Research on the development of agricultural products logistics in China based on ISM model

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Abstract: Agricultural products logistics is of great significance to regulating the supply and demand, protecting the income of peasant households and increasing the added value of agricultural products. The agricultural products logistics in China has the characteristics of long chain, multiple nodes and many influencing factors, which makes it difficult for the government and enterprises to find the effective focus of resource allocation. In view of this situation, this paper summarises 13 key factors that affect the development of agricultural products logistics in China on basis of the connotation of agricultural products logistics, in combination with actual development and expert opinions. Then, the paper establishes five-level hierarchical structure of those factors in the use of interpretive structural modelling (ISM), which intuitively reflects the hierarchical association among the influencing factors. Finally, according to the five-level hierarchical structure, this paper puts forward targeted development suggestions for relevant departments and enterprises.

Keywords: agricultural products logistics; interpretive structural modelling; ISM; influencing factors; China.


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Wenbing Wu is currently working as a Professor at the School of Economics and Management, Beijing Jiaotong University. Her research interests include strategic management and physical distribution management. She has published research papers in various journals such as China Soft Science, Science of Science and Management of S and T, and Chinese Journal of Systems Science. Also, she is the author a book entitled Enterprise Leap Forward Development Strategy and co-authored a book entitled Management Study Questions and Case Sets.
1 Introduction

Since joining the WTO, China has made many attempts to promote the linkage between agricultural production and marketing, encourage the development of cold chain logistics system and strengthen the quality and safety traceability of agricultural products, etc. However, there is still a big gap between the implementation effect and the expected goal. In the circulation market of agricultural products, the phenomenon of ‘selling difficult, buying expensive’, ‘cold chain’ and ‘broken chain’ frequently occur. The problems of information island and food safety are still outstanding. Similarly, although the constant innovation of agricultural products logistics enterprises and actively explore new mode of agricultural super docking, agricultural cooperatives, farm housing docking, e-commerce and other agricultural products, most of them failed to obtain good results and had difficulty in obtaining economic benefits. The basic reason is that the existing policy system and enterprise innovation can only temporarily alleviate the superficial contradictions exposed in the development of agricultural products logistics in China, failing to remove the deep-rooted obstacles to the development of agricultural products logistics. China agricultural products logistics as a complex and open system, its development is affected by many factors from inside and outside the system and have different influence degree of factors. Policies, institutions and resource allocation can only achieve the desired results only if they affect the fundamental reasons for the development of China’s agricultural products logistics. Therefore, it is necessary to deeply analyse the factors that affect the development of agricultural products logistics in China and find the deep reasons that restrict their development, so as to improve the pertinence and effectiveness of policy formulation and enterprise innovation.

At present, the existing research on the influencing factors of the logistics of agricultural products China mainly concentrated in two aspects: some scholars use qualitative analysis method to simply describe factors influencing the development of agricultural products logistics (Shukla and Jharkharia, 2013); the other scholars use multi-criteria decision making (Banasik et al., 2016), fuzzy analysis (Zheng et al., 2015) and other methods to compare the effect of influencing factors and more in a given area as the research object. However, scholars have not yet agreed on what is the fundamental reason for restricting the development of China’s agricultural products logistics and the study of the relationship between the factors is rarely involved. It is important to note that the factors influencing the development of agricultural products logistics in China are not independent of each other but in a relationship of mutual influence. Only by grasping the interaction and interaction between the indicators can we accurately locate the key
indicators and the underlying factors. The interpretive structural model (ISM) to reveal the structure of the system, analysis and research of complex relationship between elements is very useful (Han et al., 2015). Its application is very extensive, from the problem of energy (Zhang et al., 2015), modern buildings (Shi et al., 2015); to regional economic development issues, enterprises and institutions issues (Chauhan and Singh, 2016); social phenomenon (Feng et al., 2016); and then to personal issues, etc. In view of this, this paper will use the ISM to analyse the hierarchy of factors influencing the development of agricultural products logistics in China, hoping to cover the shortage of theoretical research and provide useful reference for the formulation of relevant policies.

