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Research Article

Study on the Factors Effect of Adopting Application in Agricultural Products Supply Chain

Chuang Lu, Ning Yang, Chun-meng Wang, Xiu-yuan Peng, Bo Wang, Xiao-lei Hou, Bing Bai and Liang-shan Feng
Liaoning Academy of Agricultural Sciences, Shenyang, Liaoning, China

Abstract: Under the intense impact of global competition, the agriculture of our country appeared the characteristics of low level of industrialization, the low level of management, the value chain of low level, low degree of information technology, organizational dispersed and in recent years the continuous emergence of food quality and safety problems, such as China's agricultural development has sounded the alarm. In order to improve the agricultural supply chain operation efficiency and competitiveness is the key to the problem of solving. Application of Internet of things in the agricultural supply chain helps to improve the agricultural supply chain information technology level, so that the operating efficiency of the supply chain of agricultural products to enhance the whole supply chain integration, the. This study establishes a can optimize the facilities fruit and vegetable cultivation resources, reduce production cost and improve the facility cultivation of a set of decision system of cultivation technology level, reduce the facilities fruit and vegetable production cost, improves the product yield, quality and market competitiveness, not only the follow-up research and popularization of agricultural technology of the Internet of things to lay the foundation, but also can effectively to enhance agriculture IOT application level and has practical application value and practical significance.

Keywords: Agricultural facilities, agricultural means of production, environmental monitoring, internet of things, pest and disease diagnosis, supply chain

INTRODUCTION

The evolution of our country agriculture is modern agriculture from traditional agriculture. Facility agriculture is an important form of modern agriculture, fruit and vegetable is the main form of facilities agricultural facilities and efficient agriculture, also is the important symbol of modern agriculture, has become the main way in our country agriculture pillar industries and increasing the income of farmers (Yang *et al*., 2015; Zhang *et al*., 2010). In recent years, solar greenhouse, plastic greenhouse in our country has many places in application, development is rapid, but there are still problems facilities simple, extensive management and so on, seriously affecting the quality of agricultural products. Therefore, improvement, facility agriculture technology change the mode of production is an urgent demand, the Internet of things as a new generation of information technology, provides the technical support for the development of facility agriculture, has brought new opportunities. At present, China's agricultural facilities according to the current situation of the development, the introduction of the Internet of things technology in facility agriculture, the key technologies need to focus on include agricultural information acquisition and application in industry of two big aspects (Wu *et al*., 2009).

The development and regulatory of agricultural means of production are directly related with the production of food, farmer's income and the order of market (Xin and Sane, 2001; Li and Chen, 2011). It plays a vital role in ensuring the quality and quantity of agricultural products. But in recent years, the business system of China has investigated tens of thousands of cases of fake cultural materials including many kilograms of substandard seeds and many kilograms of substandard fertilizer. These fake agricultural products will bring enormous loss to the farmers. In China, one of the important reasons why we cannot eliminate the problem of fake and shoddy agricultural products is that China has not established a reasonable sound agricultural supply chain (Kim *et al*., 2000). Existing agricultural supply chain has disadvantages in decentralized management and lacks of convergence. So a safe, efficient, smooth and perfect operation of the network system of agricultural products cannot be established. It is the technology of internet of things that solves the above problem by providing a feasible and efficient solution (Lavate *et al*., 2010; Sun *et al*., 2009). In our current environment, the internet of things, with its real-time, accurate and shared

Corresponding Author: Chun-meng Wang, Liaoning Academy of Agricultural Sciences, Shenyang, Liaoning, China

characteristics, will bring great changes to the technology for establishing a smooth flow of agricultural logistics and supply chain information.

In this study aiming at the existing problems of agricultural facilities, with the sensor technology, wireless communication technology, database technology and other agricultural resources of Internet of things technology as support and facilities to carry out agricultural IOT application of key technology research and application system development, the establishment of a fruit and vegetable cultivation can optimize the facilities resources, reduce production cost and improve the facility cultivation of a scientific decision system cultivation technology level, reduce the production cost of facility vegetable and fruit products, improve product yield, quality and market competitiveness, enhance the level of agricultural industry facilities. In the agricultural information processing and application infrastructure, application of facility agriculture IOT is mainly embodied in the realization of intelligent agricultural production.

