# Research on the food safety supply chain security information resources sharing platform based on multi-agent

## Kefei Liu[*]

*Henan University of Technology, Zhengzhou, Henan, China*

## Abstract

In recent years, the consumers and the food regulators pay more and more attention to the food security works due to the frequent food security problems. Because the food supply chain security information resources sharing platform can prevent the food security problem on the source, it is concerned by the producers, consumers and the food regulatory. In this paper, we propose the food safety supply chain security information resources sharing platform which is based on the multi-agent. And we expound the functions of each agent module. In this platform, the managers, producers and consumers can interact the information effectively. Finally, we analyse the functions of this platform.

*Keywords:* Food Safety Supply Chain,Multi-Agent, Security Information Resources Sharing Platform)

## 1 Introduction

With the continuous improvement of the living standards, the food security problems have become prominent increasingly. And the food security problems expose frequently by the media. These make consumers and scholars have attracted more and more attention to the food security. In order to prevent the food security problems from the source, enhance the transparency and share the food security information, it is necessary to establish food safety supply chain security information resources sharing platform.

The food security information sharing is a problem which refers to a public management problem. At the same time, it is the key words for the food security level [1]. Li Hong studied the disclosure problem of the food security information. She thought there was the certain theoretical and practical significance in establishing the disclosure mechanism of the food security information [2]. The existing regulatory model which was studied by Hu Xueshen neglected the public of the food security information. And it leaded to public distrust of the government [3]. Zhu Rong thought that the deep reasons of the food security problems in China were because of the market failure and the information presence of the food security market. Therefore, the key factor to solve this problem is to eliminate the information barriers problem in the food market in order to solve the food security problems [4]. Liu Dongmei, Liu Shu, Liu Xuemei and Kong Fanhua also discussed the food information sharing mechanism [5-8].

Due to the characters of high intelligence, autonomy and social for multi-agent, it has caused the attention of the academic researchers of different areas [9-11]. Shi Yanneng established the government regulation of food safety model and simulation which was based on the multi-agent [12]. According to establishing the food safety government supervision ecological system, author solved the adaptive function construction of the food security supervision process. Huang Shuai established the food supply chain quality monitoring system model which was based on the agent. He used the autonomy, coordination and intelligent of the agent to supervise the food security [13]. E Yue studied the quality control of the bee products which were based on the agent. And he designed the bee products quality control chain based on the agent [14]. Ai Dan studied the fresh agricultural products supply chain negotiation system which was based on the multi-agent. And he established the performance evaluation system of the fresh agricultural products supply chain negotiation system which was based on the multi-agent.

This paper, we propose the food safety supply chain security information resources sharing platform which is based on the multi-agent. The platform is composed by the supplier agent, manufacturer agent, sale agent and food safety supply chain security information resources sharing platform agent. The information of the supplier agent, manufacturer agent and sale agent is transformed to food safety supply chain security information resources sharing platform agent. And this form agent accepts the supervision of the consumers and the food security supervision department. The structure of this paper is as follows. The first part is the introduction. We introduce the related problems in this part. The second part is the status of China's food safety. In this part, we introduce the food safety status in China. The third part is the food safety supply chain security information resources sharing platform. In this part, we structure the food safety supply chain security information resources sharing platform and analyse the platform function. The last part is the conclusion...

## 2 The status of China's food safety

---

[*] *Corresponding author's* e-mail: 908809047@qq.com

## 2.1 THE CHARACTERISTICS OF THE FOOD

The food industry has been the significant problem that every society stratums concern. It is closely related to people's life. In recent years, the food security problem has been received a wide attention. There are many kinds of food, such as fruits, vegetables, meat, poultry, dairy products, grain and oil products etc. they have the following characteristics.

The first characteristic is that food has the strong periodic. The food industry has the distinct production cycle. The price fluctuates with the different seasons. Once the season goes, the products will be surplus. It makes the substantial resources waste. At the same time, the shelf life of most food is short. And it will bring the huge economic loss for the operators of the fresh agricultural products.

The second characteristic is the safety and health of the food itself. If the food is placed in a long time, its nutrition will be loss. And the food will be perishable and deterioration. In order to make the wide consumers to eat the health food, we must reinforce the supervision and the management of the food storage.

