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EMPIRICAL STUDY OF KEY SUCCESS FACTORS OF CLOSED SUPPLY CHAIN FOR VEGETABLES: THE CASE OF EXPORT FROM YUNAN TO THAILAND

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Abstract

This paper analyzes the key success factors of the closed supply chain for vegetables exported from Yunnan and Thailand by empirical study, with the aim of guaranteeing the quality and safety of vegetables. After the introduction, literature reviews with the key term of vegetable quality and safety are presented. Followed section 3 indicates data sources and methodologies from both quantitative and qualitative approaches. Then operation results and discussion are shown to determine the key success factors. The last section proposes some recommendations for member enterprises and related government departments.

Keywords: Closed Supply Chain, Vegetable Quality and Safety, Key Success Factors, Logistic Regression Model.

1. Introduction and Purpose

Nowadays, the food safety incidents occurred frequently in many countries, how to effectively address the quality and safety issues of agro-products has become the common concern all over the world. In vegetable supply chain, consumers' awareness of vegetable quality and safety is increasingly awakening, and they are quite concerned about the safety information of vegetables, however, their assessments of vegetable quality and safety are not very optimistic, which brings stress to enterprises and pushes them to improve the quality and safety of vegetables in the supply chain.

Thailand and China are the major participates of economic cooperation in Greater Mekong Subregion (GMS) and China-ASEAN Free Trade Area (CAFTA), and the structure of agro-productsin two countries are complementary. China is Thailand's second largest export market and the largest source of imports (Thai Customs, 2020).[1]Yunnan Province located in southwest boarder of China is a pivotal gateway from Thailand to China.In the first seven months of 2019, the bilateral tradevalue between Thailand and Yunnan reached 8.14billion dollars, 67.3% more than in 2018. In the first four months of 2020, vegetable exports from Yunnan to Thailand was 316,000 tons, 20.6% more than in 2019, which reached 39.7 million dollars, 18.1% more than in 2019(Kunming Customs District China, 2020).[2]

However, the risks of the quality and safety of Yunnan vegetablesstill exist, and some of products cannot reach the import standards of Thailand. In second half of 2019, the sampling inspection results from Yunnan Administration for Market Regulation indicated that in 74,989

1http://www.customs.go.th
2 http://kunming.customs.gov.cn/

samples, the quantity of unqualified was 3,353, a defect rate of 4.5%.[3] In first half of 2018, the total amount of agro-products returned or destroyed due to unqualified quality reached 20 million dollars, accounting for 6.5% of the total(Kunming Customs District China, 2018).[4] Especially since the outbreak of COVID-19, Thai Customs strictly inspects each batch of vegetables from China and makes more strict requirements of the clearance for Yunnan vegetables. In addition, the big losses in distribution process lead to high costs to the vegetables supply chain. Thus, aiming to guarantee the quality and safety of vegetables and reduce losses in the distribution, exploring a closed supply chain[5]for vegetables has great potential to benefit the tradesfor Thailand and Yunnan.It refers that on the basis of strategic cooperation of supply chain, the unified operation standards are established in each business process, and strategies are designed from different perspectives such as quality inspection and control by production and processing enterprises; supervision of government and industry association; construction of traceability information platform, and logistics system support (Jiao Zhilun,2009; Han Xiao,2014).

For this concern, two questions are proposed to be studied: what key success factors of closed supply chain would be for vegetables from Yunnan to Thailand, and what the main suggestions arefor improving the quality and safety of Yunnan vegetables exported to Thailand.

2. Literature Review

As the vegetable supply chain is a segment of agro-products supply chain, lots of theories come from that of agro-products supply chain and food supply chain. Taking vegetable quality and safety as the key term, this part reviewed researches concerning the key success factors for the vegetablesupply chain.

The origin of theories on vegetable quality and safety can be traced back to studies on economic behaviors under the condition of asymmetric and incomplete information. Two of the researches worthy of being mentioned has been contributed by Stigler's Economics of Information (1961) and Acherlof's Theory of Lemon Markets(1970). Stigler studies the cost and value of information, and the effects of information on wages, prices, as well as other factors of production. Acherlof introduces the assumption of commodity quality dimension, and using lemon market model, proves that information asymmetry could lead to adverse selection. Therefore, completeness of commodity quality information is essential to the fairness of transaction and the operating efficiency of the market.

Caswell (1996) suggests that aiming to guarantee the safe consumption for customers and safe production for enterprises, it's necessary to improve the quality inspection and testing system, certificate of market entry for agro-products, and labeling agro-products with kinds of standard labels.

Vetter (2002) deems that in order to effectively reduce the moral hazard of product quality in agro-products supply chain, carrying out the vertical integration is the best solution. Furthermore, multi-department management will result in opportunism behaviors of government, which will reduce government's inspection efficiency. Similarly, Yang Weimin (2006) suggests that the leader enterprises in agro-products supply chain should actively adopt the vertical integration in order to guarantee the quality and safety of vegetables.

3 http://amr.yn.gov.cn/info/1027/7971.htm
4http://kunming.customs.gov.cn/
5 It was first proposed by Chinese scholars in 2006 and closely focuses on product quality and safety control at each process. Further, it is oriented by market demands. The word of "Closed" means the supply chain doesn't open to all enterprises but only allows those whose products meet relevant quality and safety standards to be the supply chain members. Compared to the traditional supply chain, it increases the threshold for enterprises to enter the supply chain.From: Liu Binglian, 2007. Demonstration Project of Technology Integration and Industrialization of Closed Supply Chain for Green Agricultural Products[R], p 22.

Tan Tao and Zhu Yihua (2004) define the vertical collaboration in vegetable industry. It refers that a unit engaged in a certain link of vegetable business joins with its upstream and downstream members by contract or investment,and sharing risk as well as equal profit. This pattern can help supply chain members to effectively ensure the quality of vegetables, and improve benefits and competitive advantage.

