

Factors Affecting the Fresh Flower Cold Chain Logistics

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Abstract

The cold chain logistics of fresh flowers in China has always been high, and Yunnan Province, as the largest fresh flower market in China, also has some problems. This research aims to study fresh flower cold chain logistics and rank the factors affecting the fresh flower cold chain logistics in Yunnan Province. Flower's cold chain logistics process comprises front-end logistics, mid-end logistics, and back-end logistics. This research analyzes the influencing factors through literature reviews and evaluates the factors affecting the cold chain logistics of fresh flowers in Yunnan Province with the Analytic Hierarchy Process method. It was found that degree of loss (0.57937) is the most important, followed by transportation system (0.23413) and wholesaler activities (0.18651). Moreover, perishable (0.32322) is the most important sub-factor and other important sub-factors are cold chain transportation equipment (0.15609), transportation time (0.15258), and professionalism of employees (0.13988).

Keywords

Cold Chain Logistics, Fresh Flowers, Analytic Hierarchy Process.

1. Introduction

With the continuous development of the Chinese fresh flower industry, China has occupied an important position in the world's fresh flower production. Fresh flowers have excellent ornamental and gift properties, making them more favored by consumers in daily life and special festivals. According to data, from 16.88 billion yuan in 2016 to 53.51 billion yuan in 2019, the size of China's fresh flower e-commerce market has increased year by year. It is estimated that China's fresh flower e-commerce market will be 72.06 billion yuan in 2020 (Statista, 2020). The climate of Yunnan Province is unique and suitable for the growth of fresh flowers. The fresh flowers of Yunnan Province are also supplied to Asia and even exported to Europe. The fresh flower industry has become a very important industry in Yunnan Province.

The fresh flowers themselves are perishable, so they have high requirements for storage, transportation, and other activities. A cold chain is used to preserve, extend, and ensure the shelf life of products, such as fresh products, seafood, frozen food, film, chemicals, and pharmaceutical products. Adequate refrigeration is especially important to prevent quantitative and qualitative food loss. The cold chain is a series of uninterrupted cold production, storage, and distribution activities, as well as related equipment and logistics, which can maintain quality within the required low temperature range (Wang and Zhang, 2008).

The current Yunnan cold chain logistics system for fresh flowers is not perfect, and the logistics operation level is low. This has caused serious loss of fresh flowers, so the cold chain logistics of fresh flowers has been high, and the transaction price of fresh flowers will also increase. Therefore, it is particularly important to analyze factors of the Yunnan fresh flower cold chain logistics.

The Analytic Hierarchy Process (AHP) is a method for organizing and analyzing complex decisions, using math and psychology (Pagano, et al., 2021). It was developed by Saaty, (1980) and has been refined since then. AHP is a systematic analysis method that combines qualitative and quantitative. It can quantitatively analyze the weights of each influencing factor and various indicators of the overall goal. AHP and other methods can be used to analyze relevant data obtained from expert interviews.

This research mainly analyzes the influencing factors through literature reviews and evaluates the factors affecting the cold chain logistics of fresh flowers in Yunnan Province with AHP method. Providing suggestions on fresh flowers industry in Yunnan province are put forward to reduce the loss in cold chain logistics distribution of fresh flowers and promote the development of fresh flowers industry in Yunnan province.

1.1 Objectives

- 1) To study a process of fresh flower cold chain logistics
- 2) To rank the factors affecting the fresh flowers cold chain logistics in Yunnan Province

2. Literature Review

The cold chain logistics of fresh flowers refers to the process of pre-processing, sorting, packaging, warehousing, transportation, and distribution after fresh flowers are picked and delivered to consumers under suitable low temperature conditions, thus forming a special low temperature supply chain system to reduce the loss of products (He and Ma, 2020).

Flowers cold chain logistics process can be roughly divided into three stages, in turn: front-end logistics, mid-end logistics, back-end logistics, mainly flowers products first "set" and then "scattered" (Gu, 2014). The process chart is shown in Figure 1. Front-end logistics from picking the flower belt, after the pre-processing, classification after packaging transportation to flower wholesale market or auction center, the mode of transportation most is their own cars or rented vehicle, a few through third-party logistics companies, this journey basically uses fewer cold-chain transport, lead to flowers attrition rate is higher, the front-end logistics cost is difficult to control. Mid-end logistics is completed by air transportation, road transportation and railway transportation. Long-distance shipping is frequently done by air to maintain the freshness and aging of items. Due to the long distance, low-temperature storage is carried out in the middle transportation. Back-end logistics is the destination city flower distribution center, transportation to all levels of wholesalers, then delivery to the flower shop, was bought by the consumer, because it is the city transportation, the distance is shorter, flowers cold-chain logistics be ignored easily, lack of professional transportation, "the last mile" flowers not guaranteed quality, logistics cost also will increase.