LITERATURE REVIEW AND TECHNOLOGY

The development of internet of things: The development of Internet of things to major technological breakthroughs in various sensing technology, network communication technology and information processing technology and development needs as the foundation, with the leading role in economic development and social development (Xing and Fu, 2010). In recent years, the Internet of things as a new industry has been the rapid development of Internet, it extends the application space of development, the innovation and development of sensor, RFID equipment, wireless sensor network, mobile broadband Internet and intelligent information services and other emerging industries and applied technology.

agricultural supply chain and provides a critical

The network can realize the automatic identification of objects and locate, track, monitor and trigger the corresponding event (Rahimi-Vahed and Mirzaei, 2007). It makes use of RFID technology for scanning and reading EPC tags on the items and achieves automatic identification of goods and information sharing. At present, the architecture of the Internet of things is divided into three layers: the sensing layer, network layer and application layer. System structure was shown in Fig. 1 of the Internet of things.

The network layer is used for bearing the perception of data transmission in a wide range, including mobile communication network (2/3G, LTE), the Internet, radio and television networks, satellite communications network, network etc. After the construction of the third generation mobile communication networks and broadband optical network, the existing network infrastructure to meet the basic needs of the primary stage of the application of Internet of things. The application layer includes the industry application and Middleware of business field, through osmosis technology applied to public security, agriculture, automobile manufacturing, environmental protection industry, industry application technology of Internet of things. Business middleware curing many common functions, in practical application, need two to meet the personalized needs of the business development, are generally constructed based on traditional middleware, adding device connection and graphical configuration display module and so on.

Self-organizing sensor network digital link coding, modulation and demodulation technology based on data transmission, realize sensor and sensor nodes in the LAN between, networking, traffic management, routing technology based on self interaction, organization and

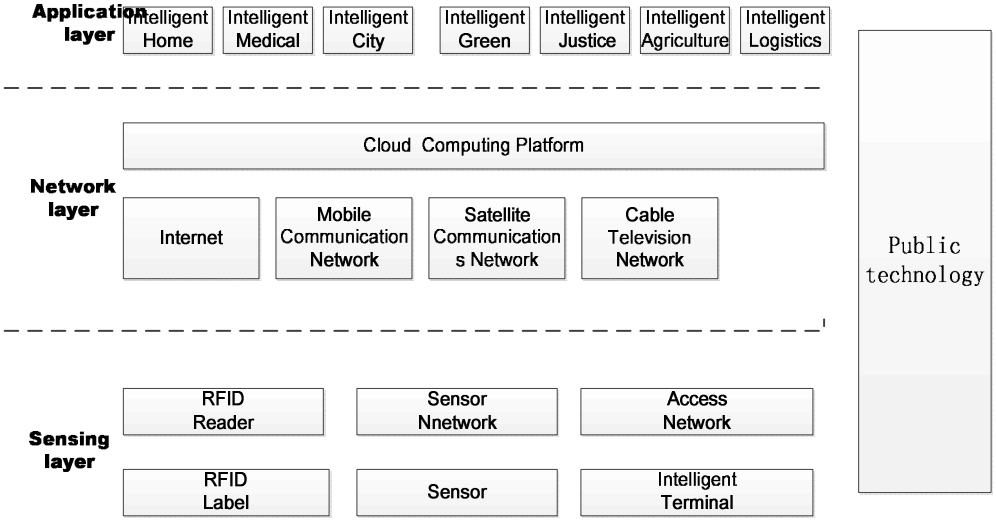

Fig. 1: Three-layers system structure

coordination among the nodes. Middleware includes embedded middleware, sensor network middleware, application in the sensing layer, in order to solve the problem of equipment management and data management, including configuration, calibration, fault detection and data conversion, such as loading. When the complete data collection, in order to effectively reduce the data redundancy, improve the quality of data, also need to data fusion, compression, clustering, recognition and other information processing technology to the original coordinate sensing data processing based on.

