Evaluation system of the supply chain stability

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Abstract: The stability of the supply chain relates to the supply chain management efficiency and effectiveness, and its concept has been extended to all aspects of business operations. This article combines researches that have been made both at home and abroad, and refers to the idea of the value chain. Based on the stability of the resource input, the stability of the value output and the stability of supply chain collaboration, we establish the three-lever index system to evaluate the performance of the whole supply chain stability, and attempts to evaluate it using analytic hierarchy process(AHP).

Keywords: Stability, Evaluation System, Analytic Hierarchy Process (AHP), Supply Chain Management

1. Introduction

With the global marketing competition intensifying, more and more enterprises attach importance to and begin implementing the supply chain management. There is a wide range of supply chain research and application (Zeng & Ma, 2010). However, the research of the overall supply chain system stability is still in the exploratory stage (Chen, 2009; Xiao & Wang, 2008). The studies are focused on the supplier partnerships and uncertainties. And research of stability of the supply chain structure as a whole is still very rare. The stability of the supply chain is paid more and more attention. How to define the moderate stability of the supply chain is the important issue of supply chain success and growth (Green, 2005).

This article starts with the reason of fluctuations in the supply chain, leading to the meaning of the supply chain stability. From dealing with the generally unexpected events, it expands to the whole process of operational planning decisions, and further explains the significance of the stability of the supply

chain. The second part of the article combines the researches of domestic and foreign supply chain stability, and establishes the evaluation index system based on the linear supply chain model (Song, 2008). Finally, on the foundation of the second part of the general measure index of supply chain stability, attempts are made to introduce the analytic hierarchy process (AHP) in order to fulfill the measurement and evaluation on the stability of the whole supply chain and provide ideas to enterprises.

2. The Reasons of Supply Chain Stability and Volatility

The stability of the supply chain is: the member companies' supply chain operation of their own and the convergence status between companies have remained within a certain range, and the input and output of a whole chain of open systems maintain balanced.

According to its nature, the risks in the supply chain are divided into emergencies and operational risks. Emergency usually means a material adverse effect on system events caused by natural disasters or man-made factors. For example, after the 2001 "911" terrorist attacks, companies in accordance with global supply chains and JIT operation of Ford, Toyota and other large manufacturing companies suffered supply shortages and had various degrees of distress(Zhang, Wang, & Diao, 2004; Lin & Gibson, 2011).

Operational risk usually refers to the abnormal fluctuations in the supply chain when the system deviates from the plan due to market demand, supply and production of raw materials. It is generally caused by changes in the industry, as well as in decision making, particularly significant in the competitive and updating industry or expansion industry. For example, over the past decade, Chinese enterprises have set off another round of merger boom. But unfortunately, the cases of failure are more than success ones.

3. The Establishment of Impact Factors and Indicators of the Supply Chain Stability

3.1. Domestic and Foreign Research

At present, the supply chain partnership has caused research and concern by domestic and foreign scholars. Bimbirg studies the control issues between the alliance partners from five aspects: (1) the absolute and relative input level; (2) the symmetry of return; (3) the degree of mutual trust; (4) the size of the uncertainty; (5) the length of the formation time of the relationship. The

importance of these factors varies with the changes in the environment, during which different combinations affect the stability of the union. Badaracco and some other people think, only when the alliance participants have their own resources in products, technologies, capabilities, financial strength, as well as talented personnel can the alliance be a solid. And Barney further divides resources into physical capital, human capital and organizational capital and into the finance, entity, management, human resource, organization and technology. Shan Miyuan and some other people think profit structure is an important factor of the strategic alliance stability, and introduces four multi-organizational game model to describe it. R•Axelrod's research results show that if the alliance companies' profits structure changes, it can make the whole union cooperation from unstable into stable. Jian Zhaoquan thinks in comparison with the immediate profit, cooperative enterprises pay more attention to future earnings, if the future is sufficiently important relative to the current, cooperation is stable, and the enterprises which pay more attention to future benefits would choose cooperation. Liao Chenglin and some other people propose that building the framework of the balance power in the supply chain can reduce the opportunistic behavior of partners, control the switching costs, and is conducive to the stability of the supply chain, thus preventing supply chain destruction due to changes of internal and external structure of the supply chain. Wang lihu and some other people from the customer satisfaction' perspective research the satisfaction with the special performance in the supply chain structure, put forward the concept of corporate satisfaction and think enterprise satisfaction is an important parameter of the supply chain structure stability, and it is closely related to the flexibility of the supply chain structure.