2 Identification of key influencing factors of development of agricultural products logistics in China

Logistics of agricultural products is a complex and open system that aims to create the time, space and potential attribute values of agricultural products, focuses on agricultural production, covers various technical, organisational, service, management and linkage activities and consists of transportation, storage, processing, handling, packaging and information processing in connection. This system not only means the process of circulation of agricultural products, but also includes the production, consumption mode and characteristics of agricultural products as a part. Besides, the spatial range and geographic location involved in the activities are also important components of the system. Therefore, any factors that affect the production, circulation and consumption of agricultural products can be the key to the evolution of agricultural product logistics in China. Based on that, by adopting the combination of literature review and expert consultation, this paper summarises the 13 key factors influencing the development of agricultural product logistics in China.

1 Construction of peasant cooperatives. To gather the decentralised peasant households by means of the peasant cooperatives can improve the organisational degree of agricultural product logistics in the initial stage; improve the coordination degree between the main bodies of agricultural products supply chain; reduce the information asymmetry phenomenon (Hitchman, 2015); ensure food safety (Hvitsand, 2016); and realise sustainable development of agricultural products supply (Balázs et al., 2016).

2 Peasants’ consciousness of cold chain logistics. As a result of the lack of cold chain, the decay rate of agricultural products in China is as high as 50%, which is 3 to 4 times that of foreign countries, resulting in considerable waste of resources. As the ‘first kilometre’ of the cold chain logistics, peasants’ cold chain awareness has an important influence on the overall efficiency and benefit of agricultural products logistics (An et al., 2015).

3 Cooperating level of node enterprises. The close cooperative relationship between logistics node enterprises can reduce the uncertainty of logistics activities; could help to optimise and integrate transportation routes, thereby reducing operation cost of enterprises (Aggarwal and Srivastava, 2016); could help to realise the sharing of market information and customer resources and improve the overall operation
efficiency of logistics (Xu et al., 2014); and it could ensure the seamless connection of the whole cold chain, so as to ensure the quality of food.

4 Construction of information service system. It mainly includes hardware equipment, software system and supporting services. The new round of information technology revolution represented by big data, Internet of things, cloud computing and mobile Internet has affected the whole process of agricultural product production, circulation and consumption of agricultural products in China. The wide application of logistics information technology has realised the full sharing and utilisation of information among enterprises (Gong et al., 2015) and changed the cooperative mode of node enterprises (Verdouw et al., 2013), improved logistics efficiency (Gong and Liu., 2013), reduced transaction costs and has promoted the coordination of all aspects of logistics system (Yan et al., 2015). Besides, it helps to trace the quality and safety of agricultural products (Kumari et al., 2015; Xiao et al., 2016).

5 Construction of market system of agricultural products logistics. It mainly refers to the scale, proportion and location choices on logistics centre, logistics parks, wholesale markets, distribution centres and other logistics infrastructures. Reasonable planning on the scale and layout of logistics infrastructures have a direct influence on the efficiency (Man, 2015), demands, pattern, cost and circulation capacity of agricultural products logistics.

6 Organisational degree of agricultural products production. The small-scale production pattern of peasant household not only has the problem of supervision difficulty, but also is unfavourable to the popularisation of scientific production technology. Moreover, it is very difficult for peasant household to directly link with supermarkets and large-scale shopping malls (Zhang et al., 2009), which will hinder the improvement of the organisation mode of agricultural products circulation.

7 Processing capacity of agricultural products. It mainly includes the handling and transportation technology, the storage, packaging and refrigeration technology of agricultural products and the processing technology of agricultural products. The realisation of agricultural products transforming from farms to dining tables with high quality must be supported by precooling technology, cold chain transportation technology and packaging technology (Augustin et al., 2016). The advanced logistics technology can increase the velocity of circulation and improve the flexibility of logistics activities. Meanwhile, processing is the key link to increase the added value of the overall benefits of logistics activities.

8 Construction of standardisation system of agricultural products logistics. It includes standardisation of transport, operation procedures, quality, hygiene and information expression. Logistics standardisation system is the basis of coordinated development of node enterprises (Verdouw et al., 2013); is the key to solving the food traceability problem (Liu et al., 2012); also it is the guarantee to promote the effective connection between agricultural products logistics and other subsystems of society, which has important practical significance for improving the efficiency of agricultural products circulation.