The third characteristic is the sensory quality and the shelf life. The production of food industry is influenced by the climate, the consumer preferences, the competitive price and other factors. The price will fluctuate with the uncertain factors. It often appears that the same product has a big price gap in different time periods. These factors makes manufactures use the bad food to take place of the good food.

The fourth characteristic is the market characteristic. In order to meet the consumer demand of the different level, the sale level of food is obvious. The different sale place, different packaging and different fresh degree make the same food become different sale levels. In order to obtain greater benefits, some manufacturers package the low level food at the high level food. Therefore, they can obtain higher illegal income. But, this behaviour harms the interests of consumers

## 2.2 THE PROBLEM THAT THE FOOD SECURITY FACES

Due to the characteristics of the food itself, the economic environment, the social environment and other factors, the competition becomes fierce increasingly in the modern economy. Because of the different business philosophy and the respective interests in each node of the food supply chain, there exists a large number of goal conflicts. These hinder the development of the food industry. And it causes great influence on the guarantee of food security.

The food industry has a very high requirement for the timeliness. It is necessary to build a perfect information sharing mechanism among the node enterprise in the whole supply chain. However, the most information sharing mechanism of the food supply chain is not wholesome. It is easy to cause the bullwhip effect and the shipment backing. Once the food cargo is backlogged, it not only causes the huge losses for the farmers and the enterprises in the supply chain, but also brings the security hidden for the food industry. At the same time, there is lack of the trust among the node enterprises. It appears the false

information and causes the security hidden. Due to the characteristics, the food industry has bigger operation risk in general. The node enterprises in the whole supply chain are difficult to establish the highly alliance partnerships. There is not the trust among them. The lack of trust not only makes the low efficiency for the whole food industry supply chain, but also brings a series of false information which makes the security hidden of the food supply chain. In addition, the food is easy to be damaged during the transport and storage because of the characteristics of the food itself. In order to reduce the loss, some bad businesses use the damaged food to instead of the good food. Or they dope some bad food in the good food. These methods cause the huge challenge in the food security.

Multi-agent has the characteristics of autonomy. In dealing with the coordination of each node and overcoming the communication problems, multi-agent has the superiority and reliability compared with other technologies. We apply the multi agent technology to the food supply chain security management. It is the advanced and scientific way currently in the word at present. According to the relative literatures, agent technology has the wide application prospect. As a new management model, it has been watched closely by the computer science and the various management disciplines scholars.

## 3 Food Safety Supply Chain Security Information Resources Sharing Platform

### 3.1 THE OBJECTIVE AND PRINCIPLE OF FOOD SAFETY SUPPLY CHAIN SECURITY INFORMATION RESOURCES SHARING PLATFORM

#### 3.1.1 The objective of Food Safety Supply Chain Security Information Resources Sharing Platform

The supply chain enterprises and the government departments provide the information of the food security. And a vast number of consumers supervise the food security. We make this as the target and design food safety supply chain security information resources sharing platform. The consumers, the supply chain enterprises and the government departments can find the food security information and the relative laws through this platform. It breaks the information island among the different departments. In addition, it can improve the legal consciousness of each enterprise and enhance the safety level from the source through the platform. In addition, this platform can enhance the food security management level of the management staffs. The establishment of the food security information sharing platform system can provide the necessary background information and the real time data that the daily management and the major decision making need. So, it can improve the food security management level. Finally, this platform not only enhances the ownership sense for the consumers, but also makes the consumers participate in the food security supervision. At the same time, it protects the legal rights for the consumers.

*3.1.2 The designed principle of Food Safety Supply Chain Security Information Resources Sharing Platform*

The first principle is the systematises. The whole food safety supply chain security information resources sharing platform is composed by the supplier agent, manufacturer agent, sale agent and the food safety supply chain security information resources sharing platform agent. The platform accepts the information from the supplier agent, manufacturer agent and sale agent. The information is managed by the food security management department and it accepts the supervision of the wide consumers.

The second principle is independence. In order to reduce the collusion among each enterprise and the false information, the design of the platform must pay attention to the independence. At the same time, food security information release unit can exercise the right of the information release independently.

The third principle is participation. The design of the platform allows the supplier, manufacture, retailer, food regulator and wide consumers participate in this food safety supply chain security information resources sharing platform. It can receive the supervision of the consumers and the food safety regulator department. At the same time, it needs to let the academic institution, media and other people participate into the design work of the platform and the food security supervision.