The key technology of the internet of things: The internet of things involves a lot of new technologies, whose core technologies include RFID, sensor technology and network communication technology and cloud computing (Zhang *et al*., 2008). The Radio Frequency Identification (RFID) is a non-contact automatic identification technology and obtains relevant data by automatically identifying the label (tag) on the objects (Huynh, 2008). It is one of the most critical technologies in the technologies of internet of things. Sensor technology is mainly responsible for the information collection of internet of things. It is the basis to achieve the perception of real-world, service and application. It is the sensor that exchanges changes in the real world into quantitative data and sends these data to specified location through certain techniques.

The technology of network communication includes a variety of wired and wireless transmission technology, switching technology, network technology and gateway technology, which is the basis of perceiving and communicating information between objects. The Cloud Computing is the products that combine traditional computer technology with network technology including grid computing, parallel computing, distributed computing, utility computing, virtualization, network storage, load balancing and other traditional computer technology and network technology. Sensor is based on accuracy and some rules to be measured into easy to identify the relationship between, a physical quantity measuring device and application.

Formal due to RFID with these advantages, RFID has been applied to many fields, create great value for society. In recent years, as the Chinese government policy to promote, the application of RFID in the field of our country has been very extensive, RFID in the electronic ticket, highway automatic toll collection, railway automatic train identification, food safety, supply chain management and many other application fields have many mature case. The RFID system generally consists of three parts: tag, reader and antenna. The label by coupling components and chips, each label is the only electronic coding for recognition of objects; reader for reading the label information; main antenna for emitting radio frequency signals, in order to guarantee the communication quality inspection of the tag and reader.

The architecture and application system of the internet of things: There is a popular view that the internet of things should be a three-tier system including the layer of perception, the layer of network and the layer of application. The layer including RFID tags, readers, cameras, sensors, sensor network and so on, which mainly solutes the problems of perceiving, recognizing objects and collecting information. It is a mature part of the internet of things. It is the infrastructure for the internet of things to realize universal service. It will direct towards the combination of the layer of perception and the layer of application in the future. The layer of application is a layer that combines the internet of things with the technology of specific industry. It is the layer of application that realizes the deep integration between the technology of the internet of things and the technology of the industry expertise. The internet of things almost applied in all areas of industry, including precision agriculture, industrial control, building control, vehicle scheduling, environmental testing, remote diagnostics, smart home and urban management. Among them, agriculture is one of the most extensive areas.

Organizational level of information technology adoption behavior theory: The implementation of the system of Kwon and Zmud will be the innovation diffusion process is divided into six stages: the question proposed, adoption, adaptation, acceptance, specification, fusion model. At the same time, Kwon and Zmud through the study on driving factors of the implementation of the various stages of process and outcome effects on the system, these factors include: the factors of user group characteristics, organizational characteristics, technical features, application of new technology of task characteristics and environmental characteristics of five kinds of effects of organization.

Tornatzky and Fleischer is the critical theory of classical diffusion of innovation, factors that influence the diffusion of information technologies not only contains the characteristic elements of the Technology itself (T), also contains the Organization characteristic elements (O), Environmental factor (E). The TOE framework is proposed, because of its wide applicability, many scholars at home and abroad based on TOE framework is studied, also studied the factors contained in this framework. The technical characteristics of the characteristics of technology itself, including technical compatibility, complexity, organizational factors include the size of the organization, high-level support, organizational culture, the environmental factors include external competition pressure, the government policy support.

ANALYSIS OF AGRICULTURAL SUPPLY CHAIN

The architecture system of the internet of things for agricultural supply chain: This study argues that the system architecture of the Internet of Things for agricultural supply chain can also be divided into three layers including the layer of perception, the layer of network and the layer of application. It is shown in Fig. 2.