9 Logistics financial development. Rural finance has a positive transmission effect and driving effect on agricultural products logistics (Clapp, 2014), which is the
reasonable measure to break through the development bottleneck and to resolve the financing difficulty in the process of agricultural products circulation (Chen et al., 2016).

10 Development of supporting institutions. It mainly includes universities, research institutions, agricultural products logistics associations, training advisory bodies and related intermediary service provider. The agricultural products logistics intermediary organisations play an active role in promoting the industrialisation of agriculture, linking the supply and demand market of agricultural products, striving for policy support, implement of supervision and management, reducing the cost of information search and transaction costs and exploring the international market (Lehtinen et al., 2016).

11 Government support. It mainly includes financial support and preferential policy-making. Government is an important factor affecting the development of agricultural products logistics in China (Mor et al., 2015). As the leading force in the social and economic development environment, government’s macro guidance and overall planning for the development of logistics can help to break the isolated segments and the restriction of local protectionism. As a rule maker and executor, the government can promote the standardisation, institutionalisation and legalisation of agricultural products logistics. Besides, the ‘incubation’ of the government in financing, fiscal expenditure, taxation, regulation, communication, traffic and so on, has an exogenous impetus to the birth and perfection of agricultural products logistics system. The government’s management of food safety has a direct impact on the investment scale of the food supply chain. The environmental protection requirements affect the infrastructure and technical content of the logistics infrastructures.

12 Consumer demand. The high quality and flexibility of consumers’ demand for agricultural products promotes innovation and optimisation of logistics operation (Mu et al., 2015; Hu, 2016); promotes the rationalisation of agricultural product logistics distribution system; also promotes the upgrading of the supply chain management of agricultural products.

13 Professionalisation and marketisation level of logistics. The logistics concept (Akhtar and Khan, 2015), organisational degree, reserve of talents and completion degree of service of the main body of supplies of agricultural products logistics, can have a direct impact on the operational effect of agricultural products logistics and management capacity of agricultural products supply chain.

3 Analysis on the hierarchy structure of key influencing factors of development of agricultural products logistics in China

3.1 Solution methodology

ISM is a widely used modern analysis method in system engineering, with which a hierarchical structure model is built through division of a complex system into several subsystems and by taking advantage of people’s practical experience and knowledge and the help of computers (Warfield, 1974). The model is based on qualitative analysis and
belongs to conceptual model. It can transform vague ideas and views into visual and well-structured models. It is especially suitable for system analysis with many variables, complicated relation and unclear structure. The various steps involved in the ISM methodology are as follows:

Step 1  Listing variables considered for the system under consideration.

Step 2  A structural self-interaction matrix (SSIM) is developed for variables through the judgement of contextual relationship among the variables identified in step 1.

Step 3  Reachability matrix is developed from the SSIM by considering the transitivity of relation. The transitivity of the contextual relation is a basic assumption made in ISM. It states that if a variable A is related to B and B is related to C, then A is necessarily related to C.

Step 4  Based on the relationships given above in the reachability matrix, a directed graph is drawn and the transitive links are removed. The reachability matrix is converted into reduced matrix.

Step 5  The reduced matrix is processed hierarchically and the interpretative structure model is obtained.

3.2 Correlation matrix analysis on the key influencing factors

According to the above analysis, the paper chooses a total of 13 key elements as the research subject, namely:

- S_1  construction of peasant cooperatives
- S_2  peasants’ consciousness of cold chain logistics
- S_3  cooperating level of node enterprises
- S_4  construction of information service system
- S_5  construction of market system of agricultural products logistics
- S_6  organisation degree of agricultural production
- S_7  processing capacity of agricultural products
- S_8  construction of standardisation system of agricultural products logistics
- S_9  logistics financial development
- S_{10}  development of supporting institutions
- S_{11}  government support
- S_{12}  consumer demand
- S_{13}  professionalisation and marketisation of logistics.