3.2. Supply Chain Stability Index System

According to these scholars who study the stability of the supply chain and business alliances, we conclude that the impact factors of the supply chain stability include three aspects: the level of resources node companies have and input, earnings structure and benefit-sharing, supply chain structure and node companies' relations. Therefore, we establish the chain structure of the supply chain, and the evaluation system based on impact factors. In this article, specific analysis of the influencing factors on the supply chain stability uses the chain structure model. Factors affecting the stability of the supply chain include the stability of the resource input, the stability of the value output and the stability of supply chain collaboration.
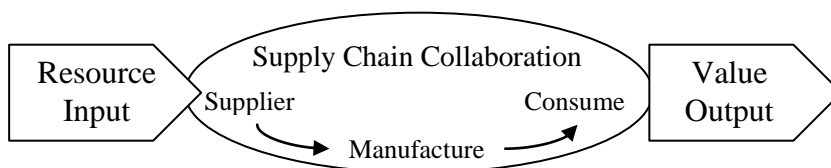
Fig. 1: The model of the supply chain analysis.

3.2.1. The Stability of the Resource Input

The stability of the resources input refers to the stability of the capital, human resource, technology and material supply. The supply chain is an open system, which need the necessary resource input in order to maintain stability.

Capital factor: The smooth flow of funds to each node in the supply chain is crucial. Capital flow problems during operation of a link or a node will result in the operation of the entire supply chain disruption. It can be measured by the return on investment, cost of capital, asset turnover, and other values.

Human Resource factor: Human resources are not only with the pilot but also strategic for future changes. And it is essential to the development of the entire supply chain. It can be measured by overall labor productivity, human cycle, labor cost and other indicators.

Technology factor: New techniques and methods leading to changes in the structure of the industry chain will enable the supply chain business to increase instability. It can be measured mainly by external technical dependence and the cost of technical use.

The Materials Supply Factors: In addition to the necessary raw materials, the related facilities for the supply of materials are also very important. It is mainly measured by the supply risk and supply costs.

3.2.2. The Stability of the Value Output

The stability of the value output is: Supply chain must be able to output the desired value to consumers and society so as to maintain stability. If the value output of the entire supply chain was instable, it would affect the valuation of the entire value chain. It is mainly measured by tangible products, intangible assets, customer demand satisfaction and other parts.

Tangible product factor: The tangible product is a concentrated expression of the supply chain efficiency. It is also a prerequisite for sustainable development of supply chain and the main aspect of the output value. It is mainly measured by the profit on sales, product life cycle, product turnover, product cost performance and other indicators.

Intangible assets factor: Although it does not reflect the benefits of supply

chain, it is of great significance to the long-term development. It is mainly measured by marketing share, goodwill and brand, industry influence and social benefits of corporate culture.

Customer demand satisfaction factor: Meeting specific customers and specific needs for specialized supply chain strategy is essential for the market segments. It is mainly measured by the proportion of customized products, service quality after sales, on -time delivery of orders, product qualification and other indicators.

Added value factor: It refers to the increase in the value of the merger and foreign investment of enterprises and the entire supply chain, as well as research and development input and output. It is mainly measured by added value to products, new product development, capital gains and other indicators.

3.2.3. The Stability of Supply Chain Collaboration

The stability of supply chain collaboration refers to planning, coordinating and controlling logistics, information and funds between the participating organizations and departments in the supply chain. It is mainly reflected by how to enhance cooperation, strengthen the co-ordination of resources and improve the management level. It includes inter-firm logistics efficiency, responsiveness among enterprises, the dependence between enterprises, supply chain costs and other factors (Li & Li, 2004; Qi & Weng, 2004; Su & Gargeya, 2011).

Logistics efficiency among enterprises factor: The supply chain is mainly composed of three aspects – business flow, logistics and information flow. Logistics is the foundation and the primary issue. It is measured by the total inventory, turnover rate and other indicators.

Responsiveness among enterprises factor: Caused by information and other reasons, the node enterprise from another gets the products or income different from expected, leading to fluctuations in the supply chain. It is measured by on-time delivery rate, production and demand rate between node enterprises and other indicators.

The dependence between enterprises factor: Profit is the driving force of the supply chain to gather together. The position of the main chain throughout the supply chain determines whether the supply chain is loose or close. It is measured by core enterprise business proportion of suppliers and distributors.