The layer of perception in the internet of things for agricultural supply chain contains the tag EPC, mobile reader RFID, sensor network and other sensing devices. In this layer, we should focus on solving the problem of perceiving and recognizing objects and collecting information. The main technology in this layer involves the technology of RFID, sensing, control and short-rang wireless communication. The information on tag EPC of agricultural products will be collected by RFID. Then it will be sent to the next layer, the layer of network.

In the layer of network, the local server sorts and filters code EPC that can be identified by reader RFID in order to send them to the local ONS. The local ONS calculator queries automatically and sends the collated EPC to the specified domain root ONS servers to obtain the required advice. Second the root DNS server send one or more EPC domain names corresponding to the IP address of PML server back to the local ONS calculator. Then the local ONS calculator sends the IP address back to the local server. At last the local server contacts with the correct PML server according to the correct IP address to obtain the required EPC of agricultural products.

The layer of network will use the processed data from the internet of things to get information about agricultural products and ultimately achieve real-time monitoring, process control, information sharing and discerning and so on.

Analysis of the internet of things for agricultural supply chain: In the traditional agricultural product supply chain, the data about the information of agricultural products is mainly collected by means of manual and bar code. This can easily result in delays, errors and lack of information of the internet of things for agricultural supply chain. And it will make logistics and information flow distorted in the transmission process. The application of the internet of things on agricultural supply chain can build a system that can control and trace the quality of agricultural products by combining agricultural supply chain with farmers' purchase.

The technology of RFID and cloud computing integrate the information of production, distribution and safety of quality in the agricultural supply chain effectively. It will ultimately combine the farmers with the internet of things and make transparency of the entire agricultural supply chain process. It is useful to establish a system that monitors and traces the quality of agricultural materials. The agricultural supply chain management based on the internet of things can process the logistics information of every aspect including the production, procurement, storage, transportation and sale. The system can sent exact number and right quality of agricultural products such as pesticides, fertilizers and seeds to appropriate places for meeting the needs of farmers in right price at the right time.

System integration scheme:

The technical route: On the whole, integrated agricultural production facility management system need solve information acquisition, information processing, information services three key technical problems. The "access to information" part of facilities fruit and vegetable planting key information collection, acquisition and transmission, as the basic data source of upper layer application service system; "monitoring processing" effective data acquisition is responsible for the storage, the basic condition to realize information analysis, statistics and application services; and "information service" part around the business application system, providing personalized service content.

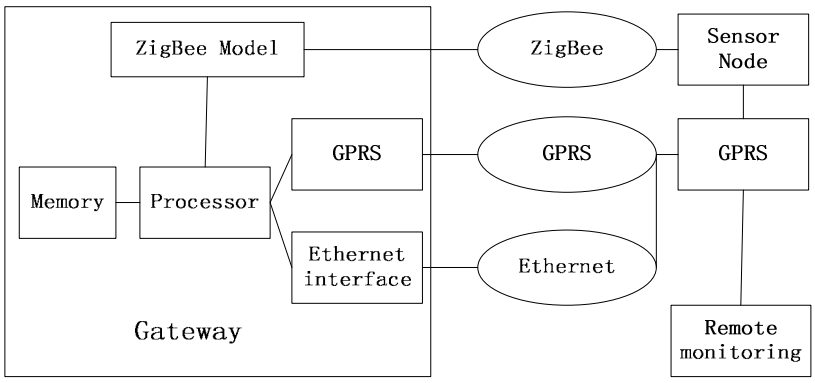

Fig. 2: The architecture system of the internet of things for agricultural supply chain