In order to accurately identify the relationship among elements, ten practice experts of agricultural products logistics in different sectors and ten theoretical scholars are invited to constitute a discussion group. According to the management experience and theoretical
knowledge of the team members, the SSIM is constructed by judging whether the elements i and j have influencing relationship, as shown in Table 1.

### Table 1 SSIM of key influencing factors

<table>
<thead>
<tr>
<th>$S_{index}$</th>
<th>$S_{13}$</th>
<th>$S_{12}$</th>
<th>$S_{11}$</th>
<th>$S_{10}$</th>
<th>$S_{9}$</th>
<th>$S_{8}$</th>
<th>$S_{7}$</th>
<th>$S_{6}$</th>
<th>$S_{5}$</th>
<th>$S_{4}$</th>
<th>$S_{3}$</th>
<th>$S_{2}$</th>
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<td>O</td>
<td>A</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>V</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>$S_2$</td>
<td>V</td>
<td>O</td>
<td>O</td>
<td>A</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
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<td>O</td>
<td>O</td>
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<td>O</td>
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<td>O</td>
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<td>O</td>
<td>O</td>
<td>A</td>
<td>O</td>
<td>O</td>
<td>A</td>
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<tr>
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<td>A</td>
<td>O</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
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<td>O</td>
<td>A</td>
<td>O</td>
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<tr>
<td>$S_5$</td>
<td>X</td>
<td>A</td>
<td>A</td>
<td>O</td>
<td>A</td>
<td>O</td>
<td>V</td>
<td>O</td>
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<td>O</td>
<td>A</td>
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<tr>
<td>$S_6$</td>
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<td>O</td>
<td>A</td>
<td>O</td>
<td>O</td>
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<tr>
<td>$S_7$</td>
<td>O</td>
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<td>A</td>
<td>O</td>
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<tr>
<td>$S_8$</td>
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<td>A</td>
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<tr>
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<td>V</td>
<td>O</td>
<td>A</td>
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<tr>
<td>$S_{10}$</td>
<td>V</td>
<td>O</td>
<td>X</td>
<td>O</td>
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<tr>
<td>$S_{11}$</td>
<td>V</td>
<td>O</td>
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<td>O</td>
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<tr>
<td>$S_{12}$</td>
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<td>O</td>
</tr>
</tbody>
</table>

The four symbols of V, A, X and O are used to denote the relationship of the key factors (i and j) influencing the development of agricultural products logistics in China: marking ‘V’ at the correlation matrix (i, j) indicates that the influencing factor i has direct or indirect influence on factor j, but j has no effect on i; marking ‘A’ at the correlation matrix (i, j) indicates that the influence factor j has direct or indirect influence on the factor i, but i has no influence on j; marking ‘X’ at the correlation matrix (i, j) indicates the interaction between factor i and factor j; marking ‘O’ at the correlation matrix (i, j) indicates that there is no interaction between factor i and factor j.

### 3.3 Reachable matrix analysis of key influencing factors

According to the correlation matrix of the elements, the relationship of the key factors influencing the development of agricultural products logistics in China is quantified and two reachable matrices are obtained, namely, the initial reachable matrix (IRM) and the final reachable matrix (FRM). The FRM is obtained by Boolean operation of the IRM. In this process, the SSIM is transformed into the IRM. The transformation principle is:

$$a_{ij} = \begin{cases} 1, & S_i \text{ has a relationship with } S_j, \\ 0, & S_i \overline{S_j}, \quad \overline{S_j} \text{ says } S_i \text{ has no relationship with } S_j \end{cases}$$

Boolean algebra is the following: With $A = IRM$, $M = FRM$ and $I$ is the unit matrix, calculated with the Boolean algebraic operation rule, if $(A + I)^{r} (A + I)^{r+1} \neq (A + I)^{r-1}$, $M = (A + I)^{r}$ is obtained and $r$ is the times of operations. After calculation, $r = 3$ and FRM is shown in Table 2.

