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Perception Data Fusion of Agricultural Products Supply Chain Based on Internet of Things

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Abstract: With the continuous development of the logistics industry and big data technology, the integration of traditional industries and the Internet of Things has become the trend of the times. However, agricultural product quality problems occur from time to time in multiple links such as the production and circulation of agricultural products. Therefore, the agricultural product supply chain based on the Internet of Things has gradually received attention. The purpose of this paper is to study the application of perception data fusion of agricultural products supply chain based on internet of things. In order to study the application of perception data fusion of agricultural products supply chain based on Internet of things, this paper analyzes the status quo of agricultural products industry traceability platform and extracts other product supply modes based on the Internet of things technology. After analysis and comparison, it comes to the perception data fusion mode suitable for the agricultural product supply chain, and uses the information technology based on the internet of things to carry out the agricultural product circulation process Internet of things transformation and process optimization. The results show that the application of data fusion based on the internet of things can solve 69.45% of the agricultural products whose origins are unknown and cannot be traced, improve the supply efficiency of agricultural products by 43%, reduce the health problems of agricultural products by 31.24%, reduce the prices of agricultural products by 13%-20%, improve the logistics efficiency and save about 5 million tons of agricultural products. Therefore, it is necessary to study the application of agricultural product perception data fusion based on internet of things.

Keywords: Internet of Things Technology, Agricultural Product, Supply Chain Awareness, Data Fusion

1. Introduction

The perception features of the Internet of things dynamically detect the objects with identification function tags, read the object attributes, and then convert the information into the format that can be transmitted through the network, so as to realize the mutual recognition between things. There are three levels of the Internet of things: terminal equipment or subsystem, communication connection system, and management and application system. The sensing layer is mainly composed of intelligent data acquisition device and transmission network before data access gateway, including RFM tag and reader, sensor, actuator, WIFI, ZigBee, Bluetooth, infrared and radar. Through the perception layer of the internet of things, the real-time perception of various physical entities in the physical world can be realized, and the attribute information of physical entities can be collected and captured, so that they can be transmitted and identified.

Before the emergence of the Internet of things, China's agricultural intelligent technology has a good foundation. RFID technology can identify high-speed moving objects and multiple tags at the same time[1]. With the continuous development of science and technology, sensors have gradually realized miniaturization, intelligence, informatization and networking, and have experienced a development process from traditional sensors to intelligent sensors to embedded web sensors [2]. The advanced man-machine interaction technology and system technology have realized sound, graphics, image, text and language processing, virtual reality technology and system, multimedia technology. In addition, intelligent signal processing, wireless sensor and video monitoring have entered a very mature product development stage, providing a good foundation platform for the technical development of the internet of things [3].

In order to explore the application of perception data fusion of agricultural products supply chain based on internet of things. Fan used the agricultural product identification code as the data carrier to analyze the traceability coding system of important links of agricultural products circulation, and then analyzed the key factors affecting the quality and safety of agricultural products supply chain [4]. Wang abstracted the traceability modes of other industries in his paper, analyzed and compared them, and proposed a hybrid traceability mode suitable for the agricultural products industry [5]. In this paper, Shaog elaborated and analyzed the interaction between the external entities of the platform, constructed the overall structure of the agricultural product quality and safety traceability platform, and carried out the transformation and process optimization of the agricultural product circulation process based on the internet of things and other information technology [6]. Ji proposed the dynamic and static modeling of the function of the traceability platform, and analyzed the functional requirements of the agricultural product traceability platform [7]. In the process of investigation, he mainly focused on observation and interview, and conducted on-the-spot interviews and investigations on grain informatization pilot units [8].

In the process of Wu's investigation, we mainly focused on observation and interview, and conducted on-the-spot interviews and investigations on grain informatization pilot units in Jiangsu province and grain depots around Beijing, which provided a realistic basis for the effective development of the research. The innovation of this experiment has three points: first, the experimenters go to the farm to collect information, participate in the production and transportation of agricultural products, and establish a data model through the farm, and transport and sell agricultural products through big data information technology. In addition, we also provide a complete basis for the design of real-life logistics products through the logistics network of agricultural products.

2. Method

2.1 Application and Characteristics of Internet of Things

The concept of logistics was introduced to China in the 1970s. At present, there are still many obstacles to the development of our logistics industry: the construction of logistics infrastructure is lagging behind, which is mainly manifested in the lack of hard technology construction and application, especially soft technology construction [9]. Affected by the planned economy in the past, restricted by the acceptance system and traditional concepts, our logistics theory lacks corresponding innovations and breakthroughs, let alone scientific, systematic, and technological logistics theory [10]. The managers of many logistics companies have insufficient market awareness in terms of ideology, market awareness and market awareness [11]. Without systematic logistics knowledge, modern logistics theory cannot be fully utilized to realize the committee's traditional concept of emphasizing material production and ignoring logistics. We have insufficient understanding of the importance of cultivating modern logistics theory research personnel [12]. Our logistics education level is relatively low, logistics talents are still in short supply, the integrated transportation system is imperfect, there is no seamless connection between different modes of transportation, the degree of specialization of the logistics industry is low, the degree of socialization is low, and the distribution of integrated logistics elements lacks coordination. The development of our logistics industry is also hindered by the lack of strong multinational companies [13]. Intelligent logistics is at the pinnacle of the times and is also the first in the development of the logistics industry. The problems faced by it are more factors than this [14]. However, the company urgently needs to develop smart logistics, and this bottom-up power is not enough. To ensure the healthy development of intelligent logistics [15]. Perceived logistics refers to some emerging forms of logistics, such as two-dimensional logistics barcodes. It has been used in the logistics field for some time, including barcodes, and also applicable to product numbers. However, there are only a few types of agricultural product barcode technology applications in the logistics industry, and the promotion and application of agricultural products has a long history. The logistic burden of this farm is [16]. The perceived logistics utilization rate of agricultural products can be calculated in Equations 1, 2, 3, and 4 according to the following formula.