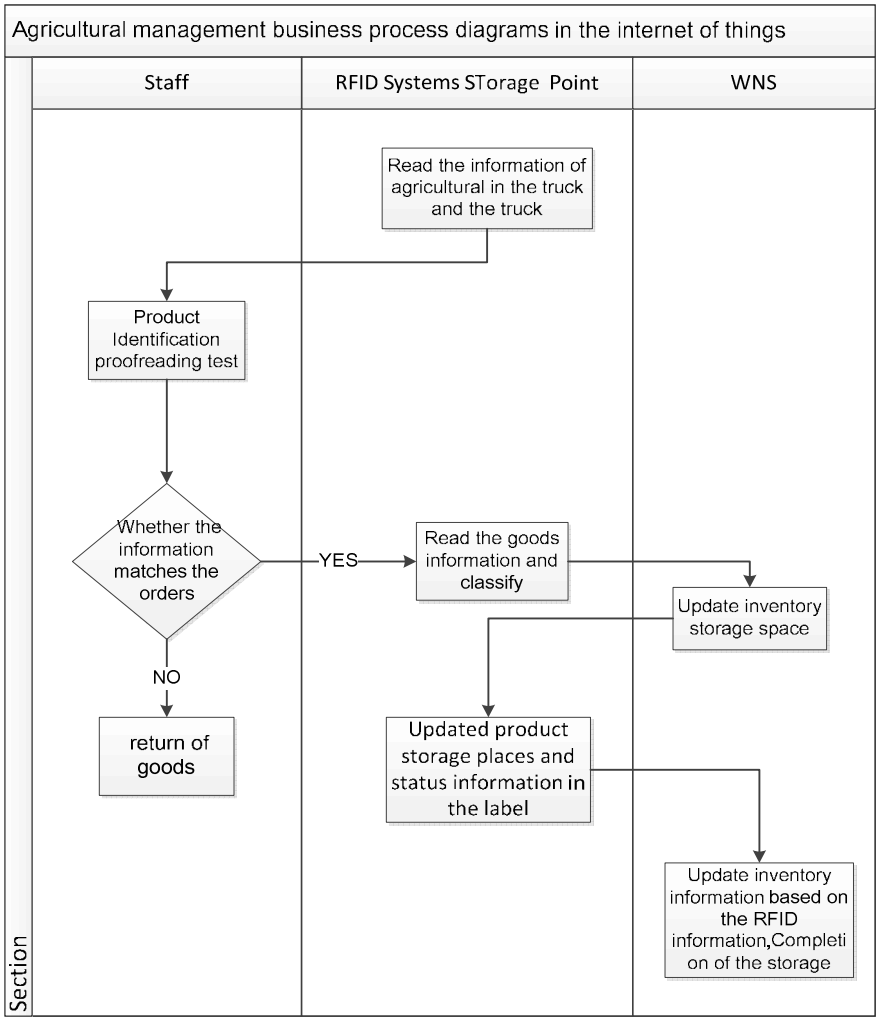

Fig. 3: Facility agriculture production management of the internet of things based on the schematic

To solve the above problem, the system relies on agriculture IOT technology to solve the problem of information acquisition and transmission, sensor and sensing technique based on the (air temperature and humidity, soil temperature and humidity, illumination and other kinds of agricultural sensor), the realization of information perception is more thorough, based on sensor network (Zigbee, WiFi), Internet (Ethernet, GPRS) implementation the interconnection of a more comprehensive. Service oriented government, agricultural enterprises, farmers and the public to provide personalized, ubiquitous.

Facility agriculture production management of the Internet of things based on the schematic was shown in Fig. 3.

Transportation stage: In the transportation stage of agricultural products, installing GPS positioning system on the vehicles enables the managers to know the location and state of the vehicles that transport the agricultural products and adjust driving direction timely in an emergency. At the same time, installing wireless data acquisition system on the vehicles can not only learn the basic information and quantity of the goods, but also detect and prevent the lost and stolen goods during the transportation.

The network structure of agricultural product supply chain management system of the Internet of things was shown in Fig. 4. The system mainly consists of farms, processing plants, distribution centers, distributors four network center and the Internet of things based supply chain management information center. Breeding base, processing plants, distribution centers and retailers three node network layout of roughly the same, mainly includes the RFID/EPC tag, RFID reader, with a temperature sensor RFID/EPC tag, PDA, ONS server, EPCIS server, database, workstation, the intra node communication equipment through the internal LAN, RFID/EPC tags and temperature sensor information to nodes within the database through a wireless network; supply chain management information center by the workstations, switches, the central processor, GIS server, ONS server,