Supply chain costs among enterprises factor: The entire supply chain operating cost is very important compared to competitive enterprise and industry level. If the cost is relatively high, the node enterprises may consider switching costs, leading to the instability of the supply chain. It is mainly measured by the rate of supplier's qualified products, delivery, price and other
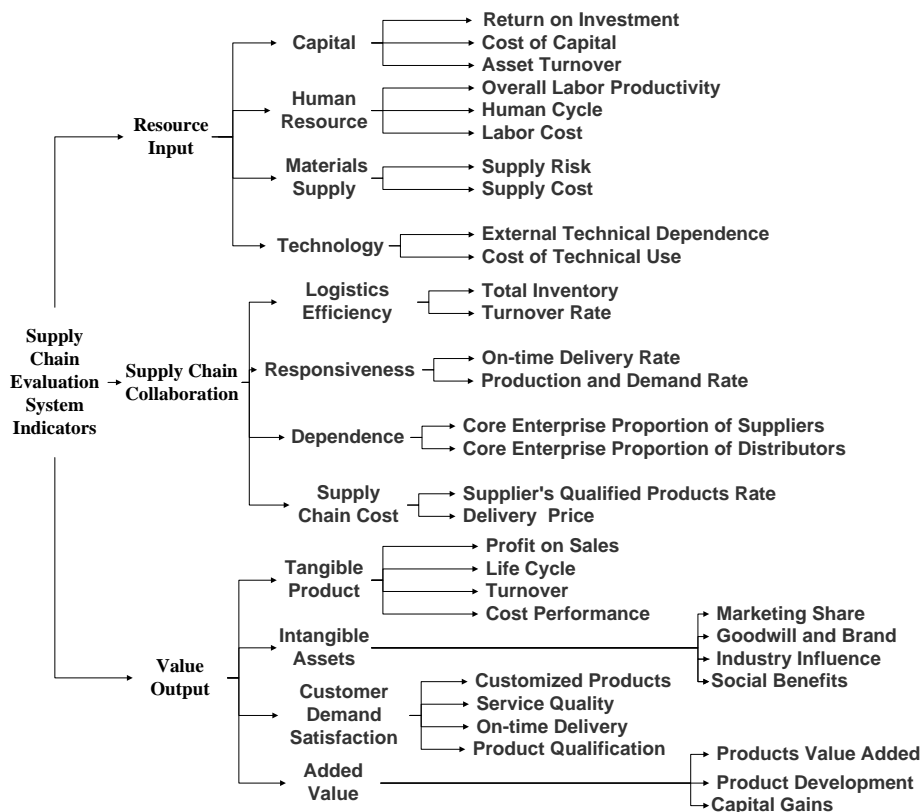
indicators.

Fig. 2: Indicators of the supply chain stability.

4. Using Analytic Hierarchy Process (AHP) To Assess the Stability of the Supply Chain

The Analytic Hierarchy Process is a qualitative and quantitative combined, systematic and hierarchical analysis method. So we take the analytic hierarchy process for example and fulfill the measurement and evaluation on the stability of the whole supply chain.

4.1. Evaluation of Dimensionless

The indicators in the evaluation system used to analyze the system have relative indicators and absolute indicators, positive indicator, reverse indicator and moderate indicators. They have different influences on result. Because of different dimension, indicators of the initial value are not comparable. If there was no dimensional process, we could not make a comprehensive evaluation of

the stability of the supply chain.

4.2. Build the Judgment Matrix

Survey of experts can be used in the judgment matrix building. By comparing the relative importance between indicators, the judgment matrix can be built. Suppose there are n indicators, their weights areω_1, ω_2... ...ω_n. Make pair-wise comparisons for those indicators.

$$A = \begin{bmatrix} \dfrac{\omega_1}{\omega_1} & \dfrac{\omega_1}{\omega_2} & \cdots & \dfrac{\omega_1}{\omega_n} \\ \dfrac{\omega_2}{\omega_1} & \dfrac{\omega_2}{\omega_2} & \cdots & \dfrac{\omega_2}{\omega_n} \\ \cdots & \cdots & \cdots & \cdots \\ \dfrac{\omega_n}{\omega_1} & \dfrac{\omega_n}{\omega_2} & \cdots & \dfrac{\omega_n}{\omega_n} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{21} & \cdots & a_{23} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \qquad (1)$$

4.3. Level Single Ranking and the Consistency Checking

The index level single ranking weights of the program layer are B_j (j = 1, 2...n) by Analytic Hierarchy Process, after the dimensionless process, the original value of the evaluation index is transformed to the evaluation value R_j (j = 1, 2... n). And the final score of the comprehensive evaluation of supply chain performance evaluation is

$$V= \sum_{j=1}^{n} R_j B_j , \ 0 \leqslant R_j \leqslant 1 \ (j = 1, 2... \text{n}) \ \sum_{j=1}^{n} B_j = 1 \ \ (j = 1, 2... \text{n}) \qquad (2)$$

The comprehensive evaluation criteria of supply chain performance evaluation is: if $V \in [0.9, 1.0]$,then it is in the first level, the supply chain is very stable and the risk coefficient is very low; if $V \in [0.7,0.9]$,then it is in the second level, the supply chain is stable and the risk coefficient is low; if $V \in [0.5,0.7]$,then it is in the third level, the supply chain is unstable and the risk coefficient is high; if $V \in [0,0.5]$,then it is in the third level, the supply chain is very unstable and the risk coefficient is very high.

5. Conclusion

The current research of supply chain stability evaluation is still in the exploratory stage, on the contents of which foreign and domestic researchers have different views. This article expands the concept of stability to the operation links in addition to emergencies. By analyzing the structure of the

supply chain, and on the foundation of the chain structure of the supply chain, we analyze the impact factors of the supply chain stability and the evaluation indicators. Based on the analytic hierarchy process (AHP), the processing of measured data is proposed to get the evaluation results of the supply chain stability.

But this article selects only the abstract theory of the related indicators of the supply chain stability to study, and the evaluation method is relatively simple with only fuzzy analytic hierarchy process. Specific introduction of a comprehensive evaluation to measure the overall stability of the supply chain and selecting some real enterprises for test will be the next focus of the study.

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