The fourth principle is transparency. The publication of platform information must follow the principle of the transparency. At the same time, we need to consider transparency of the food security situation, standard, policy and others. It makes that there is no dead angle in the information released of this information sharing platform and it can also improve the enthusiasm of the consumers.

The fifth principle is sharing. Strengthening the sharing of each enterprise in supply chain information can not only prevent the food security problems from the source, but also make the enterprise mutual supervision. In addition, enhancing the sharing information can make the information more transparent and promote the management of the food security.

### 3.2 AGENT MODELING

As the concept of the artificial intelligence, agent has its own properties, action, object and knowledge. It is an independent operating entity in a certain environment. At the same time, it also has the characteristics of initiative, intelligence and reactivity. Multi-agent system is mainly to study how the multiple-agent coordinates its own intelligent behaviours. It can solve the complex questions that the single agent cannot deal with. In this paper, we apply the theory and method of the multi-agent to design the food safety supply chain security information resources sharing platform. According to studying the agent method and theory, we refer to the relative papers and adopt the following steps to design the food safety supply chain security information resources sharing platform.

1. Firstly, we need to do the specific demand analysis, determine the objectives and solve the problem. Then, we classify the questions and design the relative tasks. According to the tasks, we need to ensure that the multi-

agent have different functions. At the same time, we need to design the ability and behaviour for each agent.
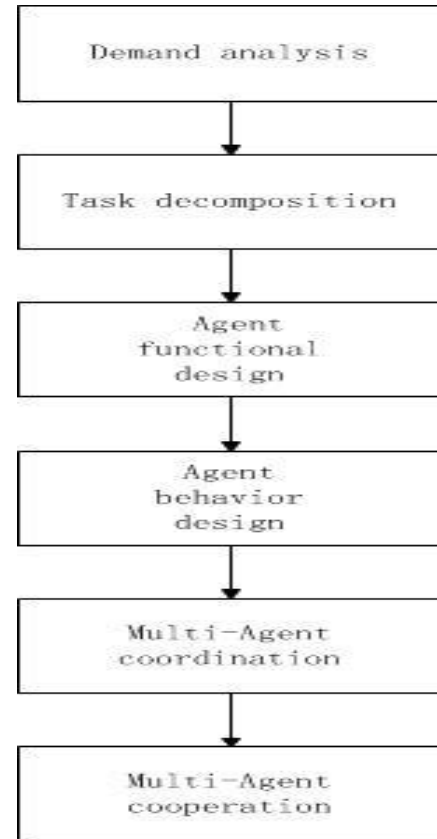


FIGURE1 The agent modelling flow chart

2. The second is the agent behaviour. In the process of this paper, we relate the agent to the information sharing platform. That is, according to perceiving the environment, the agent behaviour shows the results through its operation. Each agent has the relative behaviour database. Through the communication and negotiation, they select the different behaviour to execute from their behaviour databases. According the form, it reflects that agent has different behaviour abilities in different environments.

3. Thirdly, we consider the negotiation problems when multi-agent meet. Then we ensure and determine the connection relationship of each agent. And the multi-agent connect by the communication mechanism among the agents.

4. Fourthly, we must consider that the agent has a certain learning ability in the agent design. It can transform itself and evolve when it is influenced by the external environment.

5. Lastly, we integrate the multi-agents. We make them influent each other. Then they cooperate with each other.

### 3.3 FOOD SAFETY SUPPLY CHAIN SECURITY INFORMATION RESOURCES SHARING PLATFORM

Food safety supply chain security information resources sharing platform is divided into three layers. The first layer is the supplier agent module, manufacturer agent module

and sale agent module. The second layer is food safety supply chain security information resources sharing platform agent. And the third layer is the database. In the first layer, the suppliers provide the materials for the downstream manufacturers. The manufacturers are responsible for the procurement of the raw materials and the production. And they sell the productions to the distributors. Then the distributors sell the products to the consumers. According to a series of operation process, the supplier agent module, manufacturer agent module and sale agent module transport the final food security information to food safety supply chain security information resources sharing platform agent. The second