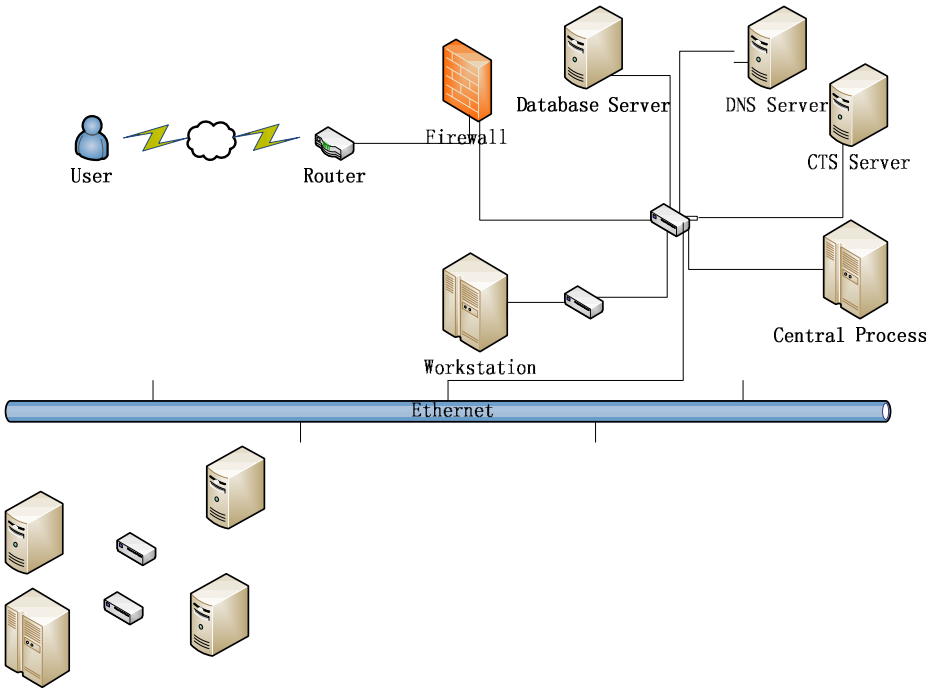

Fig. 4: The network structure of agricultural product supply chain management system

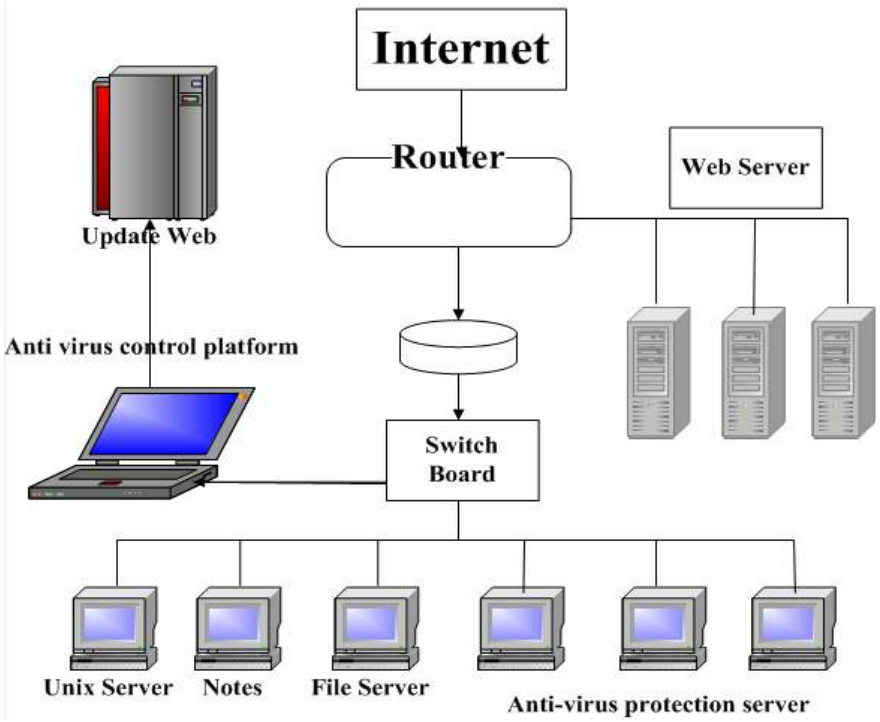

Fig. 5: Agricultural production management system infrastructure

database server and other components, its interior also through the LAN communication; between the processing plant, distribution center, retailer and supply chain management information center through the high speed Ethernet connection to other users are connected through a network and supply chain information management center (Fig. 5).