$$CV = \int x^2 nx + \frac{x^{n+1}}{n+1} + 1 \tag{1}$$

$$R(x) = \frac{f^{(n+1)}(\omega\mu\kappa)}{(n+1)!}(x - x_0)^{n+1} \tag{2}$$

$$C_{n+1} = \{s_i \mid f(c) = C_f 1 + n <= i + 1 <= n, 1 <= j <= n + 1 \tag{3}$$

$$T = \sum_{J+1}^{V-N} \frac{D_f}{D} * Info（D_f）+ \sum_{N}^{V} D^2 \tag{4}$$

CV refers to the annual penetration rate of agricultural product logistics, R(x) perceives the utilization rate of logistics, in formula 3 C represents the overall coordination rate during the operation of the internet of things, and T in formula 4 represents the compatibility of the internet of things. In formula 1, n represents the penetration rate calculation factor, and D in formula 4 is a constant for adjusting the meter compatibility.

At the macro level, logistics is a cross regional and cross industry comprehensive system. The level of its standardization is directly related to whether the internal functions, elements and modules of the logistics system can be effectively connected and coordinated development, and to a certain extent, it determines the logistics efficiency of the whole society. At the micro level, logistics standards are the key supporting factors to ensure the coordination and unification of logistics activities and the close technical connection between logistics system and other systems

[17]. Only when the logistics standardization is realized can the management efficiency of the logistics system be improved, the connection with other systems be strengthened, the economic and social benefits of the logistics system can be effectively improved, the competitiveness of the logistics industry can be enhanced, and the development of intelligent logistics can be promoted [18]. At present, China's logistics standardization work is relatively backward, resulting in poor compatibility of logistics facilities and equipment, low degree of convergence of logistics operations, and high efficiency of the overall operation of the logistics system [19].

2.2 Application Principle of Agricultural Product Supply Chain

It is generally believed that the entire Internet of Things can be divided into three basic levels: perception layer, transmission layer and receiving control layer. The perception layer mainly uses sensors to dynamically perceive the properties and changes of objects, and collects the perception status through radio frequency and other technologies. The transmission layer uses Internet technology to process the sensed data through a microprocessor to achieve long-distance transmission. The receiving control layer is the user side, which realizes the visualization of the object perception results and realizes the control of the perception objects and conditions [20]. Agricultural product supply chain management is still a relatively new management concept and method in China. Its core is to emphasize the use of integrated ideas and concepts to guide the management behavior of each node in the supply chain, that is, to guide the operation of the entire supply chain based on consumer demand and the entire supply chain is managed as a system to improve the operating efficiency and economic benefits of the entire supply chain [21]. Under this model, the node companies in the supply chain do not pursue their own profit maximization alone, but establish strategic partnerships, aiming at maximizing the interests of the entire supply chain, and use certain profit distribution mechanisms to make the economic efficiency of all trading partners in the supply chain has been improved. The impact of the Internet of things on the agricultural product supply chain is huge. The application of Internet of things technology can make the facilities, inventory, transportation, information and procurement involved in the agricultural product supply chain highly optimized; it can affect the production, transportation, and consumption of agricultural products. Real-time management of links can reduce supply chain costs and enable supply chain management to achieve a high degree of agility and complete integration [22]. The Internet of things based on radio frequency/electronic product code technology has been deeply integrated into all aspects of agricultural product supply chain management, and has had a profound impact on the optimization of agricultural product supply chain [23].

With the help of satellite communication system, the agriculture has established an agricultural information network center. On this basis, the provincial agricultural system website group and agricultural information professional website were established. The agricultural information sharing network has been established with the central government and local government to realize the agricultural information sharing with the central government and local government. Agricultural information platform integrates modern communication technology, computer network technology, information retrieval and push technology, and modern information management technology. It builds a comprehensive agricultural information service platform push, technology matching and e-commerce, which integrates hotline. SMS interaction, intelligent retrieval and informatization. With the development of the Internet of things, the internet of things technology is gradually used in the agricultural field, forming the agricultural Internet of things [24]. The multi-scale transmission of agricultural information is realized through wireless sensor network, telecommunication network and internet. The massive agricultural information obtained is fused and processed, and agricultural monitoring, scientific management and instant service are realized through intelligent operation terminal. Using summation formula and polynomial, we can calculate the new growth probability and the new development point of enterprises brought by the Internet of things [25]. Through the Internet of things, we can get the real popular and profitable product model of enterprises. We can use big data technology to accurately grasp the psychology of consumers and expand our own advantages. The commonly used formulas are 5,6,7.

$$F(a) = \left(\frac{a-1}{\mathrm{stebucstio\,n}}\right)^{a*t} + \left(\frac{a+1}{bxvsstn}\right)^{a*t} \tag{5}$$

$$GH = \frac{\left|Ax_0 + By_0 + C_0 + D\right|}{\sqrt{A^2 + B^2 + C^2}} \tag{6}$$

$$E(L) = SL + \sqrt{\frac{\sum\left[S(a) - S(b)\right]^2}{a-b}} \tag{7}$$

Among them, F(a) represents the new growth rate of agricultural products sales brought by the internet of things, the loss is the total savings of agricultural resources. GH is the profit margin of the enterprise brought about by the interconnection of all things, and E(L) represents the internet of things to save agricultural products. The amount of wasted resources. In the formula, a represents the operating coefficient of the internet of things, and b represents the growth rate operator.