layer is the food security supply chain information sharing platform agent. In this layer, food security supply chain information sharing platform agent accepts the food security information which is from the supplier agent module, manufacturer agent module and sale agent module. And it stores the information into the database. At the same time, different users identify can access the database by the food security supply chain information sharing platform. The third layer is the database. It is mainly to store the information which is transformed from the supplier agent module, manufacturer agent module and sale agent module. And it also stores the relative food security regulation knowledge.
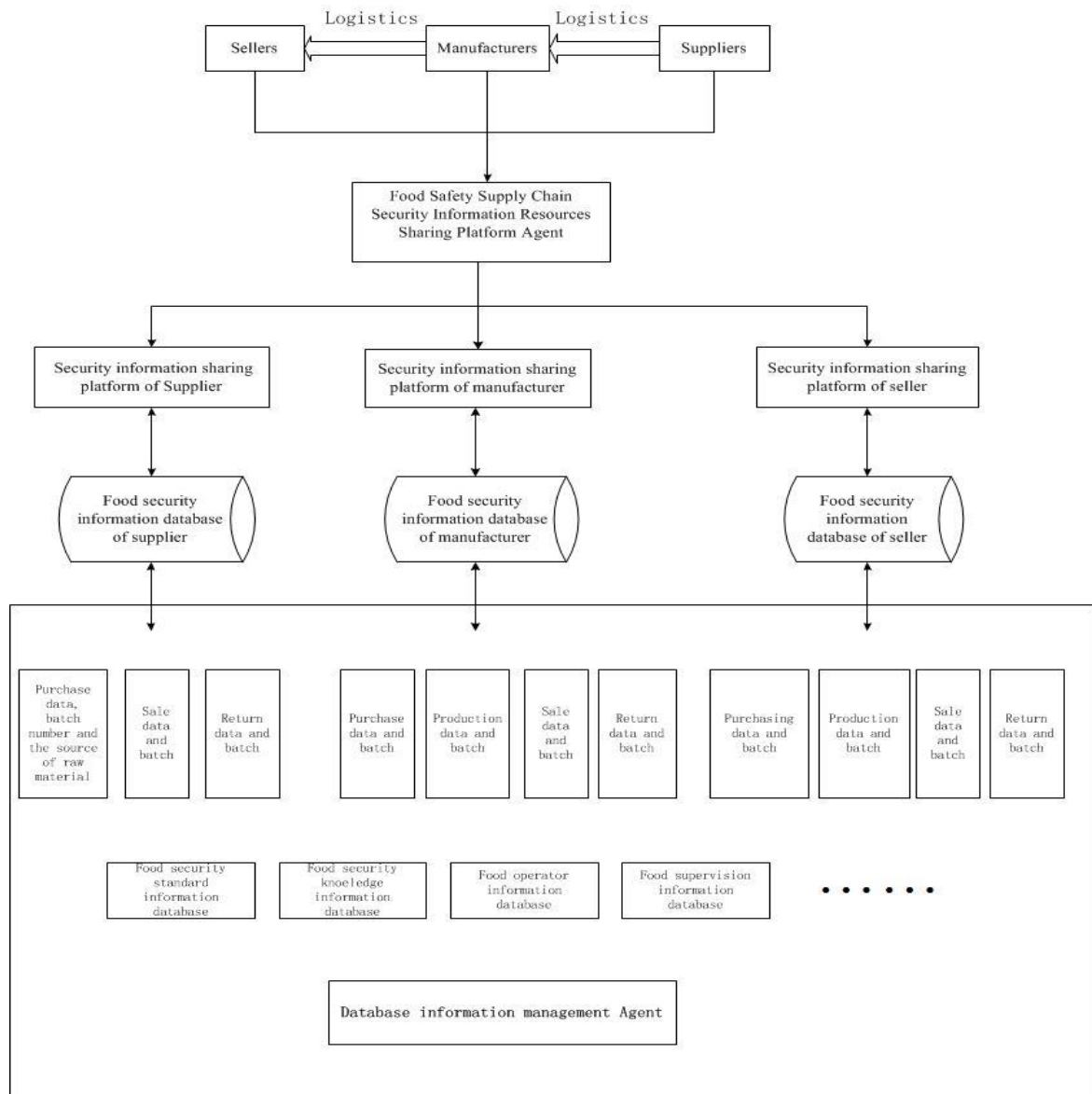


FIGURE 2 The overall structure of platform

We divide the food security information sharing platform into four modules. They are the supplier agent module, the manufacturer agent module, the sale agent module and food security supply chain information resource sharing

platform agent module. Each unit is an independent agent module. And it is also an indispensable part for the whole platform. Therefore, we introduce the multi-agent into food security supply chain information resource sharing.