Zhang Min (2010) using principal-agent theory, analyses the difficulties faced by the widely adopted model of "Leader enterprise + Farmer", and proposes to establish anew model of "Leader enterprise+ Vegetable cooperative" in the purpose of ensuring the quality and safety of agro-products and protecting famers' economic benefits.

Zuurbier (1996) based on the general supply chain, first proposes the concept of food supply chain which aims to improve the quality and safety. Now, the management mode of food supply chain has been widely used in the United States, Britain, Canada, Holland, etc., and has become the focus of academic research (Furness A.,2003).

Ritson (1998) proposes to replace the government regulation with co-regulation, which refers that when designing the regulation system, the related government department, food supply chain enterprises, research institutes, and customers should be fully involved in the system.

Buzby(2003) points out that the standard system of food safety dominated by government can effectively promote implementing the food safety regulations. Moreover, the standard system includes the safety standards of food, as well as the standards of operating procedures across the food supply chain.

Eric Eg (2005) and Pham (2008)indicate that the third-party certification provides beneficial service for food quality and safety. The certificate authority is one of the organizations that provides food quality signals to the market, and reduces the asymmetric information of food quality and opportunism in the market. In addition, market signals play an intrinsic role to the supply chain.

Starbird (2005) studies the quality information asymmetry on food supply chain, which is caused by inconsistent inspection standards, misjudgments for quality and safety information, and ethnical risks of quality and safety. Addressing this problem, he suggests the food retailer to integrate his suppliers, and encourage suppliers to implement quality certificate system such as GMP, ISO, and HACCP, etc. Additionally, the information traceability system located in retailer should transmit food quality and safety information among each node of supply chain.

The conclusion of the reviews could be summarized as below. Firstly, although academia has a long history development and fine theory system for improving quality and safety of agro-products supply chain, the agro-products supply chain (including vegetables supply chain) is mostly constructed in a general or macro way, the leader enterprise (production enterprise, processing enterprise, export and import enterprise, wholesale enterprise) as a subject of implementation, however, is sparsely and slightly mentioned. Secondly, while many researches of vegetables supply chain mainly focus on constructing the closed operational mode, the conditions and key success factors for implementing the closed supply chain still leave much space for further explorations. Thirdly, such important researches have experienced to demonstrate and analyze the operational mode, development and evolution mechanism of closed supply chainby building a theoretical model, but, using empirical approaches to study these issues for vegetables remains suspended.

Thus, the implication of the literature review can be described in two perspectives. Vegetable supply chain oriented by leader enterprise is worthy of a systematical and precise study. Furthermore, empirical study should be exploited to study the success factors of implementing closed supply chain for vegetables.

3. Data Sources and Methodology

Based on the result in the review, this part aims to demonstrate the data sources and theoretical hypothesis, then constructs a Logistic bivariate regression model for determining the success factors of vegetables closed supply chain.

3.1. Data Sources

Aiming to gain a comprehensive understanding about key success factors of implementing closed supply chain for vegetables, data acquisition comes from two ways. Firstly, during 2 January 2020 to 18 March 2020, a field survey was conducted for 6 production and processing enterprises and import and export enterprises in Yunnan Province[6,] and 4 import and export enterprises and wholesalers in Thailand.[7] Through questionnaires and face-to-face interviews, 76 questionnaires were distributed and the interviewees were selected from top managers and managers and staff from quality management department. Secondly, using the opportunity of Kunming Pan-Asian International Agricultural Exposition on 5 September 2019 to 9 September 2019, and seminars of enterprise standards for food safety held by Yunnan government inMay 2020, 120 questionnaires were issued to corporate executives and top managers. Additionally, 74 questionnaires were from DBA (Doctor of Business Administration) students inAsian Institute of Technology, and National Institute of Development Administration in Thailand. Totally 270 questionnaires were sent out, 248 were effectively received with effective recovery of 91.85%.

3.2 Hypothesis

Based on the result in the questionnaire survey, interviews and literature research, hypotheses are constructed from five perspectives referring to operational basis of supply chain, quality and safety control, production collaborative model, the role of leader enterprise, and external environment.

H1: Operational basis of supply chain plays a key role in implementing the closed supply chain for vegetables.

Operation management of agro-products supply chain directly influences the quality and safety of agro-products (Peng Jianfang, 2011). Thus, 4 observable variables are concerned in this study, including:

Factor 1.1: Informatization

Currently, in the vegetable supply chain between Yunnan to Thailand, it's rare for member enterprises to share information with each other, and farmers in Yunnan cannot get the demand information from Thailand in time, so that the varieties and quantities of Yunnan vegetables cannot exactly meet the demands of Thai markets. Thus, it's necessary to fully construct a shared traceability information platform connecting with each memberenterprise to timely query and share the demands, production and price information of the main vegetable varieties.

Factor 1.2: Standardization

It includes the standardized production base and standardized logistics container system, which are the compulsory thresholds for an enterprise to join in a closed supply chain. Under the standardized system, resources flow smoothly and punctually between each node and energy consumption is reduced, which ultimately improve the management level of the supply chain.

6 They are Kunming JiaHeAgro-Products Co. LTD, Kunming GuangChaoAgro-Products Development Co.LTD, Yao 'an New Green Vegetable Planting Base, YuanmouXueHong Vegetable Co., LTD, Yunnan YiChang Fruit and Vegetable Import and Export Co., Ltd, Yunnan TongMao Import and Export Co. LTD.

7They are Charoen Pokphand Group, WANGSWIT international Co. LTD, Department of Business Development of Talad Thai Market, and Marketing Department of Simon Market.