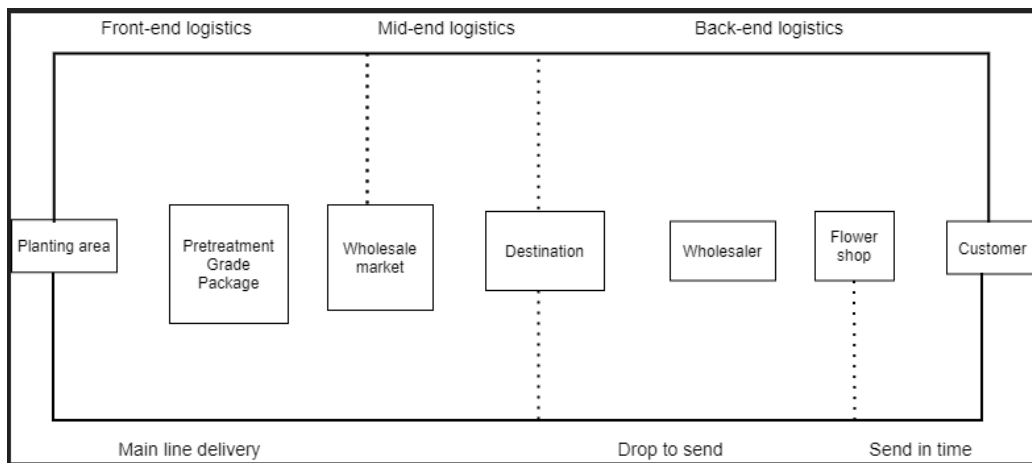


Figure 1. The process of cold chain logistics of fresh flowers

The cold chain logistics of fresh flowers in the United States is currently relatively mature. At the same time, strengthen the construction of Internet information and use electronic information technology to closely connect upstream and downstream, making the fresh flower cold chain logistics system more time-efficient and accurate. According to statistics, more than 70% of the US flower sales turnover comes from online marketing (Zeng, 2018). The cold chain logistics of flowers in the United States also has high technical requirements. After the flowers are picked, the best classification and packaging are strictly implemented on the spot according to the characteristics of the freshness of the flowers. The professional cold chain logistics company is only responsible for one or a few varieties of flowers, truly realizing professional flower transportation. Such high standards and high professionalism

ensure the quality of fresh flowers to a large extent, reduce the cost of cold chain logistics of fresh flowers, and improve the overall logistics efficiency.

The flower industry occupies an important position in the Netherlands as a major agricultural country, creating high output value for the Netherlands every year. Based on this, the cold chain logistics of flowers in the Netherlands is also highly valued. Chen and Zhao (2019) summarized the Dutch flower market strengths as high production level, comprehensive and efficient auction marketing system, modern cold chain logistics system, high quality control system, and strong product innovation and research and development capabilities. The coordination and cooperation between the auction market and professional flower logistics companies make the entire flower cold chain logistics more efficient, more standard, and reduce energy consumption and losses in the supply chain.

At present, the cold chain logistics of fresh flowers in Yunnan Province is in the stage of continuous exploration. Although the number of companies participating in cold chain logistics of fresh flowers has gradually increased. Overall, most of them are third-party logistics companies or self-operated logistics models of flower companies (Sun, 2015). The chain logistics technology is still not perfect, the degree of specialization is low, and there is a lack of professional flower product transportation companies. In addition, third-party logistics companies generally can only provide a single transportation service, and comprehensive logistics services such as fresh-keeping, low-temperature storage, sorting, packaging, transportation, warehousing, and distribution required for cold chain logistics of fresh flowers have not been developed, which restricts Development of cold chain logistics for fresh flowers. At the same time, the cold chain transportation of fresh flowers in Yunnan Province mainly adopts conventional air transportation and road and rail transportation (China farmer, 2020). In all links of its circulation, compared with the 2% loss rate of flower logistics in developed countries, the loss rate of fresh flowers in Yunnan Province is as high as 10%, the gap between the two is obvious (Sun, 2018). In addition, the consumption model of flower e-commerce in China mainland has continuously entered the eyes of consumers, but the development of flower e-commerce has also been hindered by the high requirements of the platform supply chain and cold chain distribution links.

3. Methods

The development of the cold chain logistics of fresh flowers in the People's Republic of China needs to bridge the gap comparing with the leading flower industry countries. This study examines a variety of criteria and ranks them. In the future, the most essential factor will be appropriately implemented. The AHP method is used to analyze the factors that affect the cold chain logistics of fresh flowers in Yunnan Province. The first step is to analyze and summarize the influencing factors through a survey of previously published research and interviews with relevant experts combine with questionnaires for further discussion; the second step uses the AHP to determine the weight of each factor.