Now, we need to analyse these modules.

(1) The module of supplier agent

The supplier is in the upstream of the whole supply chain. It is mainly to provide the raw materials or spare parts for the downstream manufactures. The module agent is mainly responsible for the procurement plan, inventory control, order management, delivery management, sales and return management. And it also transmits the corresponding information to the food security supply chain information resource sharing platform agent module. The module structure diagram is as follows
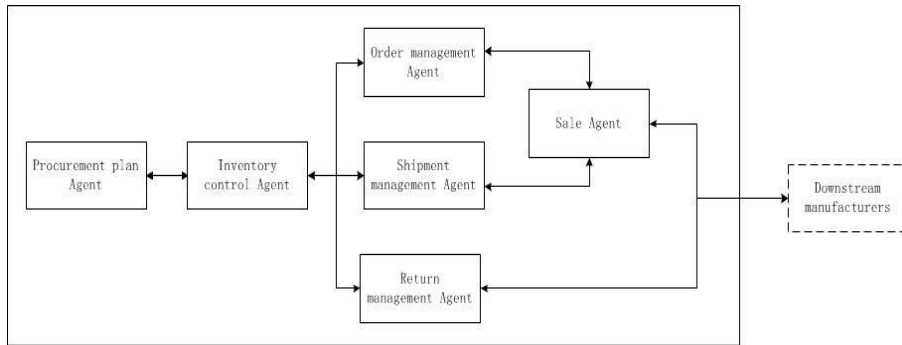


FIGURE 3 The module structure diagram of supplier agent

(2) The module of the manufacturer agent

The manufactures are mainly responsible for purchasing the raw materials or parts, producing the productions and the distribution. Through the effective distribution channels, the manufactures sell the final productions to the consumers. The manufacturer module is mainly responsible for the purchasing plan, production plan, inventory control, order management, distribution management and return goods. And they also transmit the corresponding information to the food security supply chain information resource sharing platform agent module. The module structure diagram is as follows.
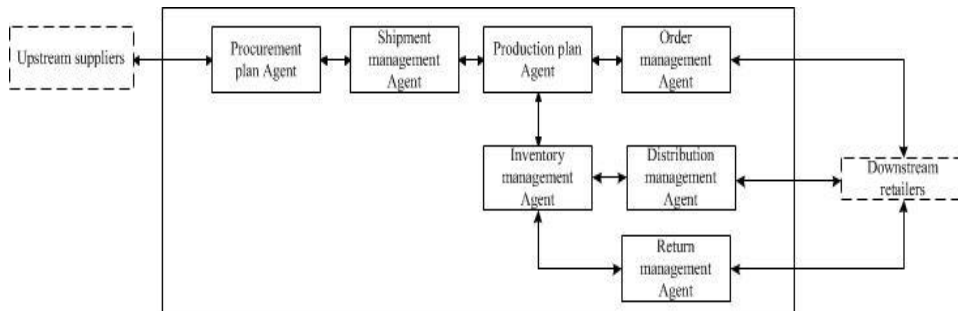


FIGURE 4 The module structure diagram of manufacturer agent

(3) The module of the sale agent

The sale agent is in the downstream of supply chain. The sales personnel are mainly responsible for selling products to the consumers through the effective sale strategies and methods. The manufacturer module agent is mainly responsible for management, sale, order management and return management. And they also transmit the corresponding information to the food security supply chain information resource sharing platform agent module. The module structure diagram is as follows
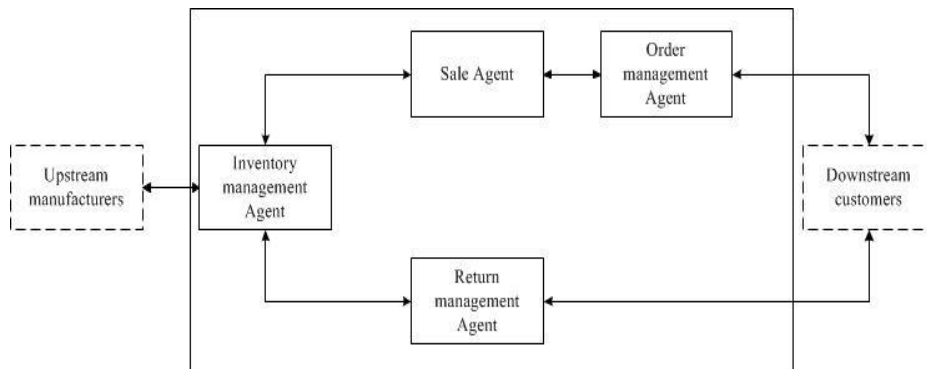


