

Research Article

The Impact of Agricultural Information System on Agricultural Product Trading Efficiency Using Internet of Things Technology

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In order to promote the application of the Internet of Things (IoT) technology in the agricultural product circulation system and to improve the agricultural product trading efficiency in China, first, the IoT technology, IoT industrial system, and agricultural information system based on the IoT technology are theoretically expounded; then, with H Company as an example, the intelligent sensor and Radio Frequency Identification (RFID) are taken as the core part of the sensing equipment of the company's agricultural product circulation information system, the Wi-Fi/ZigBee network is selected as its intelligent sensor network layer, and ZigBee, PAN, LAN, and WAN are used as the technical support of the system to analyze the operation environment of the system. The results show that the operation speed and average signal coverage of the system are higher than those of the agricultural product circulation information system without IoT technology; from 2015 to 2019, the proportion of H Company's investment in agricultural science and technology in the total investment increases year by year, reaching 90% in 2019, and the proportion of the H Company's agricultural circulation income in the total income also shows an increasing trend. The agricultural product circulation information system can improve the agricultural product trading efficiency based on the IoT technology.

1. Introduction

With the rapid development of the international economy, the Internet of Things (IoT) technology gradually spreads to all parts of the world. The IoT technology is regarded as the core content of future scientific and technological development by various countries. It can change the development of a country by promoting economic growth [1]. The IoT technology receives great attention in various fields such as transportation, power industry, logistics industry, and agriculture [2].

China is a big agricultural country, and agriculture occupies a pivotal position in China's economic structure. However, the problems of agricultural development are resource shortages, low gains, and backward production methods. Therefore, new information technology is urgently needed in the agricultural field, especially for the agricultural products circulation [3, 4]. The application of the IoT

technology to the construction of agricultural informatization can not only improve the quality of agricultural products and agricultural economic benefits but also promote the balance of supply and demand of agricultural products and the development of modern agriculture [5].

The Ministry of Commerce of the People's Republic of China has issued relevant policies to strongly support the full use of new generation information technologies, especially cloud computing and the IoT technology, to innovate the business models and the agricultural products trading by complementary forms of online and offline [6, 7]. The State Council also emphasizes the planning and construction of agricultural product circulation information platforms and the construction of a nationwide agricultural product e-commerce platform to transmit the information on the production and sale of agricultural products to relevant trading customers at the fastest speed. Based on emerging information technologies such as the IoT technology, the

production, storage, and transportation of agricultural products can be transformed completely based on the informatization [8]. For agricultural soil moisture status (hydrogeology, fertilizers, pesticides, and climate), the use of the IoT technology can refine agricultural production and greatly improve product quality [9]. Meanwhile, the establishment of an agricultural product logistics information platform using the IoT technology can promote the balance of agricultural product production and sales, thereby avoiding the waste of agricultural resources [10]. The application of the IoT technology to the construction of agricultural product sales informatization can further improve the consumption level of agricultural products in China. It can not only meet the quality requirements of the general public for agricultural products but also increase farmers' income and contribute to the modernization of agriculture and the development of informatization.

In the aspect of IoT application, researchers introduce IoT technology into the field of transportation, put forward the concept of "Internet car," and put forward the application prospect of Internet, including emergency rescue, navigation system and voice control hands-free telephone, and give some advice. The application fields of IoT mainly include smart grid safety production, production management, and product testing, and the application of IoT in industrial production is proposed, which will promote the transformation of "made in China" into "intelligent manufacturing in China" [11, 12]. Then, some scholars put forward the application of IoT technology in modern agriculture, including intelligent greenhouse, logistics and transportation, processing management, and food traceability. The application of IoT technology in the field of military aerospace mainly includes space exploration, intelligent weapons, intelligent dust, identification friend or foe, military intelligence report, and other fields [13]. The research on the circulation information of agricultural products abroad mainly focuses on the quality assurance, vertical cooperation, information management, and value chain analysis of agricultural products. Foreign scholars put forward the general principles and framework of the design of agricultural product circulation system and point out the general mode and top-level design of the construction of agricultural product circulation information platform. In addition, some scholars also put forward the transaction mode of combining online and offline in the process of agricultural and sideline products trading and propose some constructive implementation methods [14]. However, there are not many reports on the practical efficiency of using IoT technology in agricultural information system.