The system function design: Facility agriculture production management system generally includes

information monitoring network, database system, application software is composed of three parts.

The application software of the system: System application software provides software services for the majority of cooperatives, planting large, facility agriculture enterprise and so on the end user. Application software system consists of three application subsystems, unified deployed on the server, the user only needs to have the service terminal can access the Internet, can be the use of software services.

The database: Database system is the core content of the system research and development facilities, storage of fruit and vegetable planting key link sensing data, centralized management and realize the harm pest by distributed database system data, planting environment classification of data storage and classification of sharing, is the entire system data source.

Information monitoring network: Aiming at the problem of access to information, need to plant the key link in the facilities of fruits and vegetables, setting information monitoring points, the formation of fruit and vegetable greenhouse environmental information monitoring network, the realization of the fruit and vegetable production information collection.

The use of the Internet of things technology deployment of sensors, video cameras, data transmission node and other agricultural production environment sensing and transmission equipment and data facilities greenhouse information monitoring network to build intelligent. Network monitoring is the foundation of the whole system and provide the basic data resources for facilities planting vegetable fine management.

Sale stage: The application of the internet of things in the stage of agricultural products' sale can be reflected in the statistics, security and validity monitoring forms. Farmers can determine whether the agricultural product is expired according to the production date EPC tags and then judge its quality. When the accident occurred in agricultural products, manufacturers, distributors, or farmers can find the final consumer by traceability system and find the places that occurred problems. This will help form a chain of efficient management and query.

THE ROLE OF INTERNET OF THINGS

Purify agricultural material market: The agricultural supply chain based on the technology of the internet of things is a chain of setting production, storage, distribution and retail in one to provide a traceable RFID carrier to confirm the authenticity of the agricultural products. Relevant information about agricultural products can be found from tag RFID. This will face the producers directly and eliminate the fake products completely. It will strengthen quality control

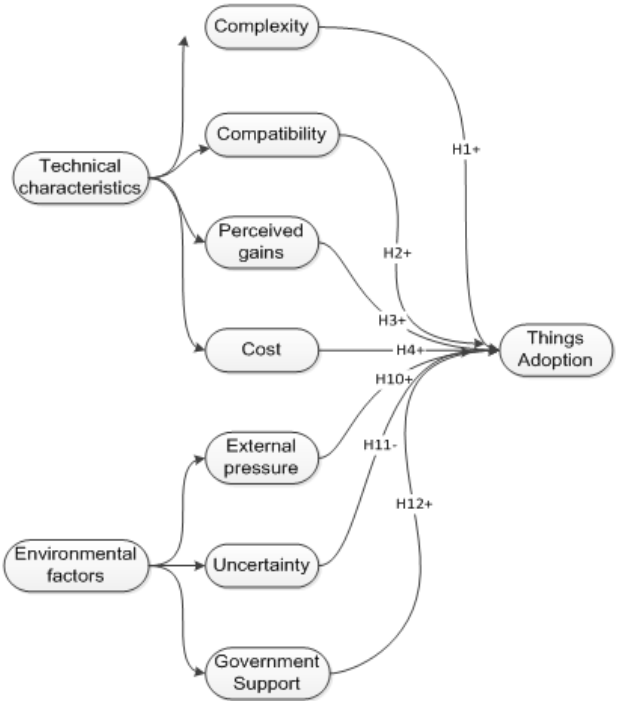

Fig. 6: The internet of things technology this study adopted model

Table 1: Fit indices measurement model

Fit indices	Chi square value	GFI	RSMEA	CFI	NNFI
Theory value	Smaller	>0.60	>0.80	>0.90	<0.10
					<0.05
					<0.01
Real value	533.3	0.94	0.83	0.92	0.062

and purify agricultural market by controlling the import and export channels. The Internet of things technology adopted model of this study was shown in Fig. 6. Factors shown in the figure are classified according to the T-O-E model. Diagram '+' said positive influence factors on the Internet of things technology adoption, '-' said factors network reverse influence technology adoption.