FIGURE 5 The module structure diagram of sale agent

## 3.5 FUNCTION ANALYSIS FOR EACH AGENT

The food security supply chain information resource sharing platform is a multi-agent system which is composed by the supplier agents, manufacturer agents, sale agents and food security supply chain information resource sharing platform agent. Each node is viewed as an agent module. At the same time, each module includes the agents which have different functions. The functions of these agents are as follows.

The first is the procurement plan agent. Firstly, we select the suppliers who have the good performances. Then we negotiate with each other, sign the purchase contract and urge them to deliver the goods on time.

The second is the receiving management agent. According to the purchasing contract, we purchase the corresponding raw materials. After receiving the raw materials, we need to examine them. If these raw materials are qualified, then they pass the receiving management agent and store the corresponding information. Finally, we submit them to the inventory management agent.

The third is the inventory management agent. This agent is responsible for the masks which are relative to the raw materials and the finished goods inventory. It includes recording the inventory, ensuring the reorder point and responding other agents (such as sale agent and material planning agent).

The fourth is the order management agent. The agent is responsible for handling the orders which is from the downstream supply chain, estimating the due date and inquiring the inventory amount by the inventory management agent. If necessary, the agent needs to transfer the orders to the upstream supply chain.

The fifth is the production planning agent. After receiving the orders from the order management agent, the agent makes the production planning and gives commands to manufacturer agent according to the product due date, production capacity and the material amount,.

The sixth is the sale agent. According to the customer historical demand, the existing orders and the market trend the agent predicts the customer demand. And then it makes the sale planning, production planning and procurement plans. When receiving the command of the order management agent, it notifies the inventory management agent to send the finished products.

The seventh is the distribution agent. The agent receives the command of the sale agent, plans the route of the material distribution and forms the optimal distribution. The agent gives feedbacks the relevant distribution information to the downstream supply chain agent.

The eighth is the return agent. The return agent includes the raw material return plans and the product return plans. It returns the unqualified raw material and the excess supply chain to the upstream agent. According to the requirement of the downstream supply chain, the upstream supply chain receives the product returning. At the same time, the return agent sends the command to the inventory management agent. Then the inventory management agent updates the raw materials and the finished goods inventory.

## 3.6 AN ANALYSIS OF THE PLATFORM FUNCTION

Information sharing service platform connects the heterogeneous, autonomous and distributed information resources together. According to the unified resource description framework, it integrates all of the valuable information. Then it can help users to obtain the timely and comprehensive food security information.

From the function, the food security information sharing service platform is mainly to solve the food security information management and the food security information service. The food security information management includes the user information management, information resource management and platform information management. The user information management is responsible for the user registration, management and cancellation etc. The information resource management combines the food security information database with the sharing platform, providing the information maintenance and information security management etc. Platform information management is mainly to manage the information which is in the platform. It includes the data inputting and data updating etc. The information service includes the government complaint service, information retrieval ser-vice and the expert advisory service. The government complaint service is mainly to provide the channels for the vast number of consumers to complaint the bad firms. The information retrieval service provides the information retrieval for the consumers and the government. The expert advisory service is to provide the windows for the consumers.
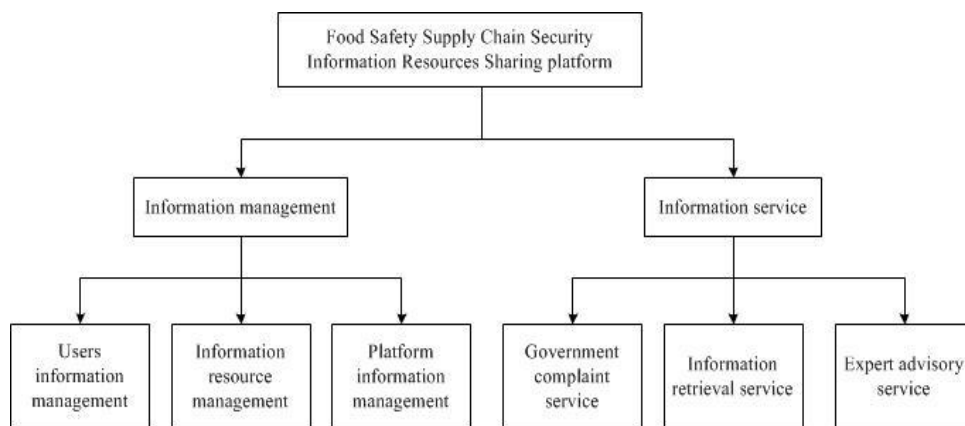