Based on this, first, the theoretical basis of IoT technology is analyzed, and the components of agricultural information system based on IoT technology are introduced in detail, including intelligent sensor and radio frequency identification (RFID) sensing equipment. In addition, with H Company as an example, the agricultural information system based on IoT technology is applied to the enterprise innovatively. The information system of agricultural product circulation based on IoT is analyzed, which provides practical basis for improving the efficiency of agricultural

products transaction and the intelligent development of agricultural product circulation system. The research innovation is that a four-layer IoT structure with one more layer is constructed based on the original IoT system. The new four layers include sensing layer, transport layer, data layer, and sensing application layer. The new data layer realizes the real-time sharing function of agricultural information. It realizes the cloud sharing of agricultural information, so that the data can be transmitted in networks with different structures and can be viewed at any place. In the physical terminal equipped with IoT client, users can view the data, which truly realizes the function of real-time database of agricultural information.

2. Method

2.1. The Concept and Industrial System of the IoT. First, the IoT is a network that can form a certain interaction relationship among things. The barcodes and two-dimensional codes are used to identify and record stored information. Through a certain connection protocol, the sensing equipment that senses information such as RFID, laser scanners, and sensors can be connected at any time and any place to realize information communication, exchange, and processing. The intelligent monitoring and management of data and information are completed [15]. The IoT technology can completely change the way people think and life models. Based on the IoT technology, the communication between things and people can be achieved. The information collaborative processing is realized through the network facilities. The interconnection among thing, thing, and people is completed [16].

Second, the industrial system of the IoT includes the technology system, the industrial system, and the application system.

The technology system of the IoT includes technical fields such as perception, network communication, microelectronics, computers, and embedded systems [17]. Figure 1 shows that the IoT technology system is divided into perception technology, network communication technology, application core technology, generic technology, and supporting technology.

Figure 2 shows that the industrial system mainly involves the service industry and the manufacturing industry.

The purpose of the IoT service industry is based on the core functions of the IoT, such as positioning, automated control, environmental control, and food safety traceability. The core includes basic network services (machine-machine, in-industry-out-industry), equipment services, and software and integration services [18].

The IoT manufacturing industry belongs to the information equipment manufacturing industry, but the main goal of the IoT manufacturing industry is to design and manufacture sensing equipment, including design guidance for other equipment, which is a new high-end manufacturing industry. Software services are mainly to control and support sensing devices, such as integrated circuits for intelligent control, and embedded software systems compatible with industry. The traditional computer

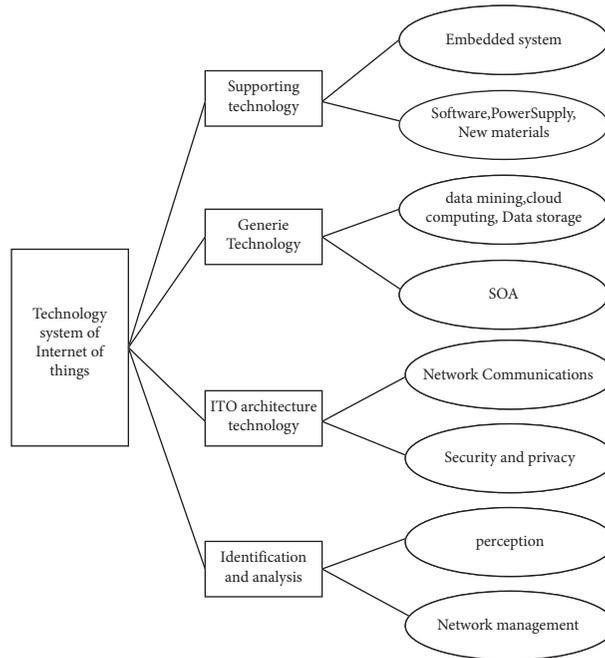


FIGURE 1: The IoT technology system.

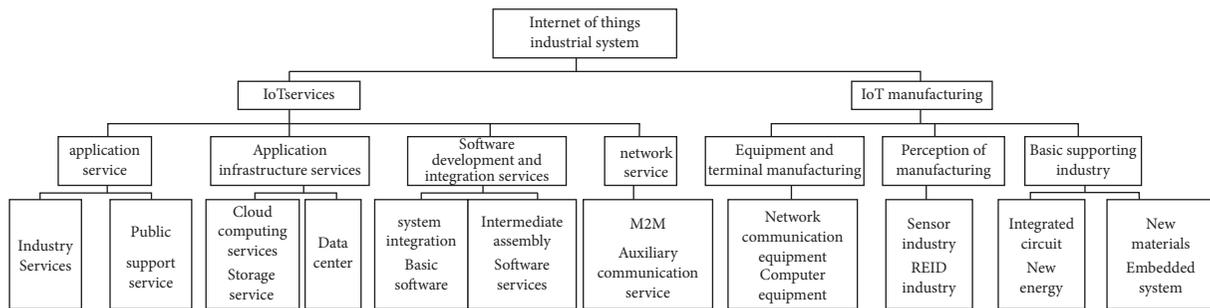


FIGURE 2: The industrial system of the IoT technology.

infrastructure is also an important part of the application of the IoT technology, so the manufacturing industry of this part is also within the scope of the IoT manufacturing [19].