There are many links in the supply chain of agricultural products, including rice planting, agricultural products processing, finished products distribution, agricultural products consumption and other basic links, as well as warehousing, transportation, loading and unloading and other logistics activities, which run through the internal links of the supply chain and the upstream and downstream circulation links. According to the current situation of production, circulation and consumption of agricultural products in China, combined with field investigation, relevant data of agricultural products planting, harvesting, rice milling, processing, detection, distribution, transportation and sales are collected, and various data are recorded with organic RFID tags, which are uploaded to the system data center layer by layer, so as to realize the tracking of agricultural products supply chain nodes, including all links and references in the whole process of agricultural products. Traceability with the unit, as well as the key steps and key processes of each link of specific batches of agricultural products, to ensure the traceability management of agricultural products supply chain. According to the different factory numbers of agricultural products, we can calculate the transportation time, growth cycle and sales volume of agricultural products by formula 8 and 9.

$$V = \frac{1}{K}\sum_{j=0}^{n}\sum_{i=0}^{n}\left(M_{(i,j)} - u\right)^2, if \quad M_{(i,j)} \neq 0 \tag{8}$$

$$\mathrm{T}(s)=\sum_{j=1}^{v}\frac{M_f}{D}*\log 2(\frac{M_f}{D})+J^V \tag{9}$$

Where V is the transportation time and shelf life of agricultural products. M is the minimum savings rate of agricultural products, and T(s) is the transportation time of agricultural products.

Where D is the transportation time and shelf life of agricultural products, min is the minimum saving rate of agricultural products, and t (s) is the transportation time of agricultural products. The distribution channels of fruits, vegetables and agricultural products are complex and diverse. As far as the main body of fruits and vegetables and agricultural products are concerned, one is farmers who organize production and operation activities as a family unit, and the other is a large-scale and specialized production base. Therefore, in order to prevent certain diseases or problems of agricultural products, it is necessary to trace the source of the disease [26]. The main tracking objects include farmers/production bases, wholesale companies at all levels, logistics supply companies and sales companies in the fruit and vegetable supply chain. The scope of corporate traceability is generally divided into internal traceability and external traceability [27]. Internal traceability emphasizes the traceability of corporate information, such as vegetable packaging, cleaning and segmentation, operator information, internal environmental information, external traceability is mainly to trace the circulation information of fruits and vegetables in the supply chain. When there is a problem in any link of the fruit and vegetable supply chain, the company can trace the origin and processing history information of the fruit and vegetable through the traceability system to analyze the cause of the quality problem [28]. For products that have already circulated to the next link or entered the market, the product range can be locked in time and customers can be recalled.

On the other hand, whether it is pilot projects, demonstration first, and supporting enterprises' gradual development model. It is still a system of division of labor, and the development model of all links going hand in hand, which provides ideas for the development of intelligent logistics and reduces the blindness of development. Enterprises and industries should focus on the innovation of smart logistics development concepts and actively explore. Through a large amount of relevant information, the prospects and existing problems of the agricultural product perception supply chain under the background of the internet of things are analyzed, and the problems that are conducive to the better development of the agricultural product perception supply chain are obtained. Data analysis is carried out on the investigation and research of the IoT-aware supply chain, and the data analysis adopts DCM technology. At the same time, through questionnaire surveys and model construction, relevant conclusions are drawn, through various data comparisons and analysis, through the presentation of data, to more intuitively understand the impact of the internet of things on the supply of agricultural products.

3. Experiments

3.1 Model Design of Supply Chain

According to the formal definition of the data collection and modeling of agricultural product logistics quality perception Internet of things, combined with the use of the formal model of the Internet of things process structure, the node classification and relationship diagrams of the agricultural products logistics are consistent with the supply chain process structure based on the agricultural products. The supply chain process integrates the IoT perception data set D in the process of agricultural product supply chain perception, the Internet of things quality set Q and the basic static information set E of quality perception, and establishes the agricultural product supply chain perception dynamic data traceability set T, and finally forms the construction cold Chain logistics quality perception IoT data collection and modeling formal model, and then realize the real-time monitoring of the agricultural product supply chain, and improve the transparency, safety and full traceability of the agricultural product supply chain perception process. Through data perception, the establishment of databases, etc., this model is used to study the results of perception data application in the agricultural product supply chain of the Internet of Things. The static information based on the supply chain model design process is shown in Table 1.

Table 1. Transportation and production of agricultural products under the Internet of things

Perceived logistics utilization	Popularization speed of Internet of things	Logistics time	Quantity of agricultural products
Perception of logistics	47.55%	7.8h	54.3%
Supply chain	84.21%	24.6h	47.89%
Perception data fusion	56.43%	34.5h	74.65%
Internet of things	64.32%	13.4h	76%
Utilization of logistics	78.45%	8.9h	69.56%

According to the three experimental methods proposed above, the above table reflects the situation of agricultural products transportation and production of big data perception under the internet of things. Among them, under the condition of Internet of things, the efficiency of agricultural products transportation has been significantly improved, from 56.78% to 89.92%, the transportation time has been reduced from the original 34h to 13h, the damage rate of transport commodities has been sharply reduced from 45% to 23%, the utilization rate of agricultural products has been significantly improved, from 68.79% to 87.5%. The farm can get more accurate information about the sale and production of agricultural products. This has greatly reduced the waste of production capacity, and the waste of agricultural products has been reduced from 10 million tons to 4.5 million tons.