Factor 1.3: Market demand orientation:

It can help farmers promptly adjust the variety structure of planting and provide what customers want based on the market demands and actual local conditions. Moreover, in a supply chain of market demand orientated, the inferior quality vegetables are decreased with customer choices, and the market adaptabilities of vegetables are able to improved, as survival of the fittest of Darwinism.

Factor 1.4: Transportation convenience

It means improving the efficiency of customs clearance. 98.5% of Yunnan vegetables transports to Thailand take Kunming-Bangkok Highway since it have been completed in 2013 (Kunming Customs Website, 2020). However, there is no "one-stop" customs clearance, but four entry and exit procedures for the goods respectively at the Mohan, Boten, HouayXai, and Chiang Khong port. Additionally, the opening hours of ports in Laos are limited, the vegetables exported from Yunnan to Thailand are transported for more than 30 hours, which greatly increases the loss rate. Thus, transportation convenience is an urgent need to be improved to keep vegetables fresh in this supply chain.

H2: Quality and safety control isgreat significantfor implementing the closed supply chain for vegetables.

A complete management system for quality and safety enables the company to more fully realize the strength of the advanced system and accumulate more experience on supervision of food quality(Golan et al., 2007). Thus, 3 observable variables are proposed to test this hypothesis.

Factor 2.1: Quality certificate system

Due to fact that there is no unified import and export inspection and quarantine standards between Thailand and China yet, the two sides are likely to disagree on some of the technical issues, especially for the chemical residues of agro-products. In 2019, the place of origin and market access system are only implemented in Yuxi, which is one of the major vegetable origins in Yunnan province (Yuxi Agricultural Information Network,2019). Green and organic certificates are still not popularized through the whole province. Thus, it's significant for two countries to establish a unified inspection and quarantine system for import and export commodities ensuring the bilateral trades go on wheels between the two sides.

Factor 2.2: Cold chain facility and technology

Cold chain logistics offers great opportunity to extend shelf-life and reduce losses of vegetables, which guarantees the quality of vegetables, and the investment of cold chain facility and technology reflects the enterprise spending serious attention on quality and safety issues. However, the cold chain logistics in Yunnan are developed on a relatively backward technological level, which needs to be improved urgently.

Factor 2.3: Technology innovation

In current process of planting, there are few varieties of pesticides with high efficiency, low toxicity and low residue. And the bio-mixed organic fertilizer and water-soluble fertilizer are not widely used in Yunnan province. Farmers are not trained on the safe use of pesticides and fertilizer. Although agricultural regulators have been managing farmers to reduce pesticide use, the green prevention and control technologies are not kept up in Yunnan, such as the use of pest-killing lamb, sticky trap, fly net, and insect pheromone. In addition, family farm production by small piece of planting takes up the majority in Yunnan, which leads to single species planting and high costs of greenhouse vegetables planting. In processing, the facilities have a low degree of automation in many small sized processing enterprises, and the technologies increasing values for vegetables are updated slowly. Thus, the lag of technology has become a

bottleneck of implementing closed supply chain for vegetables.

H3: Production collaborative model is essential for implementing the closed supply chain for vegetables.

For an enterprise, the organizational pattern influences the choice of controlling model for quality and safety of the product. The closer of partnership makes it easier to implement the technology for quality of the product, and keep the level of quality and safety stable. Especially, the implantation of traceability system is based on the level of cooperation in the supply chain (Wang Puqing, Zhou Deyi, 2009). Therefore, 3 observable variables are adopted in this study, including:

Factor 3.1: Backward integration

It refers that the leader enterprise invests in constructing the standardized production base so that it can strictly control the vegetable quality and safety from the origins, and it's easier to implement the unified technology standards in planting and processing.

Factor 3.2

Leader enterprise + vegetable cooperative + farmer, which refers to the leader enterprise signs a cooperation agreement with vegetable cooperative and farmers, in purpose of forming a long-term cooperative relationship. In this model, the leader enterprise participates in the quality and safety control in planting and procurement such as seeds and fertilizers, etc. As the leader enterprise has strict quality restrictions on the vegetable cooperative, and samples each batch of vegetables, the vegetable cooperative will be disqualifiedif it is tested not meeting the standards. Under this stress, the vegetable cooperative will actively promote farmers to strictly implement the quality and safety standards in planting.

Factor 3.3

Leader enterprise+ large farmer. It means the large farmers develop large-scale cultivation by farmland transfer (namely to acquire the right to use by leasing farmland) or becoming shareholders, and set up the family farms in the way of make-to-order or agriculture demonstration base to establish a stable benefit connection with the leader enterprise.

H4: The role of leader enterprise remains crucial for implementing the closed supply chain for vegetables.

In vegetables supply chain, the asymmetry of information and resources makes the competitive edges of some enterprises more prominent, thus forms the leader enterprise which dominates in the operation of supply chain. The leader enterprise is large-scale and has strong capacities to innovation, learning, conversion and utilization, which has positive impact on other enterprises in the supply chain(Pittaway et al., 2004). Currently, the large-scale processing and export enterprise is the leader of vegetables supply chain between Yunnan to Thailand, which connects farmers, Thai importer, and Thai wholesalers.Specifically, the processing and export enterprise purchases vegetables from farmers, vegetable cooperative, or its own production base, and then processes and transports vegetables to the ports. At the same time it looks for and signs cooperation agreements with demanders and importer of Thailand. Therefore, 4 observable variables are presented in this study, containing:

Factor 4.1: Processing and sales integration:

Recently, many of the processing and export enterprises are small sized in Yunnan where vegetables are only simply processed with low added value, and the fresh-keeping equipment is substandard. More importantly, there is no clear classification of vegetable grades, and the quality of Yunnan vegetables in Thailand is uneven. As limited by natural conditions, the

number of Yunnan vegetables is not stable in Thai markets. Therefore, if the lead enterprise integrates the processing and sales links to form a complete pattern of production and marketing, the issues mentioned above will be effectively solved and the total operating cost of this supply chain will be reduced.