Finally, for application system, the application of the IoT includes many fields, such as intelligent transportation, environmental monitoring, electronic government, agriculture, and intelligent manufacturing [20]. The emerging information technologies, such as RFID and auxiliary facilities, are inset into the things needed for human production and life, and the network is used to connect things with human society, so that people can monitor and manage things, and language communication between things and people is realized. The fine management of production and life is achieved to promote the human society to enter the intelligence era [21]. Figure 3 shows the application areas of the IoT.

2.2. Agricultural Product Circulation Informatization. First, the agricultural product circulation informatization is that the modern electronic media, such as the Internet, is used to carry out e-commerce. The circulation methods and links

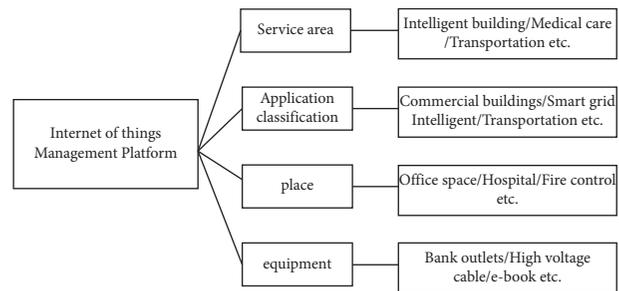


FIGURE 3: Application areas of the IoT.

of offline agricultural products are added to the Internet, and various online marketing methods are used to integrate the production, circulation, and sales of agricultural products with the help of the Internet platform. The whole process is connected through information flow fusion [22]. Its connotations include informatization of agricultural production, informatization of agricultural operation and management, informatization of agricultural science and technology, and informatization of product circulation and sales.

Second, the construction of agricultural product circulation informatization should conform to the current environment of agricultural development in China and future development of agriculture. The construction of agricultural product circulation informatization can organically unify all links in the production and sales process of agricultural products, which can not only promote agricultural economic growth but also ensure the quality and safety of agricultural products. Specifically, its role includes three aspects: improving the efficiency of information sharing in the production and sales process, increasing the economic income brought by agricultural products, and promoting the integrated operation of agricultural products [23].

Finally, the circulation methods of agricultural products are diverse, and each method has its own characteristics. The particularity of the circulation of agricultural products determines the different information construction corresponding to the circulation methods of various agricultural products. The circulation of agricultural products in China can be basically divided into three categories: the agricultural product circulation based on wholesale markets, the agricultural product circulation based on supermarkets, and the agricultural product circulation based on distribution centers [24].

2.3. Agricultural Information System Design Using the IoT Technology

2.3.1. Agricultural Product Circulation Informatization Platform Using the IoT Technology. First, construction principles: technology frontier, safety, ease of use, scalability, and openness. The construction of the platform needs to refer to international standards to ensure that the platform can be used continuously. Meanwhile, it is necessary to ensure the security of platform information and data and prevent network virus intrusion and platform data leakage to maintain the platform stability. Effective security measures can be taken for the current environment to meet the requirements of different types of customers in terms of performance, and the platform can make effective plans for new businesses under the new situation.

Second, the overall platform framework: to ensure that the particularity of the circulation links is balanced with external needs, by analyzing the circulation links of agricultural products and the corresponding information technology of each link, informatization framework of agricultural product circulation is designed based on the framework of the IoT technology. Figure 4 shows the informatization framework.

From left to right, the framework includes the application layer, transport layer, and sensing layer. The application layer includes the basic platform, application platform, and application system; the transport layer includes various data communication modes; the sensing layer includes different kinds of sensors, such as air humidity temperature and soil acidity sensor.

First, the core function of the sensing layer is to use radio waves, spectrum, infrared, and electromagnetic induction equipment to collect agricultural data that farmers can

directly use, such as light, water quality, soil, air, and vegetation planting conditions. The corresponding information coding and perception technology are used to transmit the collected information into the information center [25].

Second, the transport layer is mainly for the transmission of perception data. Its application networks mainly include Personal Area Network (PAN), Local Area Network (LAN), and Wide Area Network (WAN) [26]. Table 1 shows the specific classifications.

Finally, the application layer means that based on the IoT technology, through the joint action of the IoT data supervision and service protocols, the overall management is conducted on various perception data in the transport layer. The informatization and intelligent development of various agricultural application directions are realized such as agricultural product production and transportation, monitoring management, technical services, and information inquiry through the construction of circulation information.