The FRM shows the interaction among the 13 key influencing factors. Factors such as ‘the construction of standardisation system of agricultural products logistics (S8)’ have direct or indirect impact on four factors including itself.
Table 2  FRM of key influencing factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
<th>S7</th>
<th>S8</th>
<th>S9</th>
<th>S10</th>
<th>S11</th>
<th>S12</th>
<th>S13</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>1*</td>
<td>1*</td>
<td>0</td>
<td>1*</td>
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<td>0</td>
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<td>S3</td>
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<td>S4</td>
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<td>1*</td>
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<td>0</td>
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<td>1*</td>
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<td>S11</td>
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<td>1*</td>
<td>1</td>
<td>1</td>
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<td>1</td>
<td>1</td>
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<tr>
<td>S12</td>
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<td>1</td>
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<td>S13</td>
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<td>1*</td>
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</table>

Note: * and 1 signifies that the values in Table 2 appeared due to the transitive relationship.

Table 3  Key influencing factor of regional division and hierarchical relationship

<table>
<thead>
<tr>
<th>S_i</th>
<th>R(S_i)</th>
<th>A(S_i)</th>
<th>C(S_i)</th>
<th>Hierarchy</th>
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<tbody>
<tr>
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<td>1, 10, 11</td>
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</tr>
<tr>
<td>S_2</td>
<td>2, 3, 4, 5, 7, 13</td>
<td>2, 10, 11</td>
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</tr>
<tr>
<td>S_3</td>
<td>3</td>
<td>2, 3, 4, 5, 8, 9, 10, 11, 12, 13</td>
<td>3</td>
<td>I</td>
</tr>
<tr>
<td>S_4</td>
<td>3, 4</td>
<td>2, 4, 5, 8, 9, 10, 11, 12, 13</td>
<td>4</td>
<td>II</td>
</tr>
<tr>
<td>S_5</td>
<td>3, 4, 5, 7, 13</td>
<td>2, 5, 9, 10, 11, 12, 13</td>
<td>5, 13</td>
<td>III</td>
</tr>
<tr>
<td>S_6</td>
<td>6</td>
<td>1, 6, 10, 11</td>
<td>6</td>
<td>I</td>
</tr>
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<td>S_7</td>
<td>7</td>
<td>2, 5, 7, 8, 9, 10, 11, 12, 13</td>
<td>7</td>
<td>I</td>
</tr>
<tr>
<td>S_8</td>
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<td>8, 10, 11, 12</td>
<td>8</td>
<td>III</td>
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</table>

3.4 The hierarchy division of key influencing factors

The key factors influencing the development of agricultural products logistics in China are divided into regions. The regions are independent from each other, but there is interaction in factors of sub-regions. First, the reachable set R(S_i), the prior set A(S_i) and the common set C(S_i) are partitioned according to the FRM. R(S_i) refers to the set of all the factors that can be influenced by the factor S_i, that is, R(S_i) = \{S_j \in N \mid m_{ij} = 1\} and N
is the set of all nodes; $A(S_i) = \{S_j \in N \mid m_{ij} = 1\}$, where $N$ is the set of all nodes and $A(S_i)$ is the set of all the factors that can reach $S_i$. The common set $C(S_i)$ is the intersection of reachable set $R(S_i)$ and prior set $A(S_i)$.

After dividing the different regions, it is necessary to determine the hierarchical status of the factors within each sub-region. If the factor $S_i$ satisfies the principle $R(S_i) = R(S_i) \cap A(S_i)$, the factor $S_i$ belongs to the highest-level factor in ISM. Once the highest-level factor is found, it can be removed from the FRM by the row and column where it is located. And then find the new $R(S_i) = R(S_i) \cap A(S_i)$ from the remaining factors of the FRM to find the subordinate factors. Carry on in the same way until the lowest level factor is determined. After hierarchical partitioning, the 13 factors in the FRM can be divided into five levels: $L = \{L_1, L_2, L_3, L_4, L_5\}$. Table 3 shows the regional distribution and hierarchical relationship of those key factors.