Factor 4.2: Brand building

Due to the restriction of production conditions, technology, and standard procedures, many individual farmers and large vegetable production bases in Yunnan have not established their own brands, and vegetables are actually labeled by the processing and export enterprises. In wholesale market of Thailand, there is no barcode on the package of Yunnan vegetables, which makes it impossible to track information about each link of vegetable production. Only high-end vegetables entering Thai supermarkets have the bar codes of processing and export companies. In addition, all Yunnan vegetables exported to Thailand have no geographic indications of agro-products on their packages, which cannot highlight the regional uniqueness of plateau agro-products so that consumers have no brand awareness of Yunnan vegetables. Compared with vegetables from other provinces in China or other countries, there are few well-known brands and few high-end vegetables from Yunnan in Thai markets. Most of them are cheap with less profit. Thus, it's necessary for the leader enterprise to build a complete brand system.

Factor 4.3: Export collaboration

Currently, most of the export enterprises in Yunnan are small in scale, and operate separately without centralized customs declaration, which leads to weak resource integrations and anti-risk capabilities. Moreover, many medium and small export enterprises face the financing challenges because of low credits, and high bank loan thresholds. Thus, exploring an effective export collaboration will offer practical support for export enterprises.

Factor 4.4: Compensation for breach of contract

When vegetables are damaged or deteriorated in transit, or are tested not reaching the standards of China and Thailand, the leader enterprise is able to assume the liability for breach of contract and settle the compensation for the losses, which contribute to a long-term and stable cooperative relationship among supply chain members.

H5: The influence of external environment is extremely important for implementing the closed supply chain for vegetables.

The policy environment, industry environment and market environment faced by enterprises will influence their decision-making (Golan et al., 2007). Thus, 4 observable variables are selected in this study containing:

Factor 5.1: Agriculture department supervision

Currently, the policy of high quality and high priceor a punishment and constraint mechanism is implemented in many countries on agriculture department supervision of safety and quality for agro-products. This study takes the "quality detection frequency" to measure this factor.Agricultural departments in Yunnan recentlyenhance random testing on agricultural inputs, including fertilizers, pesticides and seeds, and carry out the certificate of origin for vegetables. They also push the production bases to regulate the farm records, and strictly perform the standards on planting and processing. In Thailand, MOAC (the Ministry of Agriculture & Cooperatives) issued a new phytosanitary regulation to add a chemical residue test for fruits and vegetables in early 2003. Currently, Thailand implements tariff quota administration on 23 agro-product based on the WTO agreement on agriculture. In brief, these supervisions are effectively guaranteeing the quality and safety of vegetables in this supply chain.

Factor 5.2 Government supports, which can be described from 4 aspects.

Firstly, policy support. The policy executive strength is strongest in Yunnan in the past five years including the subsidies for export credit, fee exemptions for inspection and quarantine of import and export agro-products , as well as financial and tax supports. In terms of Thailand's trade policy, MOAC (the Ministry of Agriculture & Cooperatives) has simplified and accelerated customs clearance procedures. The great majority of vegetables that Thailand imports from China are free except garlic, which belongs to commodity of import control. When applying for vegetables import, the procedures are relatively simple, and documents required usually include plant import application form (No.7 Form), copy of bill of lading and copy of invoice. Secondly, financial support. Yunnan provincial department of commerce has set up special funds to directly subsidize and abate tax for the export of agro-products.

Meanwhile, it offers the prime rate of loan and interest subsidies to agricultural enterprises, invites investment from social capital and financial institutions in the production, processing and distribution of vegetables. Thirdly is technical training. Farmers have poor safety awareness to ignore the safety plastochrone of pesticide. When the price of vegetables is high, they hurriedly harvest to the market. Thus, technical training for farmers is urgently needed. Fourthly, department cooperation. Recently, a joint meeting mechanism for agro-products export has been established in Yunnan, which attends by departments of agriculture, commerce, inspection and quarantine, customs.Through the mutual recognition of pre-inspection of origin and inspection and quarantine, a rapid customs clearance mode isbeing set up. The inspection and quarantine departments are implementing the filing management, quality verification, and 24-hour inspection appointment for export enterprises so as to improve the efficiency of customs clearance and reduce the loss of vegetables.