A data layer is added based on the above traditional IoT infrastructure. The data layer is a private IoT cloud platform used to store farmland data and realize data encryption and whole network sharing. In the new data layer, when using HTTP protocol for communication, the server cannot actively deliver the message to the client when the client does not send a request to the server. The protocol belongs to a stateless protocol, that is, the current request of the same client and the previous request do not correspond to each other and are independent of each other. After the path is established, the client sends an HTTP request to the server. When the server receives this request, it will return the corresponding response information. After the client receives the information sent to it by the server, the information will be displayed on the web interface of the client. Finally, the connection between the client and the server will be disconnected. The main control unit responsible for controlling data acquisition, packaging and uploading is FL-EM7688 module, which takes MT7688 chip as the core and supports encrypted wireless network. In AP mode, wireless network signals can be sent. The wireless camera device can be connected with it through password for data transmission, with a maximum transmission rate of 150 Mbps.

2.3.2. Agricultural Product Production Informatization Construction Using the IoT Technology. First, the agricultural soil moisture status informatization construction: it is to use the IoT technology to intelligently monitor agricultural information and combine infrared remote sensing and Global Positioning System (GPS) [27] to collect agricultural information and know the growth status of crops. After all-round analysis, a virtual crop growth diagram is obtained. The corresponding agricultural production and management personnel can take corresponding measures according to the diagram to complete refined production.

Second, the product processing informatization construction: after agricultural products are transported to the logistics distribution center, they undergo simple processing (cleaning and simple packaging). The local RFID system is used to complete the coding of the origin and processing

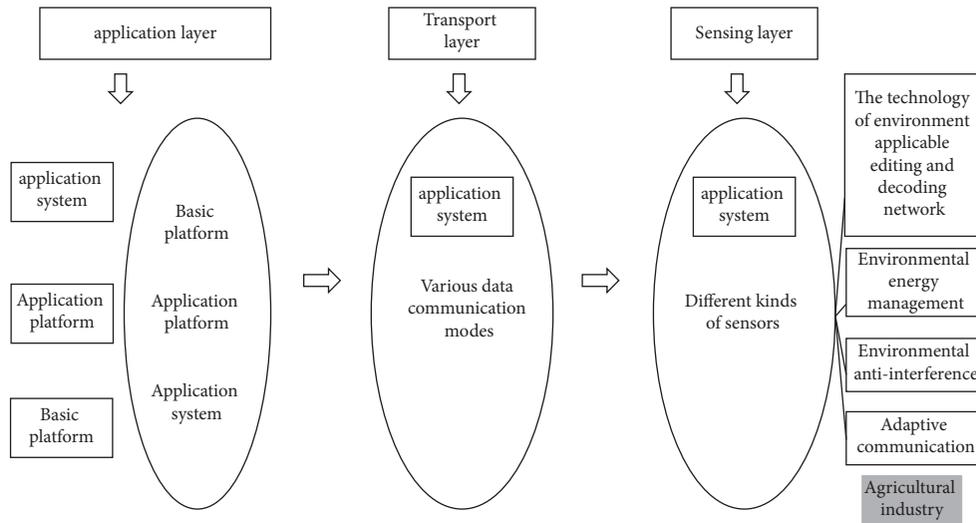


FIGURE 4: The informatization framework of agricultural product circulation using the IoT technology.

TABLE 1: The network classification of the transport layer.

The network classification	PAN	LAN	WAN
Specific coverage	ZigBee, UWB, WiFi, Bluetooth, CAN bus	Ethernet, WiMax, WLA	G PRS, CDMA, 3G, PSTN, ATM

information of agricultural products, and the coding information is input into the electronic label. When they are shipped, the delivery vehicles are tagged with electronic labels, and all product electronic label information is input into the on-board electronic label, and the electronic label information of agricultural products and the label information of delivery vehicles are input to the electronic label management center. Therefore, the distribution center can monitor the transportation of agricultural products based on the electronic labels. Consumers can also scan the labels to know the origin, processing, and delivery time to the supermarket when purchasing agricultural products in the supermarket.

2.3.3. Information Construction of Agricultural Products Logistics Based on IoT Technology. First, the agricultural products storage informatization: product storage is an important part of the circulation of agricultural products. Mass storage information is generated during the storage management process. When the storage management is carried out, the agricultural products information in the warehouse is obtained based on RFID technology [28], and the information is transmitted to the computer management center to calculate the specific location of agricultural products storage. If agricultural products are shipped out of the warehouse, the intelligent storage management system can automatically issue instructions to the forklift based on the electronic label information of the agricultural products and the input location information. After the forklift confirms the electronic label information of the agricultural products, the agricultural products are packed into the corresponding delivery vehicle. Furthermore, inventory and movement of agricultural products can be completed by using the IoT technology, the entire operation process is

recorded by the reader, and the data information is transmitted to the information management center.