3.5 Interpretative structural model and model analysis of key influencing factors

It can be seen from Figure 1 that the 13 key factors influencing the development of Chinese agricultural products logistics can be divided into five different levels. Factors at different levels have different influential degrees and there is interaction between them, that is, the elements of the lower-level factors will have an influence on the higher-level factors. The above five hierarchies are explained and analysed as follows:

**Figure 1** Hierarchical structure of key influencing factors of agricultural products logistics
Factors at the bottom level include: the development of supporting institutions ($S_{10}$) and government support ($S_{11}$). These two influential factors run through almost all the important parts of the whole system. They are the fundamental factors that influence the development of agricultural products logistics in China. On one hand, the government’s strong support on capital and taxation directly promote the development of agricultural products logistics in China; on the other hand, the government’s policy guidance can encourage and guide the flow of resources such as social capital and high-level talents to the field of agricultural products logistics, so as to promote its development. In addition, the government has a direct impact on the development speed and standard of farmer cooperatives. Supporting institutions play an active role in training senior management personnel, training operators, setting standards of logistics industry, pushing for policy support from government and transferring market demand.

Factors in the fourth level include: peasants’ consciousness of cold chain logistics ($S_2$), logistics financial development ($S_9$) and consumer demand ($S_{12}$), which are the driving factors and deep reasons for impacting the development of agricultural product logistics in China. To effectively meet the consumer demand is the goal of Chinese agricultural logistics, therefore, the construction of market system and the standard system of agricultural product logistics will be affected by consumer demand. It should be noted that the consumer demand has strong independence and it is not affected by the factors in the lower level, which means that individual considerations need to be taken into account. The peasants are the primary link of agricultural products logistics and their consciousness of cold chain determines the status of agricultural products into the circulation field, directly influences the efficiency of logistics enterprises and service quality. Logistics finance, especially in agricultural products field, can provide financial guarantee for the development of professional logistics enterprises and the construction of public logistics infrastructure.

Factors in the third level include: professionalisation and marketisation level of logistics ($S_{13}$), the construction of market system of agricultural product logistics ($S_5$), the construction of standardisation system of agricultural product logistics ($S_8$), which are the intermediate factors influencing the development of agricultural products logistics. Professionalisation and marketisation level of logistics have a direct impact on the construction of information service system. High-quality logistics personnel, intelligent logistics equipment will ensure the accurate acquisition and timely transmission of logistics information, which is helpful to improve the information service network and is conducive to speed up information technology innovation. The orderly construction of the market system provides hardware support for the development of processing enterprises and professional logistics enterprises in field of agricultural products. In turn, the powerful professional logistics enterprises can improve and perfect the modern market system by self-built logistics infrastructure. The standardisation of the logistics industry directly affects the development of information systems and storage, packaging, sorting, processing and other operating standards.

Factors in the second level include: the construction of information service system ($S_4$) and the construction of peasant cooperatives ($S_1$) are the shallow reasons influencing Chinese agricultural products logistics. The complete information service system can realise the timeliness and accuracy of information transfer, thus reducing the transaction
costs of enterprises, improving the efficiency of enterprise collaboration, increasing the possibility of long-term cooperation among node enterprises. Developing peasants’ cooperatives is conducive to promoting the industrialisation of agriculture and improving the organisation level of agricultural production.

Factors in the first level include: the cooperating level of node enterprises \( (S_3) \), processing and transformation capacity of agricultural products \( (S_7) \), the organisation degree of agricultural production \( (S_6) \), are the superficial factors, which are the direct reason for the development of agricultural products logistics in China. Poor cohesion between node enterprises increases the uncertainty and lag of logistics decision-making and reduces the overall efficiency of logistics activities. The processing and transformation capacity of agricultural products directly affects the safety of agricultural products and the value added level of logistics activities. The diversification and small-scale production of individual peasant household increases the difficulty of standardisation and scale operation of the agricultural products logistics and reduces the quality and efficiency of logistics service.