3.2 Experimental Test Data

According to the research in this article, due to the limitation of grain storage capacity and technology, the loss of fresh agricultural products from the factory is generally 25%-30%, while that of developed countries is only about 5%. At present, the degree of processing of agricultural products in developed countries has reached more than 80%, the processing power is less than 30%, and the processing value-added rate is also low. Cold chain logistics technology plays an important role in ensuring food safety and stabilizing food quality. In developed countries, the proportion of fresh agricultural products in the logistics link is generally around 5%, but our proportion is much higher. Our fresh agricultural products are generally transported by conventional methods at natural temperatures, and low-level packaging and low-level storage are common, which directly lead to serious corruption of fresh products in the logistics process, as shown in Table 2.

Table 2. A comparative study of developed countries and China

Loss rate of agricultural products	Processing degree	Decay rate	Cold chain transportation rate	Packing tightness
63.4%	67.8%	96.4%	75%	25%
42%	56.3%	73.7%	67.85%	86%
37%	78.5%	58.5%	61.8%	75%

According to statistics, in the process of agricultural products circulation, the no-load rate of China's transportation has reached about 40%. The reason is that the market scale is small and the information circulation channel is not smooth, resulting in huge cost loss. Due to the information asymmetry, on the one hand, it will lead to blind production of farmers, leading to "buy cheap and sell expensive", and the prices of agricultural products will rise and fall sharply. On the other hand, there will be a high amount of intermediary fees. According to a company, intermediary fees are charged for logistics information provided by enterprises. Generally, the price per 10 tons is about 300-400 yuan. This will not only increase the cost of agricultural products logistics process, but also greatly damage the interests of consumers and farmers. The establishment of agricultural products green logistics information network system based on the Internet of things can achieve the flow of agricultural products through reducing costs. The specific data is shown in Table 3.

Table 3. The impact of Internet of things on green logistics information network system of agricultural products

Air freight rate	Price floating range	Cost floating range	Data popularization of Internet of things	Information penetration rate
Farm	9.76%-23.75%	3.54%-7.85%	56%	47%
Factory	13.6%-21.7%	2.43%-5.43%	43%	53%
Logistics	3.75%-9.74%	6.78%-12.5%	67%	34%
Database	5.43%-7.78%	25.5%-31.5%	54%	29%

China's agricultural products logistics is mainly based on normal temperature logistics or natural form logistics. The lack of refrigeration technology is the bottleneck of China's transportation industry, especially in the transportation of agricultural products. The survey shows that the loss rate of fruits, vegetables and other agricultural products in logistics links such as picking, transportation, storage and transportation is relatively high, especially in the transportation link, reaching 20%-28%. Among them, the loss of agricultural products in transportation is as high as 75 billion yuan, which makes us deeply realize that improving the technology of transportation link is an important means to realize the value-added of transportation link. This data is obtained by formulas 10 and 11.

$$S(u)=\sum_{k=0}^{n} C_n^k u^{n-k} v^{(k)} \tag{10}$$

$$\int \mathrm{f}(\frac{dx}{ax+b}) = \frac{1}{a}\ln|ax+b|+c \tag{11}$$

Where s (U) is the total loss and f (DX) is the transportation loss rate.

4. Results and Discussion

4.1 Analysis of the Impact of IOT Supply Chain on Farm Products

According to the data analysis of this paper, the backwardness of logistics technology is finally reflected in the logistics cost. In the cost of domestic finished products, the logistics cost accounts for about 34%, and the proportion of fresh agricultural products is even as high as 50%. However, the logistics cost in developed countries only accounts for about 10% of the cost of finished products. In addition, the third-party logistics of agricultural products has not yet formed a scale, agricultural products mainly rely on the self-supporting logistics mode of agricultural enterprises, and the cold chain logistics has not yet developed and popularized, which makes the loss of agricultural products in the whole circulation link is large, which also intensifies the operation cost of the whole agricultural product supply chain. Using simulation research to eliminate inventory inaccuracy can reduce the operation cost and shortage level of the whole chain. Through building a model to prove the total cost change problem under the condition of inaccurate inventory caused by different reasons, and study the radio frequency technology to eliminate the inaccurate inventory difference value part is quantified. This paper proves that the application of RF technology can reduce the inventory inaccuracy rate by 20%-37%. It is helpful to get a clearer understanding of the internet of things environment and more accurate design and analysis of the supply chain management operation system. The specific data is shown in Figure 1.

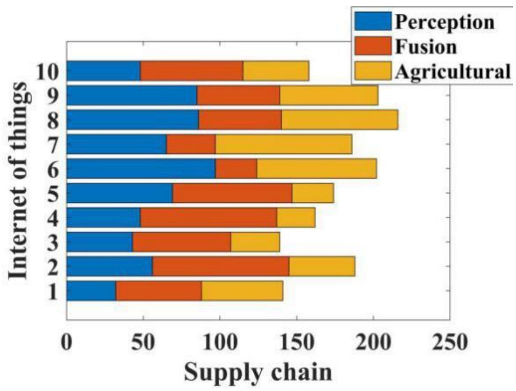

Figure 1. The tensile elastic modulus and tensile strength of composite materials are significantly improved

As can be seen from the data in Figure 1, the logistics cost accounts for about 34% of the cost of domestic finished products, and the proportion of fresh agricultural products is even as high as 50%, while the logistics cost of developed countries only accounts for about 10% of the cost of finished products. This paper proves that the application of RF technology can reduce the inventory inaccuracy rate by 20%-30%.