FIGURE 6 The analysis of the platform function

## 4. Conclusion

With the improvement of people's living standards, food security awareness is strengthening gradually. Therefore, food safety supplies chain security information resources sharing platform is a very important livelihood project. The construction of food safety supply chain security information resources sharing platform involves many departments and fields. The construction of this system must rely on the participation of the whole society. In this paper, we apply multi-agent technology to the food safety supply chain security information resources sharing platform. And we establish food safety supply chain

security information resources sharing platform based on Multi-Agent. Then we describe the functions of each agent. Finally, we analyse the functions of this platform.

## Acknowledgements

## References

[1] Li Ganqiong. Preliminary design of food safety information sharing system[C]. Chinese Academy of Agricultural Sciences,management of agricultural economy,2006.
[2] Li Hong. Study on the problem of food safety information disclosure [C]. Huazhong Agricultural University,management of agricultural economy,2006.
[3] Hu Xueshen. Research on The food safety information disclosure system [C]. Graduate school of Chinese academy of social sciences,law,2013.
[4] Zhu Rong. The research of the Chain food safety information barriers and its elimination in path[C]. Jiangxi University of Finance and Economics,theoretical economics,2013.
[5] Li Dongmei. On the reporting system of food safety in China[C]. Southwest University,Civil Law and Commercial Law,2011.
[6] Liu Shu. Research on Chaina's food safety information disclosure norm[C]. East China University of Political Science and Law, economic law,2013.
[7] Liu Xueni. Research on quality and safety information transfer for retailer [C]. Shandong Normal University,Regional economic law,2013.
[8] Kong Fanhua. Research on the Food safety information for internal circulation mechanism in China [J]. Journal of Guangdong Institute of Public Administration,2012, 24(2):48-53.

[9] Gong Wang, T.N. Wong, Xiaohuan Wang. A hybrid multi-agent negotiation protocol supporting agent mobility in virtual enterprises [J]. Information Sciences, 2014, 282(20): 1-14.
[10] Arsun Artel, Fouad Teymour, Michael North, Ali Cinar. A multi-agent approach using perceptron-based learning for robust operation of distributed chemical reactor networks [J]. Engineering Applications of Artificial Intelligence, 2011, 24(6): 1035-1045.
[11] Prashant Sethia, Kamalakar Karlapalem. A multi-agent simulation framework on small Hadoop cluster[J]. Engineering Applications of Artificial Intelligence, 2011, 24(7):1120-1127..
[12]Shi Yaneng. A model and simulation of government regulation of food safety based on Multi-Agent[C]. Wuhan University of Technology,technology economy and management,2011.
[13]Huang Shuai. Modeling for quality monitoring in foodstuff supply Chain based on Agent[C]. Inner Mongolia University,computer technology,2011.
[14]E Yue. Study on bee products quality control based on Agent[C]. Chinese Academy of Agricultural Sciences,Agricultural information science,2012.
[15]Ai Dan. Research on the fresh agricultural products supply chain negotiation system based on Multi-Agent [C]. Yunnan University of finance,business administration,2013.

**Authors**

**<Kefei Liu>,<13/Mar./1975>,<Zhengzhou, Henan>**

**Current position, grades: Associate professor**
**University studies: Agricultural economics**
**Scientific interest: Food safety supply chain**
**Publications: The Industry Chain-Based Food Quality And Safety Management System Construction. BioTechnology: An Indian Journal, 10, 4127-4133(2014).**
**Experience: Sept., 1993 - Jun., 1997, Bachelor of Trade and Economic, Henan University of Finance and Economics, China; Jul., 1997 - present, Associate professor, Henan University of Technology, China; Sept., 2002 - May, 2005, Master of Business Administration, Xi`an Jiaotong University, China**