4 Conclusions

4.1 Conclusions and policy suggestion

On the basis of the existing research results, in combination with the actual development of and expert opinions on China’s logistics of agricultural products, 13 key factors that affect the development of agricultural products logistics in China are summarised, including:

- \( S_1 \) construction of peasant cooperatives
- \( S_2 \) peasants’ consciousness of cold chain logistics
- \( S_3 \) cooperating level of node enterprises
- \( S_4 \) construction of information service system
- \( S_5 \) construction of market system of agricultural products logistics
- \( S_6 \) organisation degree of agricultural production
- \( S_7 \) processing capacity of agricultural products
- \( S_8 \) construction of standardisation system of agricultural products logistics
- \( S_9 \) logistics financial development
- \( S_{10} \) development of supporting institutions
- \( S_{11} \) government support
- \( S_{12} \) consumer demand
- \( S_{13} \) professionalisation and marketisation of logistics.

Later, the paper applies the idea of system engineering and adopts the ISM to construct the hierarchical structure model of the 13 key influencing factors, which directly reflects
the hierarchical relation among the factors and clarifies the complex relationship between the factors influencing the development of Chinese agricultural products logistics.

Combining with the conclusion of this paper and the current development trend of agricultural products logistics in China, this paper puts forward the following suggestions:

1 The Government should give more support for agricultural logistics to create a harmonious operating environment. On the basis of strengthening the construction of logistics infrastructure and increasing capital investment, the government should play an active role in policy guidance and macro-control. In the public opinion guidance, the propaganda of the importance of the whole cold chain should be further increased and the public, especially peasantsʼ awareness of cold chain should be enhanced. In policy formulation, the government should deepen the reform of the circulation system and simplify the approval procedures of the whole freight line; extend the limitation on bank loans and broaden the financing channels for small and medium logistics enterprises of agricultural products; actively cultivate industry leaders and encourage large-scale logistics enterprises in eligible conditions to list and finance; support logistics enterprises, industry associations and private education institutions in organising practitioner training; establish the whole mechanism that can effectively stimulate and supervise the cold chain logistics market, so as to speed up the process of marketisation of logistics enterprises. In construction of laws and regulations, the government should strengthen the agricultural base certification, quality certification, origin environmental monitoring, strictly implement agricultural access system and the dealer access system; so as to remove the monopolistic behaviour.

Reasonably plan the agricultural product logistics market layout system and build high-level logistics backbone nodes. Based on the regional characteristics of China agricultural economy and consumption of agricultural products, by reference to the layout of Chinese agricultural product circulation backbone networks, in combination with the future spatial pattern of urban system, government should focus on the construction of high-level agricultural product logistics backbone nodes. Within urban agglomeration, give priority to the construction of multi-functional logistics parks that integrate low-temperature storage, inspection and quarantine, circulation processing, information service, trade show and electronic settlement in the small towns with convenient traffic. At the traffic hubs of the urban periphery, construct intelligent flexible distribution centres and provide special vehicles for cold storage and low-temperature refrigerating storages.

2 Give full play to the role of supporting institutions. Colleges and universities should expand agricultural logistics management major, deepen production-learning-research cooperation and innovate logistics personnel training mode. Scientific research institutions should deepen cooperation with logistics enterprises, increase the R&D investment and achievement transformation of logistics technology according to the actual needs. Social service consulting institutions should organise trainings of peasant skills in rural areas. Logistics associations should actively convey the aspirations and needs of enterprises and consumers to the superior level; assist the government to formulate logistics standards and timely respond to the implementation of policy; strictly implement the qualification examination system
and license issuance system; actively promote the advanced concept of logistics, introduce the successful case of enterprise innovation and encourage enterprises to establish long-term alliance cooperation.

3 The agricultural products logistics financial model should be innovated. The traditional logistics financial service should expand its object scope. Peasants should be encouraged to participate in the logistics finance of agricultural products. Promoting land trust circulation mechanism in rural and converting the rural real estate of ‘immovable land’ and ‘wasted land’ to chattel mortgage of ‘movable land’ and ‘golden land’. The online agricultural supply chain finance should be actively developed, that is, based on the network trade information between upstream and downstream, taking electronic warehouse receipts/orders as the pledge to complete financing by efficiently cooperating with the core enterprises and other enterprises. The agricultural logistics business management level and risk prevention ability should be enhanced through the establishment of agricultural products enterprise credibility certification system and agricultural products warehouse pledge certification testing system.