Investigation and research have found that when the loss rate of fresh agricultural products inventory is very small, as the replacement rate a of fresh agricultural products increases, the profit loss of the agricultural product supply chain decreases, and with the gradual increase of the agricultural product inventory loss rate, the agricultural product supply chain. The profit and loss of will change strongly with the change of the replacement rate a of agricultural products, which indicates that the replacement of agricultural products will reduce the shortage penalty cost caused by the loss of agricultural products inventory. This also proves that as the replacement rate an increase, the profit of the agricultural product supply chain will increase. Its effective demand rate and profit rate will also increase, as shown in Figure 2.

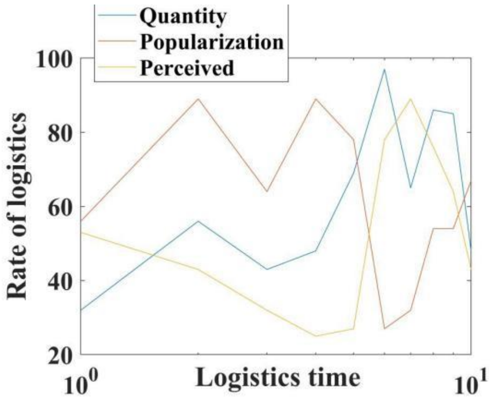

Figure 2. Composite tennis balls and rackets are highly wear-resistant

The profit loss of the agricultural product supply chain decreases with the increase of the fresh agricultural product substitution ratio a, while the profit loss of the agricultural product supply chain will change strongly with the agricultural product replacement ratio. With the continuous upgrading of logistics technology, the waste of agricultural products will be reduced by 23% - 40% every year, and the transportation time has changed from 34h to 13h.

4.2 Analysis of Internet of Things in the Transportation of Agricultural Products

After the experiment, the start time, end time, life cycle and the actual number of data frames of each sensor node are counted in the database. Compared with the theoretical frame number calculated by using the life cycle and sampling interval, the packet loss rate of the node in the whole life cycle and the whole data link span is obtained. The test results show that the highest packet loss rate is 4.59% and the lowest is 1.40%. The average packet loss rate is about 3.58% and the variance is 1.15%. The communication link of system integration is relatively reliable. Under the condition of 1440mwh battery power supply, the life cycle of sensing node is less than 490000s, and the number of data frames is about 9000. Reducing the communication energy consumption and prolonging the system life is an important prerequisite for the practical application of the system, as shown in Figure 3.

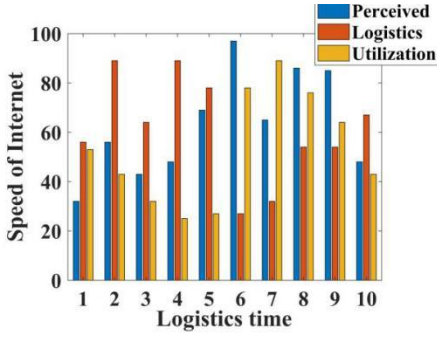

Figure 3. Stability data of tennis balls and rackets made of fiber nanocomposites under electrostatic spinning technology at high temperatures

As can be seen from the data in Figure 3, the highest packet loss rate is 4.59%, and the lowest is 1.40%. The average packet loss rate is about 3.58%, and the variance is 1.15%. The communication link of system integration is relatively reliable.

The development concepts such as "intelligent logistics is the inevitable trend of the development of the logistics industry", the logistics industry should further accelerate the development, only can be related to the "intelligent logistics", such as the Internet of things should be popularized and transformed into social cognition, so that the public can pay attention to the development of intelligent logistics, recognize the development of intelligent logistics, and then promote the development of intelligent logistics. According to our survey, 89.98% of the respondents agree with the concept of 10000 household interconnection, and 15.98% think that there are hidden worries. In order to ensure the food safety of people's daily life, the traceability of agricultural products has become a very important topic. The use of internet of things technology can effectively achieve the traceability of agricultural products, including the production, processing, transportation, circulation and sales of agricultural products throughout the entire agricultural supply chain, as shown in Figure 4.

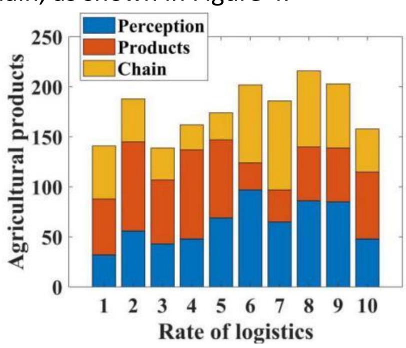

Figure 4. Data on water solubility of tennis balls and rackets

As can be seen from the data in Figure 4, according to our survey, 89.98% of the people who agree with the concept of 10,000 households are in agreement, and 15.98% of those who think there are hidden concerns. On the other hand, whether it is pilot projects, demonstration first, and supporting enterprises' gradual development model. It is still a system of division of labor, and the development model of all links going hand in hand, which provides ideas for the development of intelligent logistics and reduces the blindness of development. Enterprises and industries should pay attention to the innovation of intelligent logistics development concepts and actively explore. 78.42% of enterprises are connected to the internet of everything, 74.37% of enterprises believe that the perception of the internet of things is very important, and the tracking of information through bar code entry is the most basic operating.