Factor 5.3: Industry association participation

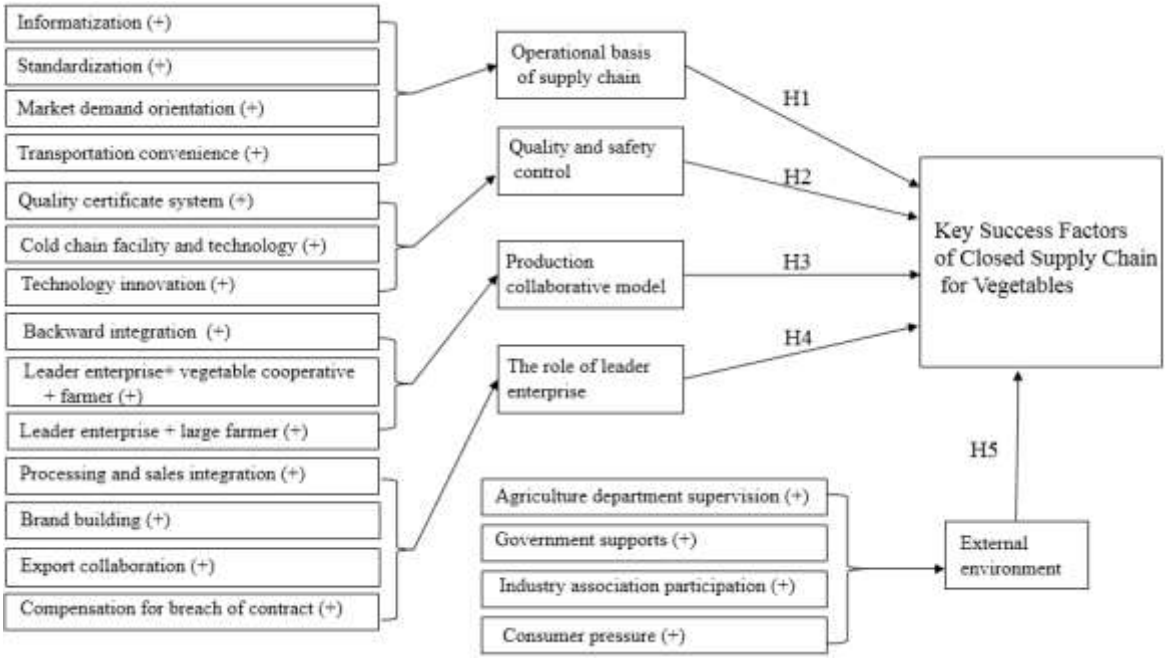
There are some chambers of commerce for bilateral trade between Yunnan and Thailand, but they have no effective supervision of regulating vegetable prices. In Thai vegetable market, the price of vegetable reflects the instantaneous relation between supply and demand in the region. The price of the same variety of vegetables varies in different wholesale markets and varies every day. Even at different times on a same day, due to the change of volume of goods arrived, the relation between supply and demand is accordingly changed, which leads to the fluctuation of vegetable price. Sometimes, the price difference between morning and afternoon is quite a few times. Therefore, there needs to set up an organization to normalize sector import and export behavior, safeguard the legitimate rights of members, and assist government departments in trade management.

Factor 5.4: Consumer pressure:

Nowadays, consumers' awareness of food safety is growing all over the world. Consumers are quite concerned about the safety information of vegetables and are very willing to pay extra for the safety of vegetables, however, their assessments of safety of vegetables are not very optimistic, which brings stress to companies in the supply chain. Meanwhile, consumers pursue high-quality vegetables with ideal taste and nutrition, which pushes enterprises to improve the quality of vegetables.

In conclusion, based on the hypotheses above, a structure diagram of key success factors of closed supply chain for vegetables is set up as shown in Graph 1.

Graph 1: Structure Diagram of Key Success Factors of Closed Supply Chain for Vegetables



Note: "+" means the key success factor shows a positive correlation with the explained variable.

3.3. Variable Setting And Theoretical Model

3.3.1 Variable setting

There are 5 key success factors that influence enterprises to implement closed supply chain for vegetables, includingoperational basis of supply chain(X1), quality and safety control(X2), production collaborative model(X3), the role of leader enterprise(X4), and external environment(X5), and their variables setting and value ranges are shown in Table 1.

Table 1: Variable Setting and Value Range

Variable		Name of Variable	Value Range
Y	Y	A closed supply chain for vegetables	Implementing=1 Not implementing =0
X1	X11	Standardization	Fully standardized=4 Mostly standardized=3 Partially standardized=2 Not standardized=1
	X12	Informatization	Implementing SCM =4 Implementing ERP=3 Partially implementing ERP=2 Not implementing ERP=1
	X13	Market demand orientation	Yes=1 Not really=0
	X14	Transportation convenience	30%-50%=4 20%-29%=3 10%-19%=2 Below 10%=1
X2	X21	Cold chain facility and technology	Have=1 Not have=0
	X22	Quality certificate system	Set=1 Not set=0
	X23	Technology innovation	Have=1 Not have=0
X3	X31	Backward integration	Backward integration=1 Not in this form=0
	X32	Leader enterprise+ vegetable cooperative + farmer	Leader enterprise+ vegetable cooperative + farmer=1 Not in this form=0
	X33	Leader enterprise + large farmer	Leader enterprise + large farmer=1 Not in this form=0
X4	X41	Processing and sales integration	Processing and sales integration=1 Cannot =0
	X42	Brand building	Brand building=1 Cannot =0
	X43	Export collaboration	Export collaboration=1 Cannot =0
	X44	Compensation for breach of contract	Compensation for breach of contract=1 Cannot =0
X5	X51	Government supports	Yes=1 No=0
	X52	Supervision frequency of agriculture department	At least once a month=4 At least once a quarter=3 At least once half a year=2 At least once a year=1
	X53	Industry association participation	Yes=1 No=0
	X54	Consumer pressure	Highly stressed=4 Stressed=3 Not too much stressed=2 Not at all=1

3.3.2 Theoretical Model

For each factor applied in a closed supply chain model, there are likely to be two endpoints for the enterprise:"implementing" a closed supply chain and "not implementing" a closed supply chain. Each enterprise will relationally make the best decision, which is a typical binary decision problem. Therefore, aiming to determine the key success factors of implementing closed supply chain for vegetables, this study adopts the binary Logisticmodel as shown below:

$$p = F(y = 1|X_i) = \frac{1}{1+e^{-y}} \quad (3.1)$$

In (3.1), y denotes a closed supply chain for vegetables, if y=1, it indicates the member enterprises implement the closed supply chain; if y=0, it means themember enterprises don't implement the closed supply chain. *p* is the probability for members to implement the closed supply chain. X_i (*i*=1, 2...n) is defined as the key success factors influencing the members to implement the closed supply chain. In addition, in (3.1), y is the linear combination of X_i (*i*=1, 2...n), namely that

$$Y=b_0+b_1X_1+b_2X_2+...+b_nX_n \quad (3.2)$$

In(3.2), b_i(*i*=1, 2...n) denotes the regression coefficient of the *i*th explanatory variable. If $b_i>0$, it means the *i*th factor has positive effect on implementing closed supply chain; if $b_i<0$, it indicates the *i*th factor has negative effect on implementing closed supply chain. Then, based on formula (3.1) and (3.2), a Logistic model represented by probability ratio is set up as below:

$$Ln(\frac{p}{1-p}) = b_0 + b_1x_1 + b_2x_2 + ... + b_nx_n + \varepsilon \quad (3.3)$$

In (3.3), b_0 is the constant term, and ε is the random error.