4 Strengthen the application of new internet technology. In the link of production and processing, establishing different types of electronic tag codes for raw materials, which should be input into a special database and the entire production process, should be monitored in real time, including the growth of agricultural products, processing operating procedures and biological indicators change of agricultural products. In the storage management link, attaching RFID tags to the agricultural products trays and the package to track the storage goods dynamically. In the transport link, applying the internet of things to position transport vehicles and goods in transit in real time, big data and cloud computing should be used to quickly match the transport vehicles with the optimum route. In the consumption link, adopting big data to discover the consumers’ demand and collecting consumers’ feedback to improve public participation in food safety regulation and enterprise service evaluation. In the process of information processing, using big data and cloud computing to collect, store and analyse the market supply and demand information, corporate credit evaluation and related industry standards and policies, so as to achieving the full sharing and use of information.

5 Speeding up the standardisation process of agricultural products logistics. First, government should promote the standardisation of agricultural production. Government departments, associations and certification bodies need to promote the construction of agricultural standards system (including pollution standards, green standards and organic standards), to promote the implementation of advanced standards, to strengthen the supervision of the implementation of standards and to promote agricultural quality certification. Second, to promote the standardisation of processing, so that agricultural products can be graded, classified and packaged in a normalised way. Third, actively promoting the standardisation of agricultural products circulation and establishing a complete agricultural logistics quality certification system to speed up the integration with international standards. Fourth, to promote the standardisation of agricultural products circulation information, to normalise related equipment, facilities and other hardware technology and database
Improving the level of information service platform integration. Departments of agriculture, sanitation, quality control, industry and commerce, taxation, customs, banks, insurance, information and so on should be encouraged to participate in the construction of information service platform to realise the interconnection of all links in the agricultural products supply chain. The platform should be built into a comprehensive platform which integrates information collection, information storage, information inquiry, notification release, data exchange, logistics transaction support, cargo tracking and industry application hosting services.

4.2 Contributions

By reviewing the factors affecting the development of agricultural products logistics in China, it is found that there is no consensus on the main factors hindering its development and there is a lack of research on the relationship between influencing factors when analysing the degree of factor influence. In view of this, based on the connotation of the logistics of agricultural products, in consideration of the intricacies among factors, by using ISM, this paper establishes a hierarchical structure of the key factors that affect the development of China’s logistics of agricultural products.

At the same time, this paper has important revelation to the government policy-makers as well as the enterprise decision-makers. In view of the current shortage of the development of agricultural products logistics in China, when making policy adjustment and strategy formulation, we should explore the underlying reasons behind the phenomenon, so as to identify the effective policy focus and the key point of enterprise management innovation. For example, Scholars have realised that efficient collaboration among logistics node enterprises plays an important role in improving the efficiency of Chinese agricultural products logistics. Therefore, scholars urge the enterprises to raise their cooperation consciousness and strengthen the management of supply chain relationship. However, the conclusion of this paper shows that the cooperation level of the node enterprises is influenced by the completeness of the information service system, the construction level of the logistics standardisation system and the demand of the consumers in turn. From the enterprise level alone, it is difficult to effectively improve the efficiency of logistics node enterprise collaboration. We should make full analysis of consumer demand, on this basis, establishing the corresponding product packaging standards, cold chain transport standards, data collection standards and other logistics standard system and information service system, thus reducing transaction costs and promoting the cooperation of node enterprises.

4.3 Shortcomings and prospects

There are limitations of this paper during the research process: first, the limitations of the number of experts. It is difficult to get full collection of all the views of experts who are related to the agricultural products logistics in the actual research, which may affect the completeness of the research results to some extent. Second, due to the existence of subjective prejudice of experts, it may has deviation when analysing the relationship of
the influencing factors; Third, although the hierarchical structure model of the key factors influencing the development of agricultural products logistics has been constructed in this paper, it is still qualitative analysis and lack of statistical test of the results. The structural equation model (SEM) can quantitatively test the validity of such analytical models, therefore, in the future research, we can use the SEM to further test the interpretative structural model obtained in this paper and quantitatively obtain the function degree of each key influence factor.

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References


Research on the development of agricultural products logistics