5. Conclusions

(1) The results show that the application of data fusion based on the Internet of things can solve 69.45% of the agricultural products whose origins are unknown and cannot be traced, improve the supply efficiency of agricultural products by 43%, reduce the health problems of agricultural products by 31.24%, reduce the prices of agricultural products by 13%-20%, improve the logistics efficiency and save 5 million tons of agricultural products.

(2) The results show that under the condition of Internet of things, the transportation efficiency of agricultural products has been significantly improved, from 56.78% to 89.92%, the

transportation time is reduced from the original 34h to 13h, the damage rate of transported goods is sharply reduced from 45% to 23%, and the utilization rate of agricultural products is significantly increased, from 68.79% to 87.5%. The farm can get more accurate sales of agricultural products. Therefore, the waste of production capacity has been greatly reduced by selling production information. The waste of agricultural products has been reduced from 10 million tons to 4.5 million tons.

(3) This paper shows that the logistics cost accounts for about 34% of the cost of domestic finished products, and the proportion of fresh agricultural products is even as high as 50%, while the logistics cost of developed countries only accounts for about 10% of the cost of finished products. This paper proves that the application of RF technology can reduce the inventory inaccuracy rate by 20% - 30%. The highest packet loss rate is 4.59% and the lowest is 1.40%. The average packet loss rate is about 3.58% and the variance is 1.15%. The communication link of system integration is relatively reliable.

List of Abbreviations

Recency Frequency Monetary (RFM)
Wireless-Fidelity (WIFI)
Radio Frequency Identification (RFID)
Internet of Things (IOT)

Declarations

Consent for publication: Approved.

Competing interests

These no potential competing interests in our paper. And all authors have seen the manuscript and approved to submit to your journal. We confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

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Author’s contributions

All authors take part in the discussion of the work described in this paper. These authors contributed equally to this work and should be considered co-first authors.

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Figures

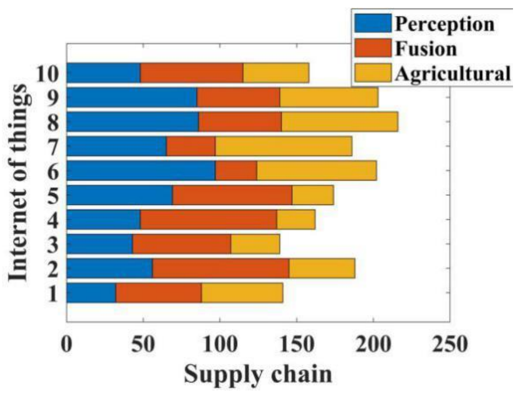


Figure 1. The tensile elastic modulus and tensile strength of composite materials are significantly improved

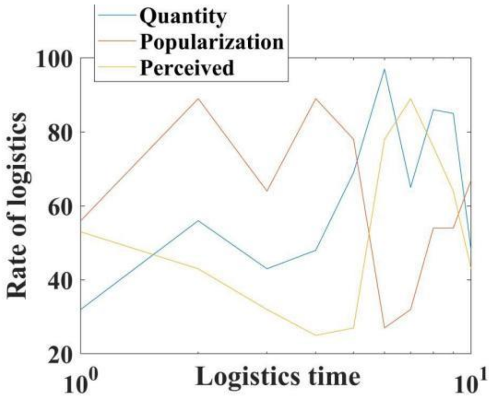


Figure 2. Composite tennis balls and rackets are highly wear-resistant

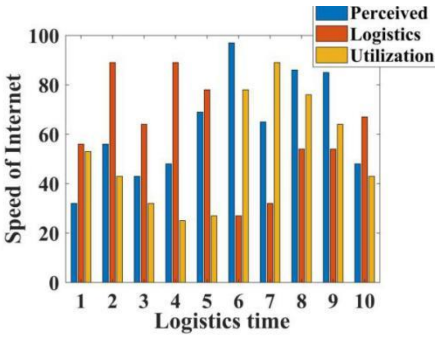


Figure 3. Stability data of tennis balls and rackets made of fiber nanocomposites under electrostatic spinning technology at high temperatures