3.1 Data collection

This step discusses the factors affecting the fresh flower cold chain logistics in Yunnan Province based on literature reviews on the fresh flower cold chain logistics. The most frequently mentioned factors were extracted from the papers. Ten experts from the Dounan Flower Market in Yunnan Province assessed the prepared questionnaire to compare factors using the analytic hierarchy approach to evaluate the influencing factors of the fresh flowers cold chain logistics in Yunnan Province.

3.2 Analytic Hierarchy Process

AHP is applied to determine the problem and structural level, set the goal from the top level, then go through the middle level to the lowest level, and finally get the weight. The method uses a nine-point scale (Table 1) for each pair of factors for pairwise comparison.

In order to determine the appropriateness of the questionnaire content and expert interview data, it is necessary to take the largest eigen value, and the evaluation must be tested for consistency, that is the Consistency ratio (CR) and Consistency index (CI) are calculated (Wanitwattanakosol et al., 2016). The mathematical formula is as follows:

$$CI = (\lambda_{\max} - n) / (n - 1) \quad (1)$$

where, λ_{\max} indicates an approximation of the maximum eigenvalue.

$$CR = CI / RI \quad (2)$$

Generally, if $CR < 0.1$, it is considered to have passed the consistency test, otherwise it is not considered consistent. Among them, the consistency index generated by Random consistency index (RI) under different orders, and the random index under different orders are shown in Table 2.

Table 1. Values of importance level for pairwise comparison

Numerical Rating	Verbal Judgment
1	Equal important
2	Equal to moderately more important
3	Moderately important
4	Moderate to strongly important
5	Strongly important
6	Strongly to very strongly importance
7	Very Strongly important
8	Very Strongly more important
9	Extremely important

Table 2. Random consistency index

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52	1.54	1.56	1.58	1.59

4. Results and Discussion

Through literature review, eleven factors were derived such as degree of loss, transportation system, wholesaler activities etc. The specific definitions and sources of each factor are shown in Table 3. AHP was applied to build a hierarchy comprised of three main factors: degree of loss, transportation system and wholesaler activities. The other factors are sub-factors as shown in Figure 2. The pairwise comparison was performed at the same level, and the standard important weights were obtained after consistency testing, as shown in Table 4 and 5. It was found that degree of loss (0.57937) is the most important, followed by transportation system (0.23413) and wholesaler activities (0.18651). Sub-factors of main factor A (degree of loss) are depicted in Table 6 and 7 as an example of the sub-factor section. Perishable (0.55789) is an important role in term of degree of loss factor.