Second, the agricultural product distribution informatization: the distribution link of agricultural products can connect the agricultural product supply chain, including producers, processors, and sellers. In agricultural product distribution information, the application of GPS [29] and RFID technology to monitor the transportation of products in real time is successful.

2.3.4. Information Construction of Agricultural Products Sales and Traceability Based on IoT Technology. First, the agricultural product sales informatization means that each product has an electronic label, and it is connected to the monitoring center to monitor the products on the shelf. If there is a shortage of goods, the system reminds the staff to replenish the goods in time. If the position of the goods is wrong, the system also reminds the staff to reposition them in time. Meanwhile, the IoT technology can effectively prevent the goods theft. If the goods are taken out of the supermarket without settlement, the reader/writer device installed at the exit generates an alarm sound to prevent the goods theft. The electronic label not only contains the origin and processing information of the agricultural product but also can input its production date and shelf life into the electronic label. The application of the IoT technology can not only increase the efficiency of the cash register but also promptly remind the staff of expired products. Thus, discount sales and other marketing approaches are conducted to reduce the cost of goods.

Second, agricultural product quality traceability informatization construction: the product quality traceability based on the IoT technology [30] mainly includes three aspects: one is the use of RFID technology for video information

collection; the second is the use of wireless sensors for real-time monitoring; the third is the use of GPS technology to ensure the disclosure of transportation information. In the process of product formation, the system can control the safety performance, source, and inventory of each product, provide timely warnings on food safety, and timely grasp and process agricultural product data information within the monitoring range. The agricultural product information can be upload by the network in a timely and accurate manner, so that relevant departments and consumers can use the Internet. The relevant departments can quickly and efficiently estimate potential food safety hazards and provide a data basis for scientific early warning. Consumers can also quickly query the agricultural food data information they purchase, effectively protecting their legitimate rights and interests. The safety of agricultural foods is guaranteed by a completely transparent management model.

2.4. Research Methods. The stochastic frontier analysis model (SFA), based on input-output orientation, is used to evaluate the relative efficiency. Considering the time variable stochastic frontier production function model of technical efficiency loss term proposed by Battese and Coeli [17], the general form of the model is shown in

$$y_{it} = f(x_{it}, \beta) e^{(v_{it} - u_{it})}, \quad i = 1, 2, \dots, n; t = 1, 2, \dots, n \quad (1)$$

$$s.t. v_{it} \sim N(0, \sigma_v^2),$$

where y_{it} stands for the production level of i province during t period, x_{it} stands for the input level of i province during t period, β stands for the parameter to be estimated, v_{it} stands for the systematical random error of i province during t period, which is used to measure the sample observation errors and other random disturbance errors and obeys normal distribution $N(0, \sigma_v^2)$, u_{it} stands for the technical efficiency loss of i province during t period, which obeys a semi-normal distribution where the mean value is zero, and is independent from v_{it} .

$$u_{it} = u_i e^{-\eta(t-t_0)}, \quad (2)$$

where u_{it} stands for the technical efficiency loss of i province during t period, u_i is assumed to obey a semi-normal distribution where the expectation is zero [18], i.e. $u_i \geq 0$; in formula (2), $\exp[-\eta(t-t_0)]$ stands for time variation coefficient, η stands for a degree coefficient that represents a change in the efficiency of the technology over time, when $\eta > 0$, the loss of technical efficiency decreases with the elapse of time; when $\eta < 0$, the loss of technical efficiency increases with the elapse of time; when $\eta = 0$, the loss of technical efficiency stays constant.

Therefore, according to the general form of stochastic frontier production function, formula (1), the expression of technical efficiency can be inferred, as shown in

$$TE_{it} = \frac{f(x_{it}, \beta) e^{(v_{it} - u_{it})}}{f(x_{it}, \beta) e^{(v_{it})}} = e^{(-u_{it})}. \quad (3)$$

In it, TE_{it} stands for the technical efficiency of i province during t period.

$$FE_{it} = e^{(-u_{it}/\beta)}. \quad (4)$$

2.5. System Implementation. The information resource directory management system includes four modules: exchange management, specification management, directory management, and system management. It has the functions of directory management, directory retrieval and positioning, directory service, directory audit, and data item management. It provides services for sharing agricultural information resources in combination with the exchange system. In the data exchange and sharing system, standardized security docking means are provided to realize information resource sharing and avoid new information islands. Extract Transform Load (ETL) products are adopted. Based on standard Java DataBase Connectivity standard (JDBC) and Open Database Connectivity (ODBC) interfaces, support for various mainstream database systems is realized.