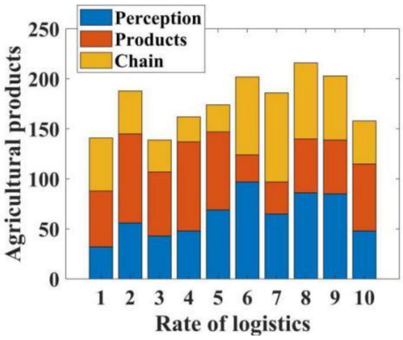


Figure 4. Data on water solubility of tennis balls and rackets

Figures

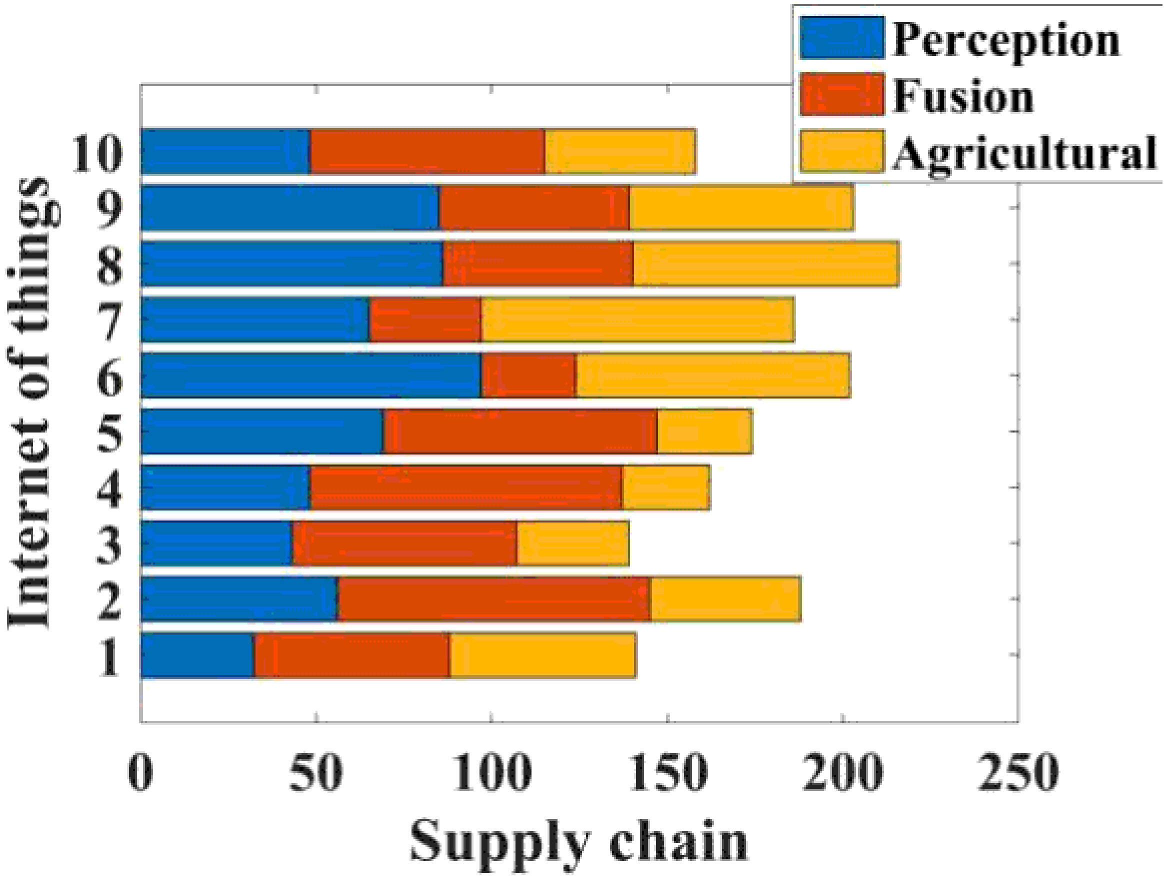


Figure 1

The tensile elastic modulus and tensile strength of composite materials are significantly improved