4.Operation results and discussion

In this phase, the statistical software SPSS 20.0 is used for Logistic regression processing on 248 samples, and the Likelihood Ration Test (LR) and backward selection method are adopted. The backward selection method refers that all variables are introduced into the regression equation, then the software tests the significances of variables and eliminates the variable of the smallest LR. After that, equation fitting and testing are performed once again until all variables in the equation reach the level of significance. Meanwhile, Cox & Snell R Square and Nagelkerke R Square are given to judge the fitting effect of the model, as well as Hosmer-Lemeshow (HL) Test is used for the goodness of fit. Due to the calculation process is exactly the same, this study representatively elaborates the one-step fitting in 4.1 and two-step fittings in 4.3.

4.1 Impact analysis of indicators in operational basis of supply chain

The operational basis of supply chain includes 4 secondary indicators. The results of the summary calculation of the logistic regression model (Table 2) show the Nagelkerke R Square reaches 0.869, that is, the model can explain most of the variation. In addition, as shown in Table 3, the results of HL Test do not reach the level of significance, which means the model fits well.

Table 2: Summary of Impact Model of Operational Basis of Supply Chain on Closed Supply Chain

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	82.113a	0.652	0.869

Table 3: HL Test of Operational Basis of Supply Chain on Closed Supply Chain

Step	Chi-square	df	Sig.
1	6.305	8	0.613

As shown in Table 4, the fitting results indicate that the regression coefficients of x11, x12, x13 and x14 respectively reach the level of significance, and theirvalues of regression coefficient and Exp (B) decrease in turn. That's to say, for the dependent variable, all of the 4 indicators are preserved in the model and their importance decrease in turn. In practice, we can see the construction for informatization, standardization, market demand orientation, transportation convenience are essential for member enterpriseswhich can help themsuccessfully implement the closed supply chain mode. Thus, the final regression equation can be expressed as followed,

$$\text{Logit } Pr(Y=1 \mid Xi)=-13.810+2.136x11+1.876x12+1.820x13+0.909x14 \quad (4.1)$$

Table 4: Fitting results of Impact Model of Operational Basis of Supply Chain on Closed Supply Chain

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1	X11	2.136	.459	21.678	1	0.000	8.466
	X12	1.876	.318	34.787	1	0.000	6.527
	X13	1.820	.846	4.626	1	0.031	6.174
	X14	0.909	.297	9.371	1	0.002	2.481
	Constant	-13.810	2.277	36.784	1	0.000	0.000

a. Variables enter on step 1: x11, x12, x13, and x14.

4.2 Impact analysis of indicators inquality and safety control

In the same way as 4.1, the estimation is terminated at 4 iterations and the results show the Nagelkerke R Square reaches 0.384, that is, the model can explain part of the variation. In addition, the results of HL Test do not reach the level of significance, which means the model fits well.Further, the fitting results indicate that the regression coefficients ofx21, x22, and x23 have significant positive effects on the dependent variable, and theirvalues of regression coefficient and Exp (B) decrease in turn. That's to say, for the dependent variable, all of the 3 indicators are preserved in the model and the importance are x21 > x22 > x23. Therefore, the final regression equation can be described as followed,

$$\text{Logit } Pr(Y=1 \mid Xi)= -1.883+1.397x21+1.220x22+0.968x23 \quad (4.2)$$

4.3 Impact analysis of indicators inproduction collaborative model

The results of the summary calculation of the logistic regression model in Table 5 show the Nagelkerke R Square reaches 0.404, that is, the model can explain part of the variation. In addition, as shown in Table 6, the results of HL Test do not reach the level of significance, which means the model fits well.

Table 5: Summary of Impact Model of Production Collaborative Model on Closed Supply Chain

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	254.139a	0.303	0.404
2	254.178a	0.303	0.404

a. Estimation is terminated at 4 iterations because the change scope of parameter estimation is less than .001.

Table 6: HL Test ofProduction Collaborative Modelon Closed Supply Chain

Step	Chi-square	df	Sig.
1	1.222	4	.875
2	.714	2	.700

As shown in Table 7, in step 1, the regression coefficients of x31 and x32 have significant positive influence on the dependent variable (sig<0.05), however, x33 cannot reach the level of significance (sig>0.05). In step 2, the regression coefficients are recalculated after removing x33, and the results show that the influence of x31 on dependent variable is higher than that of x32. That means as the key success factors, x31 and x32 are preserved in the model and their importance are x31>x32. Thus, the final regression equation can be expressed as followed,

$$\text{Logit } Pr(Y=1 \mid Xi) = -1.333+1.684x31+1.501x32 \quad (4.3)$$

Table 7: Fitting results of Impact Model of Production Collaborative Modelon Closed Supply Chain

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	X31	1.690	0.337	25.161	1	0.000	5.417
	X32	1.494	0.334	20.035	1	0.000	4.453
	X33	0.062	0.314	0.039	1	0.844	1.064
	Constant	-1.365	0.275	24.702	1	0.000	0.255
Step 2[a]	X31	1.684	0.335	25.202	1	0.000	5.387
	X32	1.501	0.332	20.492	1	0.000	4.487
	Constant	-1.333	0.221	36.476	1	0.000	0.264

a. Variables enter on step 1: x31, x32, and x33.