Through the construction of unified identity authentication and single sign on portal, the agricultural big data management platform, collaborative office system, its integrated business systems, and data resources are integrated into the unified portal. In this way, users can carry out unified identity authentication between systems through the portal to ensure free access among multiple systems at one time. The internal data transmission of farmland depends on the field data transmission module. The module is equipped with a wireless receiving module, which can receive the wireless signal sent by the weather sensor. On the farmland data transmission module, a File Transfer Protocol (FTP) server is built to classify and store the received meteorological data. The network data transmission module is taken as the FTP client to realize the field long-distance transmission of data between the two.

The last part is the integration of the business system. It is to integrate the five business systems including the confirmation system of rural land contracted management right, the mortgage registration system of rural contracted land management right, the operation and management platform, the farmers' education and training management information system and the agricultural product price early warning system with the agricultural big data management platform, develop unified authority management function, and complete joint commissioning test.

2.6. Practical Application of the IoT Technology. The H Company is taken as an example, and H Company's agricultural product circulation information system based on the IoT technology is established.

First, sensing devices: the sensing devices include intelligent sensors and RFID. The intelligent sensors are characterized by low cost, small size, low energy consumption, and flexible performance. To a certain extent, the

performance of intelligent sensors represents the performance of the entire IoT. Advances in intelligent sensor technology can transform the IoT industry. RFID also belongs to the core of the IoT technology, and it is generally used in logistics and food traceability in agriculture.

Second, the intelligent sensor network layer: the core task of the intelligent sensor network layer is to control and manage the sensor network, perform protocol conversion, and assist data transmission. The intelligent sensor network layer functions with sensors such as ZigBee [31] and transmits the information collected by the sensing layer to Machine to Machine (M2M) and performs conversion according to the corresponding protocol. There are three types of intelligent sensor network layers, including wired network layer, Wi-Fi Bluetooth network layer, and Wi-Fi ZigBee network layer. Table 2 shows the performance comparison of the three network layers.

Third [32], M2M platform can connect application platform and mobile terminal, and it is open to the application platform. It can import applications with different performances. When it is closed for mobile terminals, it uses the same protocol for communication as the platform does. The application platform includes the control platform, the business platform, and the information platform. The terminal includes data transmission-type data equipment, metrical equipment, and sensors.

Figure 5 shows the IoT technology-based agricultural products circulation information system of H Company.

2.7. Technical Support of H Company's Agricultural Product Circulation Information System. The core part of its sensing equipment is intelligent sensors and RFID, and its role is to monitor soil nutrition and fertilization, insect disease prevention, collection and management of farmland information, environment, and pollution. The intelligent sensor network layer transports the information collected by the sensing layer into the M2M platform and conducts management, protocol conversion, and data transmission on the sensor network. M2M is open to the application platform and can be accessed to different functions, but it is closed to mobile terminals. It uses the same protocol for communication as the platform does. The applications of agricultural product circulation include smart greenhouses, smart irrigation, smart storage, and traceability of agricultural products. The applications of agricultural product circulation [33] include smart greenhouses, smart irrigation, smart storage, and traceability of agricultural products.

As for the agricultural product circulation information system, the stability and flexibility of the network are very strong, so the Wi-Fi/ZigBee network layer is selected.

First, Zigbee is selected as the sensing layer, its frequency is universal 2.4 G, and the rate is 250 Kbps. The communication distance is [100, 1000] m, and it is in a low energy consumption state. Second, three types of networks are selected as the transport layer, namely PAN, LAN, and WAN [34]. Finally, the application layer is composed of a functional support platform, a network

connection platform, an information analysis platform, a security control platform, and a service platform to realize collaborative management, data processing, information storage, and service performance for industries or users.

Table 3 shows the operating environment of the agricultural product circulation information system.

3. Results

3.1. Performance Comparison of Agricultural Product Circulation Information System Using the IoT Technology. First, the functions of agricultural IoT information management system are tested, including data transmission test, classification model correctness test, and the use of PC client application. The basic functions have been realized, and the working state of the whole system is normal. Internet transmission is realized through the network data transmission module. After accessing the communication network, the data can be uploaded to the cloud storage platform. In any terminal equipped with a client, users can view the data and truly realize agricultural data sharing by obtaining permissions through account and password.

The performance of the agricultural product circulation information system of H Company without using the IoT technology is compared with that of the agricultural product circulation information system based on the IoT technology, and Table 4 shows the results.