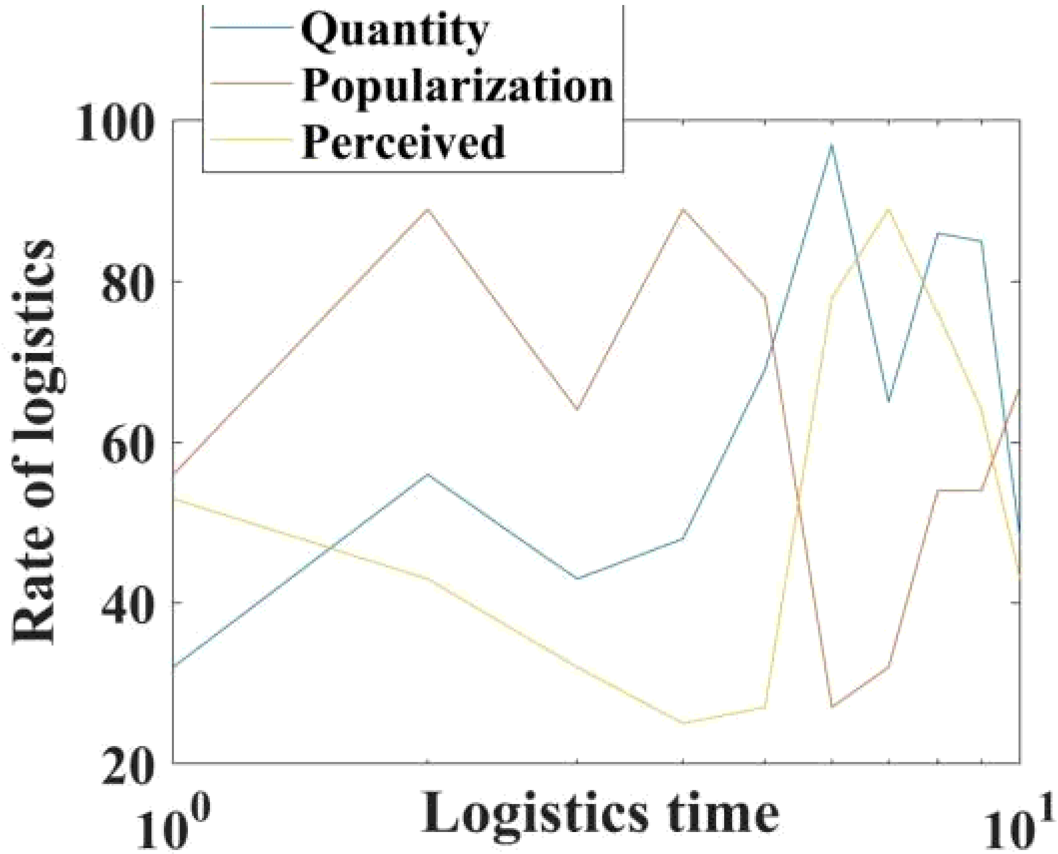
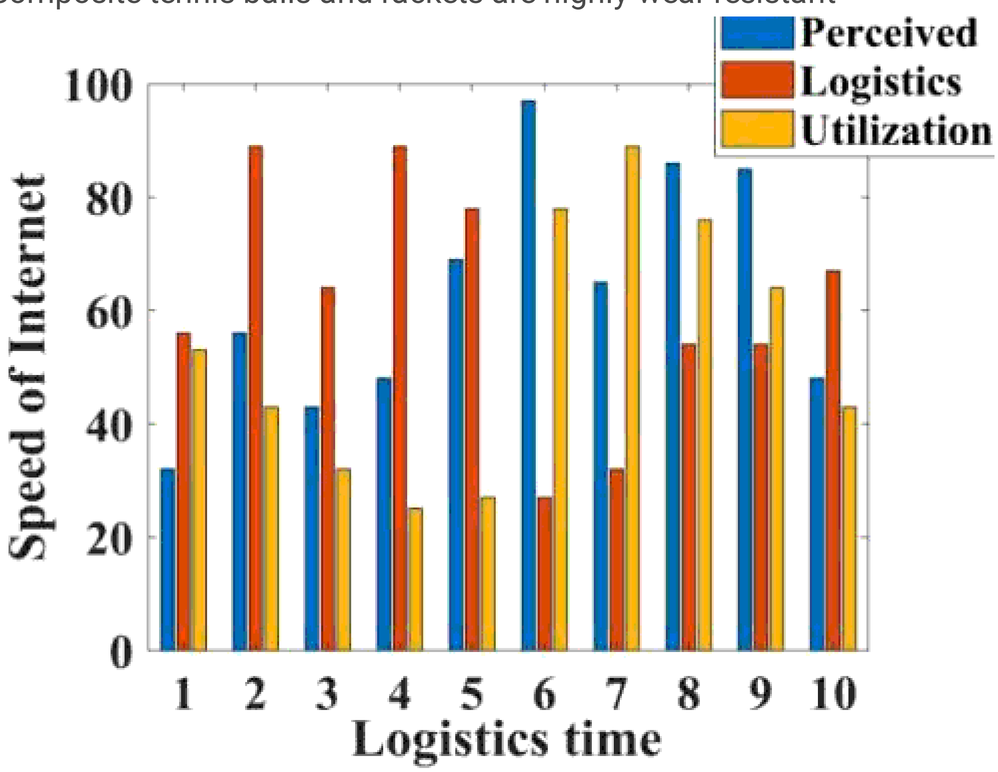


Figure 2

Composite tennis balls and rackets are highly wear-resistant



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Stability data of tennis balls and rackets made of fiber nanocomposites under electrostatic spinning technology at high temperatures

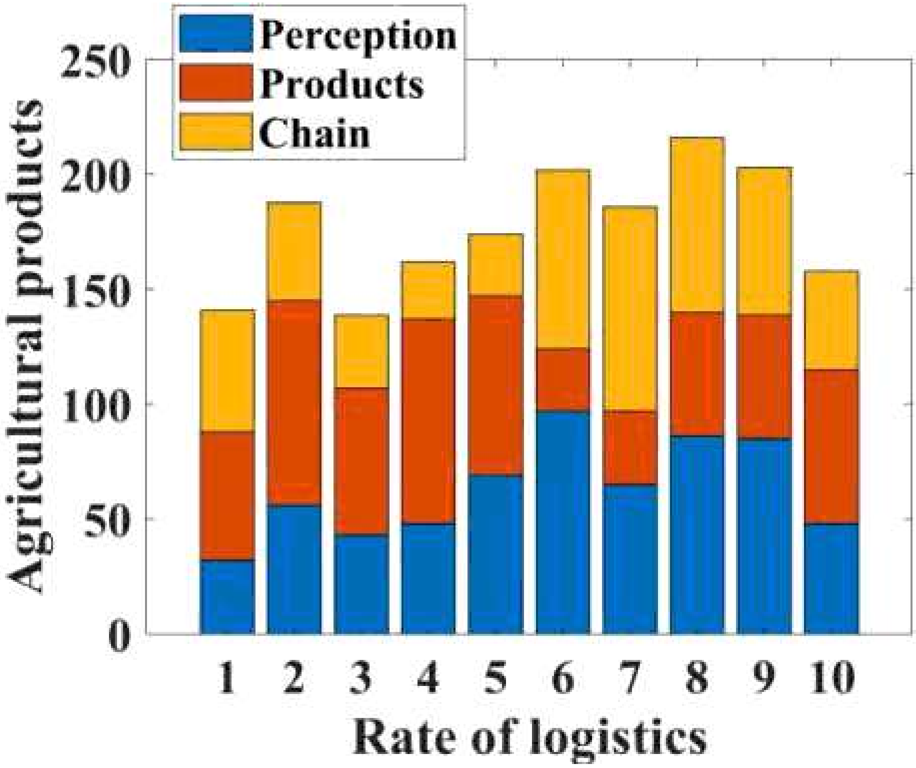

Figure 4

Data on water solubility of tennis balls and rackets