In fact, the current situation of vegetables supply chain between Yunnan and Thailand agrees with the computational results. The reason why x33 cannot be proved is that the traditional form of organization, namely to “leader enterprise + large farmer”, does not adapt to the closed supply chain mode.As lack of the restriction mechanism to larger farmers, the quality of their vegetables is not stable. The leader enterprise prefers to implement the backward integration so as to control quality and safety from the origins, and carries out the unified technology standards. In addition, the leader enterprise does not cooperate directly with farmers, but purchases farmers’ vegetables through vegetable cooperative, which is subject to the performance assessment of the leader enterprise. Thus, the vegetable cooperative will actively promote farmers to strictly implement the quality and safety standards in planting.

4.4 Impact analysis of indicators inthe role of leader enterprise

In the same way, the results of the summary calculation of the logistic regression model show the Nagelkerke R Square reaches 0.321, that is, the model can explain part of the variation.

Additionally, the results of HL Test shows the model fits well. Further, the fitting resultsindicate that the regression coefficients ofx41, x42 and x43 have significant positive influence on the dependent variable, however, the regression coefficient of x44 does not reach the level of significance. In step 2, the regression coefficients are recalculated after removing x44, and the results show that the influence of x41 on dependent variable is higher than that of x42, and both of them are higher than that of x43.That is,x41, x42 and x43 are proved as the key success factors,and their importance are x41>x42>x43.Therefore, the final regression equation is shown below,

$$\text{Logit Pr}(Y=1 \mid Xi)=-1.459+1.239x41+0.997x42+0.650x43 \quad (4.4)$$

In the above analysis, the compensation for breach of contract (x44) isn't proved, and the reason can be summarized as follows. Firstly, the breach of contract is few because in most cases, the upstream suppliers provide vegetables to the leader enterprise in accordance with the contract. Secondly, the leader enterprise doesn't have the high requirements for vegetable quality and safety, or its inspection standard is not as high as expected where no quality problems are detected in the products provided from suppliers.

4.5 Impact analysis of indicators in external environment

Similarly, after 4 iterations the results indicate the Nagelkerke R Square reaches 0.252, that is, the model can explain part of the variation. In addition, the results of HL Test showsthe model fits well. Further, the fitting results indicate that the regression coefficients ofx51, x52 and x53 have significant positive influence on the dependent variable, however, the regression coefficient of x54 does not reach the level of significance. In step 2, the regression coefficients are recalculated after removing x54, and the results show that the influence of x51 on dependent variable is higher than that of x52, and both of them are higher than that of x53.Therefore, the analytic equation can be expressed as followed,

$$\text{Logit Pr}(Y=1 \mid Xi)=-2.223+0.685x51+0.635x52+0.602x53 \quad (5.4)$$

Two possible reasons for why the consumer pressure is not be proved are as follows. Firstly, due to the fact that Yunnan province is adjacent to Thailand, Yunnan vegetables have a large market share in Thai markets, such as the off-season vegetables growing in green house, whose market share reaches 70%. Secondly, field surveys indicate that Yunnan vegetables are quite popular in Thai markets, demands for some varieties are outrunning supply, such as broccoli, purple cabbage and Dutch bean. Since Kunming-Bangkok Highway have been completed in 2013, the convenient transportation makes logistics costs lower, the price of vegetables is more affordable and accepted by most Thai people. Therefore, the consumer pressure from the Thai market is not obvious so far, and it does not constitute a key success factor for closed supply chain.

4.6 Impact analysis of the first level indicators

By using the method of Structural Equation Model (SEM), 15 second level indicators are combined into 5 first level indicators, and the influence of the 5 first level indicators on the dependent variable are analyzed through M plus 7.4 software. The results in Table 8 show that all of the fiveones have significant influence on the dependent variable regression ($p<0.05$),andtheir path coefficients arerespectively 0.957, 0.689, 0.684, 0.592, and 0.534, namely that their influenceis F1>F2>F3>F4>F5. That's to say, the 5 factors are verified as the success factors of closed supply chain for vegetables exported from Yunnan to Thailand, however, the degree of influence decreases in turn.

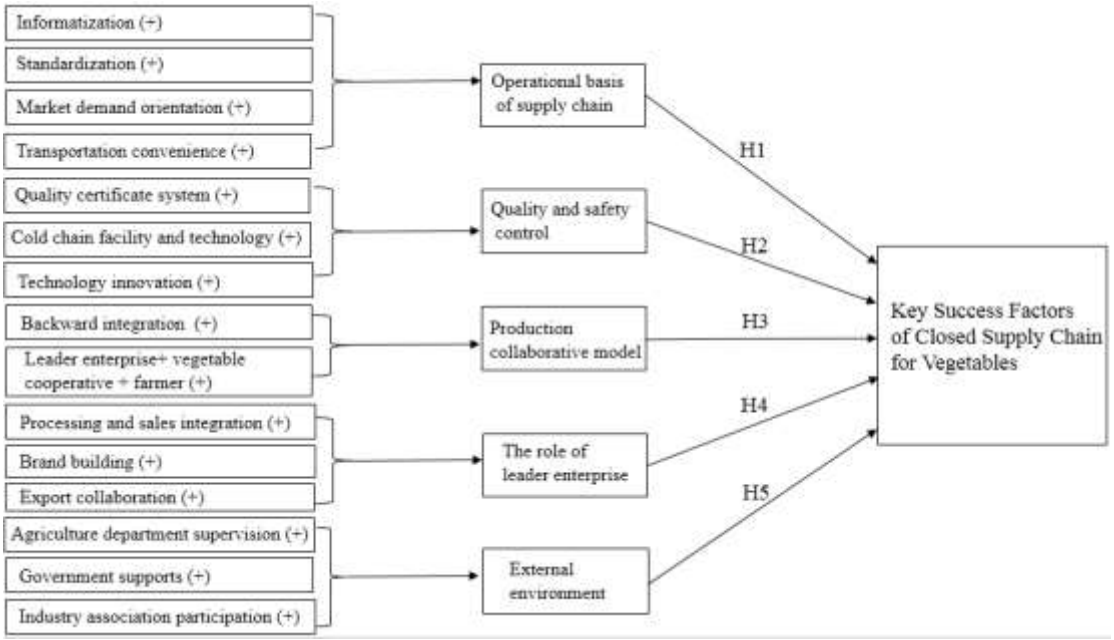
So far, H1 to H5 have been proved to be valid. Firstly, the operational basis of supply chain plays the most significant role for closed supply chain, because constructing traceability information platform, standardized production base, and standardized logistics container system are