Figure 6 shows the comparison of system operation rate and average signal coverage.

Figure 6 shows that the agricultural product circulation information system based on the IoT technology has higher system operation rate and larger average signal coverage than those of the agricultural product circulation information system without the IoT technology. In particular, the average signal coverage of the former is nearly twice as large as that of the latter.

The popularization of the IoT technology in the agricultural field is relatively slow, because the popularization of the IoT technology requires high investment and has slow recovery. However, the benefits of the IoT technology to the agricultural product circulation information system are obvious. Therefore, a new type of agricultural industry information service system should be actively established in China to form an intelligent business model, so that the agricultural industry chain can truly serve people and farmers can truly benefit. The popularization and application of IoT in agriculture requires agricultural enterprises to conquer and break through its core technology. Only by breaking through, overcoming, and surpassing the bottleneck of core technology, can it be transformed into independent research and development based on independent products, so as to form the industrialization of some core technology. The results show that the agricultural product circulation information system based on IoT technology has high efficiency and wide signal coverage, which is consistent with the research results of Liu et al. [35].

TABLE 2: The performance of the three network layers.

Network layer	Wired network layer	Wi-Fi Bluetooth network layer	Wi-Fi ZigBee network layer
Network stability	Strong	Weak	Strong
Network flexibility	Weak	Strong	Strong
Network anti-interference	Strong	Weak	Medium

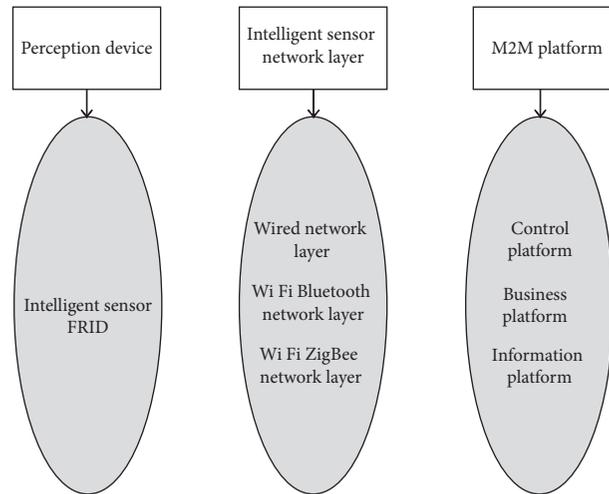


FIGURE 5: The IoT technology-based agricultural products circulation information system of H Company.

TABLE 3: System operating environment.

Equipment	Operation system	Application server	Database	Development tool	Browser	Modeling tools
Introduction	Windows 2000 Server and above	Jboss	Sql Server2000 and above	Sql Server2000 and above	Internet Explorer	Rational Rose Enterprise

TABLE 4: System performance comparison.

Type	Operation rate	System stability	System flexibility	System anti-interference
Agricultural product circulation information system without using the IoT technology	Weak	Weak	Weak	Weak
Agricultural product circulation information system based on the IoT technology	Strong	Strong	Strong	Strong

It will enable China’s agriculture to occupy the market in the fierce international market and then gradually occupy the commanding height of international agricultural industry development, forming an absolute advantage and surpassing other countries. It is also conducive to the development of China’s agriculture, laying a solid foundation for the safe and controllable production and sustainable development of industry.

3.2. *The Impact of the Agricultural Product Circulation Information System on the Trading Volume of Agricultural Products Using the IoT Technology.* H Company’s research and development investment in agricultural product circulation information system based on IoT technology from 2014 to 2019 is analyzed, as shown in Figure 6.

Figure 7 suggests that the annual total agricultural investment of H Company from 2014 to 2019 shows an upward trend, and the proportion of agricultural science and technology investment in the total agricultural investment also presents an upward trend.

Figure 8 shows the comparison of the impact of the agricultural product circulation information system using the IoT technology on the trading volume of agricultural products of H Company from 2015 to 2019.

Figure 8 shows that from 2015 to 2019, the proportion of H Company’s investment in agricultural technology in the total investment had increased year by year, and the proportion accounted for 90% in 2019. The proportion of H Company’s income from agricultural circulation in the total income also increased year by year, and it accounted for 81% in 2019.

