obtains a comparison chart of transportation costs and storage costs for the month, and the result is shown in Figure 9. Figure 9(a) is a comparison chart of online and offline transportation costs of agricultural products in the month, and Figure 9(b) is a comparison chart of online and offline storage costs of agricultural products in the month.

From the comparative analysis in Figure 9, it can be seen that compared with offline supermarkets, the transportation costs of online platforms are higher, while the storage costs are lower. After calculation, the average online platform transportation cost for the month was 16.2 million, and the average storage cost was 3.87 million. The average transportation cost of offline supermarkets was 9.192 million, and the average storage cost was 8.5 million. Since online platforms only need to provide logistics and distribution services, transportation costs are significantly higher, while storage costs are lower. On the contrary, offline supermarkets only need to purchase goods from the manufacturer and then store them, and the distribution to consumers is also in the same city, so the transportation cost is lower and the storage cost is higher.

5.4. Cost and Profit. Finally, we need to consider the economic indicators in various modes. This experiment compares the circulation modes of offline supermarkets, online

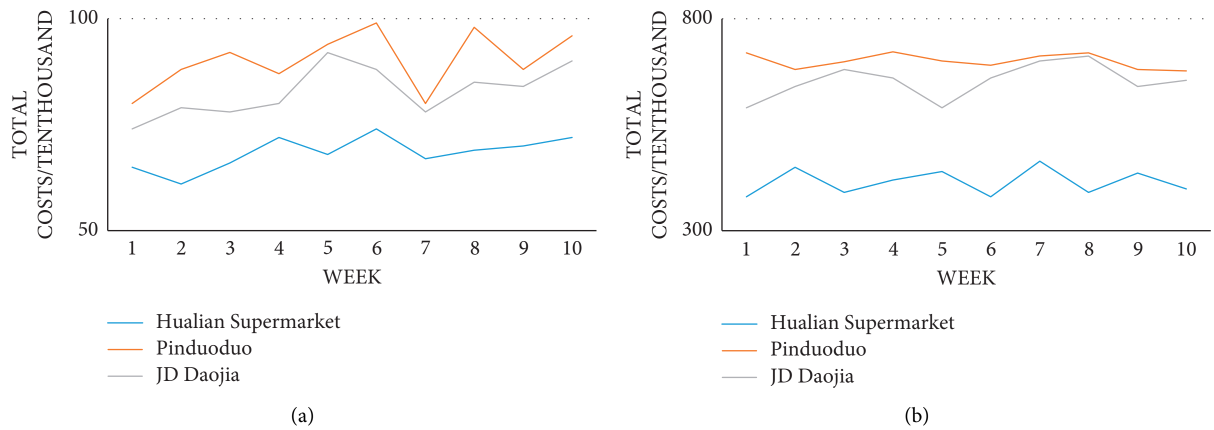

Figure 10: Comparison chart of total cost and total profits.

platforms, and online and offline. The total cost and profit of agricultural products for 10 weeks in Hualian Supermarket, Pinduoduo, and Jingdong Daojia are calculated. It gets a comparison chart of total weekly cost and total profit, as shown in Figure 10. Figure 10(a) is a comparison chart of the total cost of the three models of agricultural products, and Figure 10(b) is a comparison chart of the total profit of the three models of agricultural products.

By comparing offline supermarkets (Hualian Supermarket), online platforms (Pinduoduo), and online and offline (JD Daojia) circulation models, the total cost of agricultural products and total profits show that offline supermarkets have lower costs. But at the same time, it is subject to geographical restrictions and can only sell agricultural products to local consumers and at the same time pay the store rent, so the profit is also low.

Online platforms have higher costs due to higher transportation costs, but they can sell agricultural products to all parts of the country, have a larger coverage of consumers, and obtain higher profits. *Combination of Online and Offline.* Because of both offline stores and online platforms, the cost is between the two, and the profit is slightly lower than the online platform. Consumers in the same city can pick up the goods directly from offline stores or deliver them to the store. Consumers outside the same city are transported through online platform logistics. The delivery quality will be better than that of online platforms, the freshness of agricultural products will be higher, and consumer satisfaction will be better.

6. Conclusion

This article takes the integration model of offline supermarkets and online e-commerce in the process of agricultural product circulation as the research object. This article analyzes the relationship between this model and the three models of offline supermarkets and online e-commerce through the introduction of the working principle of the model and knew the feather of the comparison of logistics information processing time, delivery quality, transportation and storage costs, total cost, and total profit. It can be seen that the online and offline integration model is more conducive to market development, but the offline supermarket and online e-commerce model are also indispensable in the market because the online and offline integration model is developed by the integration of these two models. And multiple models can maintain the diversity of the market and the arbitrariness of consumer choice and promote the sound development of the agricultural product market. There are still some shortcomings in the research process of this article, and further research is needed in the future. This article does not consider the degree of synergy between online e-commerce and offline supermarkets in the online and offline integration model of agricultural products. It only compares and analyzes the three models. It does not discuss how to coordinate the development of online and offline in the integration model. In this regard, we will study the synergy between online e-commerce and offline supermarket products in the future.

Data Availability

No data were used to support this study.

Disclosure

Qin Yu and Hui Nie are co-first authors.

Conflicts of Interest

The authors declare that there are no conflicts of interest with any financial organizations regarding the material reported in this article.

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