proposed to be compulsory thresholds for the members in closed supply chain. In addition, the market demand orientation and transportation convenience improve the flexibility and responsiveness of the supply chain, which are essential requirements for the effectiveness of quality and safety for vegetables. Secondly, the path coefficient of quality and safety control is closed to that of production collaborative model, showing that both of them are more important for closed supply chain. As the superior of quality and safety of products is the most distinctive feature that distinguishes the closed supply chain from the traditional supply chain, the two aspects provide technical supports as well as new models of collaboration for closed supply chain. Thirdly, the role of leader enterprise has a certain degree of influence on the closed supply chain. The leader enterprise is dominating in international business of vegetables, whose importance is increasingly growing. Fourthly, the external environment has minimal impact on closed supply chain, which is consistent with findings of field survey. The supervision and supports from government and vegetable cooperative indeed provide substantial assists for supply chain members, but they are not the decisive factors. Implementing closed supply chain should be started from internal construction between and within member enterprises. After eliminating the insignificant variables, the modified structure diagram of key success factors of closed supply chain for vegetables are shown in Graph 2.

Table 8: Calculation Results of Standardized Regression Coefficient

Factor	Estimate	S.E.	t	p
F1	0.957	0.017	56.948	0.000
F2	0.689	0.053	13.061	0.000
F3	0.684	0.049	14.046	0.000
F4	0.592	0.053	11.180	0.000
F5	0.534	0.062	8.593	0.000

Graph 2: Modified Structure Diagram of Key Success Factors of Closed Supply Chain for Vegetables



Note: "+" means the key success factor shows a positive correlation with the explained variable.

5. Recommendations

5.1. Operational Basis Of Supply Chain

Firstly, a shared traceability information platform is proposed to be constructed including ERP, VRM, and CRM, etc., connecting with the whole procedures of vegetable production, processing, and distribution, and integrating various information resources to realize the data exchange among the systems and information share, as well as satisfying customer demands. Secondly, as basic requirements for the effectiveness of quality and safety control in vegetables supply chain, it's proposed to construct a standardized production base to carry on non-environmental pollution food, green food and organic production, and a standardized logistics container system core to pallets, turnover boxes and containers. Thirdly, it's urgent to simplify customs clearance process. As vegetables are perishable and have a short shelf life, "two country, one inspection", a more convenient and rapid custom clearance model is suggested to take the lead to be implemented between China to Thailand. Meanwhile, due to customs works closely with inspection and quarantine department, only one declaration, one inspection, and one clearance are required for the enterprise, which improves customs clearance efficiency and shortens the retention time of vegetables in distribution.

5.2. Quality and Safety Control

Firstly, quality certificate system is suggested to be enforced in planting and processing including QS, HACCP（Hazard Analysis Critical Control Point）, GMP, GAP, ISO(22000), which can help the farmers and processing enterprises to comply with the international standards, and develop the core competence of enterprise superior to the competitors. Secondly, supply chain members are recommended to extensively apply the temperature control facilities and equipment, as well as unified technical standards for sorting and processing, package label, precooling, freezing and refrigeration, transport and check. Thirdly, in order to reduce pollution, protect the ecological environment, and achieve a virtuous cycle of production, the planting and processing enterprises should keep on technology innovation, namely to biotechnology, planting technology, prevention and control technology, processing technology and logistics information technology such as Barcode,RFID,EDI,GPS,GIS, and Intelligent Technology.

5.3. Production Collaborative Model

For leader enterprise, backward integration and cooperating with vegetable cooperative are accordant with the requirements of closed supply chain. However, to implement the collaborative models, the source of farmland is a difficult problem for leader enterprise. Therefore, it is necessary for the government to formulate effective policy for transfer of the right to use the rural land, so that the leader enterprise can obtain the management rights of contracted lands to construct the production base.

5.4. The Role Of Leader Enterprise

Firstly, the processing and export enterprise is advised to improve its processing technology, facilities and equipment to increase the added value of vegetables, and sets up branch offices in major cities of Thailand, which engage in developing markets, collecting market information, and timely feeding it backto the leader enterprise in order to help farmers to plan and arrange productions. Secondly, it is proposed to develop contract farming, unified production, packaging and selling in the name of leader enterprise, as well as implement brand marketing for Thai markets, through the international vegetable expo, forum, and gourmet festival so as to promote the brands and products, and improve reputation of Yunnan vegetables. Thirdly, cooperative economic organizations are recommended to be established by Yunnan's export enterprises to strengthen the risk resisting and competitive ability in vegetable exports.

5.5 External Environment

Firstly, for the department of agriculture, it is necessary to assign experts to train farmers to use new technologies so as to improve their scientific management and awareness of quality and safety. In addition, comprehensive treatment measures shall be adopted for the major diseases and pests of vegetables. Secondly, vegetable industry association is proposed to set up, which is a non-profit social organization with independent legal personality whose members include vegetable producers, processing and marketing companies, relevant government departments, and research institutions. In order to avoid the vicious competition of export enterprises, the vegetable industry association has responsibility to coordinate the prices of vegetables and set minimum prices, and help companies resolve disputes in vegetable import and export trade. Moreover, as the vegetable industry association has better information channels, it should provide accurate and timely market information for members such as market share, supply and demand relations, price trends, as well as information of latest technology patents to improve the effective decision-making of members.

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