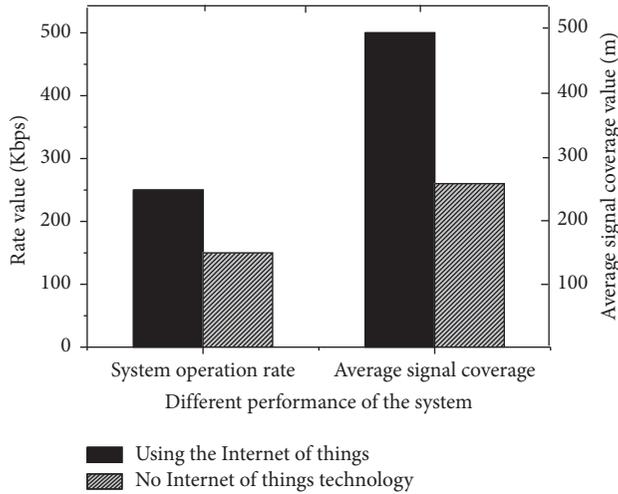


FIGURE 6: System operation rate and average signal coverage comparison.

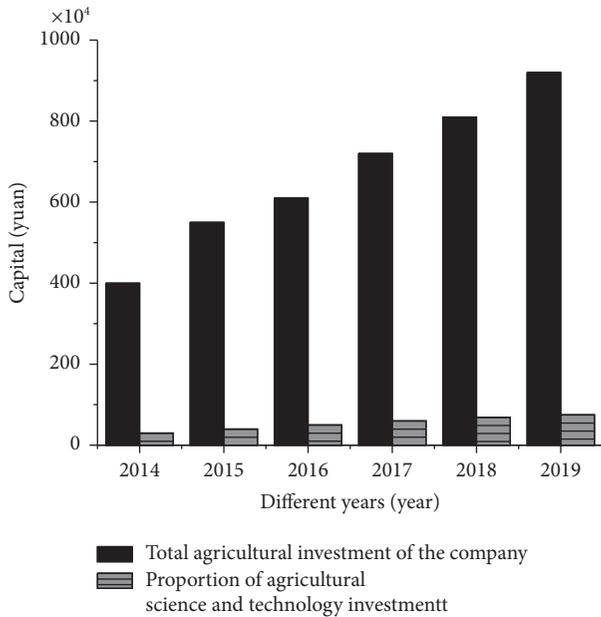


FIGURE 7: Investment in agricultural science and technology related to agricultural products of H Company.

A new agricultural industry model based on the IoT technology should be established, such as the agricultural product network supermarket. It enables modern agricultural product circulation and management to truly achieve high production and high returns, so that the application of the IoT technology is no longer limited to the government’s public needs in China, but to efficiently release the consumption needs of corporate users and consumers.

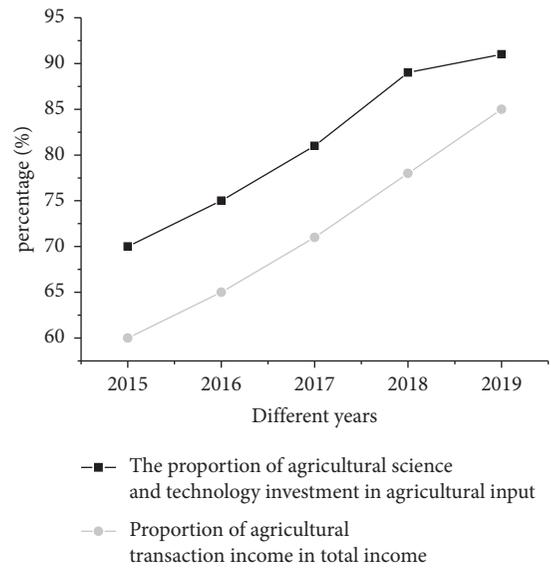


FIGURE 8: The impact of agricultural product circulation information system on agricultural product trading using the IoT technology.

4. Conclusions

Through the theoretical overview of the IoT technology, the agricultural product circulation informationization, and the agricultural information system based on the IoT technology, the H Company is taken as an example to introduce its agricultural product circulation information system based on the IoT technology. The intelligent sensors and RFID are selected as the core part of the sensing device, Wi-Fi ZigBee network is used as its intelligent sensor network layer, and Zigbee, PAN, LAN, and WAN are adopted as the technical support of the system. The stability, flexibility, operation rate, and anti-interference of the agricultural product circulation information system based on the IoT technology are stronger than those of the agricultural product circulation information system without the IoT technology, and it also improves the agricultural product trading efficiency.

Due to the limited personal ability, there are some deficiencies. Because of the lack of complete, and long-term serial data on the circulation direction of agricultural products, the data used are between 2015 and 2019, and the complete trend of agricultural product trading efficiency cannot be directly analyzed from the perspective of data. The comparative study between the agricultural product circulation information system based on the IoT technology and other different types of agricultural product circulation information system will be the research focus in the future to promote the intelligent development of agricultural product circulation system in China.

Data Availability

The data supporting the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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