Reduce the burden on farmers: The agricultural supply chain based on the technology of the internet of things makes each step of the supply chain improve the transparency greatly. Tag RFID can automatically record the entire supply chain of agricultural products in the flow-from production to final farmers. It can not only greatly reduce the "bullwhip effect", inventory costs and labor costs in logistics center, but also improve inventory utilization. And then it will lower agricultural products price to give benefits to farmers and reduce their burdens.

The purpose of this study is to identify the key factors in the agricultural products supply chain effect of Internet of things technology adoption and the analysis of the various factors on the impact of the Internet of things technology adoption. Therefore, in order to achieve these objectives, needs analysis of the data collected through the investigation and the data were analyzed by statistical analysis method suitable. Analysis of the data involving many variables: variables (items), endogenous latent variables (adoption intention), exogenous latent variables (factors), so this research chose the Structural Equation Modeling (SEM) as a data analysis method.

Structural Equation Model (SEM) is the application of a system of linear equations to show that the statistical method of relations between observed variables and latent variables and latent variables and latent variables. Structural equation contains parameters, random variables, may sometimes contain non random variable. Among them, the random variable contains the observed variables, latent variables and the error variables.

Serve the agriculture, rural areas and farmers better: The agricultural supply chain based on the technology of the internet of things can guarantee the supply of cultural materials and serve every link of agricultural production well. It will improve the efficiency of agricultural supplies and meet the needs of agricultural products by adopting advanced management concepts, management tools and distribution methods of agricultural products.

Business process analysis framework and network provides a good way for enterprises based on network, as the networking technology application in the agricultural supply chain provides a reference guide; adoption of agricultural enterprises of Internet of things technology. Analysis on Internet of things technology adoption drive factors, can make agricultural enterprises to understand what are the key factors affecting the adoption of Internet of things technology, can focus on these factors in the process of technology adoption, make things better, faster to implement in the agricultural products supply chain.

Test of goodness of fit: The agricultural supply chain based on the technology of the internet of things can promote the large-scale sales of agricultural products and make the services of agricultural technology standardization by using the way of modern logistics and marketing. This will improve the efficiency of the supply of agricultural enterprises and service level. At the same time it will enhance the competitiveness of China's agricultural enterprises.

By using the chi square test results are as follows: CMIN = 583.32, p = 0.03, in the 0.05 level of significance, the null hypothesis is not rejected, the fitting degree of model teaching. At the same time, index of GFI = 0.961, the other NNFI = 0.83, CFI = 0.912, RSMEA = 0.063 and the rational value of contrast, NNFI close to the rational value, the rest of the indexes such as the acceptable range, this also shows that the overall fit of the model is better. Fit indices measurement model was shown in Table 1.

CONCLUSION

Through the comprehensive agricultural development status analysis of the existing facilities, the comparison of domestic and agricultural facilities inadequate was discussed. According to the existing technical conditions, the theoretical basis for the system design of facility agriculture production management. In order to solve the above problem, the application of new technology is a feasible method. In this study, the applications of the Internet of things technology to the agricultural products supply chain, in order to improve the operation efficiency of the supply chain of agricultural products, promote the development of agriculture in our country. Of course, there are many factors affect the adoption of agricultural products supply chain of the Internet of things. There is still a long run for the internet of things to enter into the practical stage of agricultural supply chain. There are

also many problems for the internet of things to solve, which include how to reduce costs, carry on the R&D of core technology, develop industry standards, protect the privacy and so on. But the internet of things based on RFID technology has been integrated into all aspects of supply chain management and it will has a significant impact on the development of supply chain management.

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