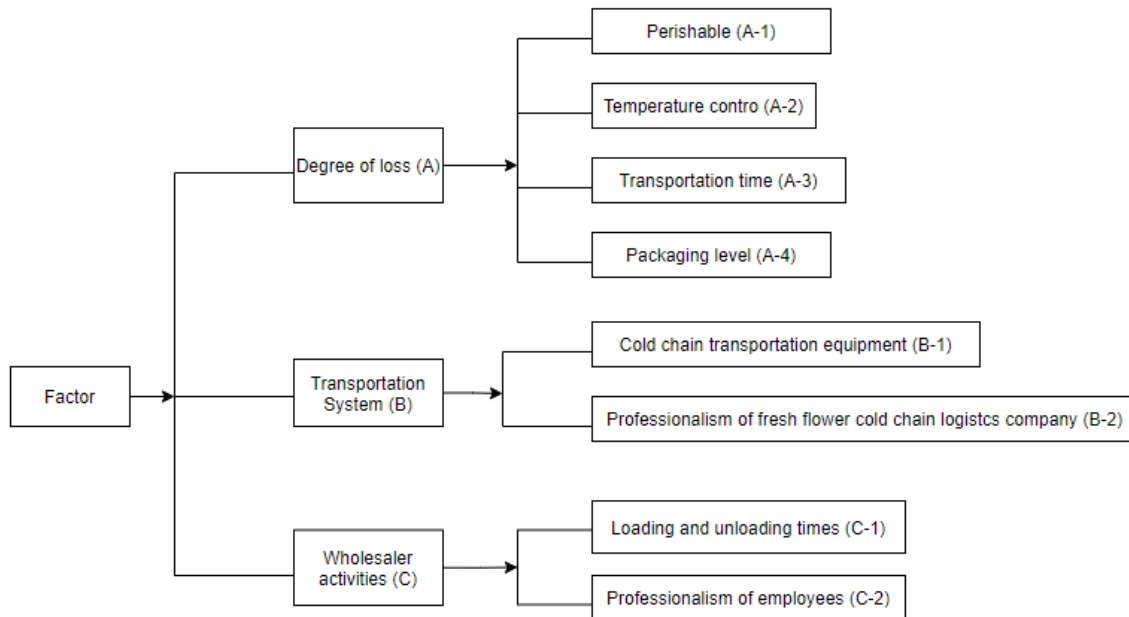


Figure 2. The hierarchy of the fresh flower cold chain logistics

Table 3. The factors affecting the fresh flowers cold chain logistics

Factor	Code	Definition of factor	Reference
Degree of loss	A	The degree of damage to fresh flowers in various links.	Tingting, (2017) Gu, (2014)
Perishable	A-1	The fresh flowers themselves are perishable.	Tingting, (2017)
Temperature control	A-2	Temperature change control of fresh flowers during storage and transportation.	Gu, (2014) Li and Wang, (2018)
Transportation time	A-3	The length of time the fresh flowers are transported in each link.	Hu and Lu, (2020) Gu, (2020) Li and Wang, (2018)
Packaging level	A-4	In the process of cold chain logistics of fresh flowers, the packaging method and level of fresh flowers.	Hu and Lu, (2020)
Transportation System	B	A cold chain logistics transportation system for fresh flowers mainly composed of transportation equipment, transportation companies, etc.	Hu and Lu, (2020) Gu, (2020)
Cold chain transportation equipment	B-1	Cold chain logistics equipment used to transport fresh flowers, with the function of constant temperature and transportation, such as cold chain vehicles.	Hu and Lu, (2020) Sun, (2018)

Professionalism of fresh flower cold chain logistics company	B-2	Specialized in the service of flowers cold chain logistics transportation and management of the company, different from the traditional logistics companies.	Wang et al., (2016) Hu and Lu, (2020)
Wholesaler activities	C	In the transport link, experienced many wholesaler activities.	Liao and He, (2008)
Loading and unloading times	C-1	The number of loading and unloading of fresh flowers in the intermediate links of cold chain logistics transportation.	Hu and Lu, (2020) Tingting, (2017)
Professionalism of employees	C-2	Professionals with knowledge of flowers and cold chain logistics, responsible for artificial technology of cold chain transport of fresh flowers.	Sun, (2018)

Table 4. Main factor pairwise comparisons

	A	B	C
A	1	2	4
B	0.5	1	1
C	0.25	1	1

Table 5. Summary of main factor analysis

Code	Feature vectors	Weight value	Maximum eigenvalue	CI	RI	CR
A	1.738	0.57937	3.054	0.027	0.520	0.052
B	0.702	0.23413				
C	0.560	0.18651				

Table 6. Sub-factor pairwise comparisons

	A-1	A-2	A-3	A-4
A-1	1	5	3	7
A-2	0.2	1	0.3333333	3
A-3	0.3333333	3	1	5
A-4	0.1428571	0.3333333	0.2	1

Table 7. Summary of sub-factor analysis

Code	Feature vector	Weight value	Maximum eigenvalue	CI	RI	CR
A-1	2.232	0.55789	4.118	0.039	0.890	0.044

Code	Feature vector	Weight value	Maximum eigenvalue	CI	RI	CR
A-2	0.487	0.12187				
A-3	1.053	0.26335				
A-4	0.228	0.05689				

Table 8 displays sub-factor ranked results. Perishable (0.32322) is the most important sub-factor in the main factor A, followed by transportation time (0.15258) temperature control (0.07061), and packaging level (0.03296). In the main factor B, the weight of sub-factor is cold chain transportation equipment (0.15609), professionalism of fresh flower cold chain logistics company (0.07804). In the main factor C, the weight of the sub factor is professionalism of employees (0.13988) and loading and unloading times (0.04663).

5. Conclusion

As China's largest fresh flower trading market in Yunnan Province, cold chain management is crucial to the sales of fresh flowers in Yunnan Province. It could improve the quality of the fresh flowers by prolonging the life of the fresh flowers and increasing the value of the fresh flowers. Flowers cold chain logistics process can be roughly divided into three stages, in turn: front-end logistics, mid-end logistics, back-end logistics. Among reviewed factors, degree of loss (0.57937) is the most important, especially on the perishable (0.32322) as the most weighted sub-factor. The flower industry in Yunnan Province needs to develop a diversified cold chain transportation system to solve the perishable problem. Moreover, fresh flower employees should be trained by foreign professional team to leverage skills.

Table 8. Sub-factor ranking

Code	Factor	Weight
A-1	Perishable	0.32322
B-1	Cold chain transportation equipment	0.15609
A-3	Transportation time	0.15258
C-2	Professionalism of employees	0.13988
B-2	Professionalism of fresh flower cold chain logistics company	0.07804
A-2	Temperature control	0.07061
C-1	Loading and unloading times	0.04663
A-4	Packaging level	0.03296

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Biographies

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