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Research on Supply Chain Reengineering for Hazardous Chemicals

Qing Li

College of Management,Lang Fang Normal University, Langfang 065000, China
anthoney@163.com

With the purpose the research on the supply chain reengineering for hazardous chemicals, the documentary analysis, investigation, and diagnostic analysis was combined in this paper to put forward the formation and division model of the supply chain nodes targeting the characteristics and problems in the supply chain of hazardous chemicals enterprises, based on a brief analysis of the supply chain reengineering theory and the investigated status quo of the supply chain of hazardous chemicals enterprises. Additionally, with Daqing Oilfield as an example, specific implementation programs were proposed on the supply chain nodes reengineering and inter-node relationship reengineering, hoping to provide a new reference model for the supply chain reengineering for hazardous chemicals.

1. Introduction

The hazardous chemicals industry is a pillar industry that relates to the national economy and the people's livelihood. Due to its uniqueness, the industry is demanding in the production, transportation, and warehousing (Karlsson et al., 2011). In recent years, with the acceleration of the reform and industrial restructuring, all sectors have gradually attached importance to the management of the supply chain of hazardous chemicals, which has become one of the focus of domestic and foreign researchers.

The supply chain encompasses all directly or indirectly product-related processes from the supply of raw materials to delivery to consumers (Scruggs, 2013), such as raw material suppliers, distributors, and customers. Supply chain reengineering (Thibodeaux et al., 1982) refers to the integration of the node companies on the supply chain and their relationship with the goal of improving the core competitiveness of supply chain business units and maximizing value creation.

The formation and division strategies for supply chain nodes (Haastrup and Brockhoff, 1991) can be interpreted with the transaction cost economics theory, resource/capacity theory and division of labor theory. Combining the three theories, the division of supply chain nodes should fully consider reasonable division of labor, transaction costs saving, and agglomeration of resources for corporate development. On the other hand, the coordination of relations among supply chain nodes should involve the self-optimizing fractal theory and the decision-balancing game theory (Kim et al., 2004).

Researches on the supply chain reengineering at home and abroad include theories, models, and specific implementation plans for supply chain reengineering (Voudouris and Consulting, 1996). Despite a relatively complete system of the foreign researches on supply chain reengineering, limitations have been found in the previous domestic and foreign studies, such as the lack of development perspective in the supply chain reengineering analysis, the absence of supply chain management ideas in supply chain reengineering studies, and few researches on the supply chain reengineering of related process companies (Reiskin et al., 2010).

To this end, this paper, in order to study the supply chain reengineering for hazardous chemicals, investigated and analyzed the supply chain performance including the supply chain management of hazardous chemicals, the operation and relationship coordination of supply chain node companies, based on domestic and international literatures. Additionally, the supply chain node formation and division model was proposed combined with the supply chain management theory. Finally, with Daqing Oilfield as an example, a specific implementation plan for the supply chain node re-building and inter-node relationship reengineering was constructed.

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2. Survey on supply chain status quo of hazardous chemicals enterprises

2.1 Questionnaire design

In order to understand the status quo of the supply chain of hazardous chemicals in China, this paper, based on the domestic and international supply chain researches and interviews with industry experts and business managers (García-Flores and Wang, 2002), designed a questionnaire on the supply chain performance including the supply chain management of hazardous chemicals, the operation and relationship coordination of supply chain node companies, targeting the business units on the value chain of hazardous chemicals companies. A total of 200 questionnaires were distributed online and offline, with 189 valid questionnaires received.

2.2 Survey results

Through statistical analysis of the questionnaires, the status quo of the supply chain of hazardous chemicals in China was obtained:

2.2.1 Establishment of supply chain relationship coordination mechanism

Among all issues to be urgently solved in hazardous chemicals enterprises and business units, the business interests and cooperation business information communication accounted for the most, 48.8% and 37.1% respectively. In addition, the management mechanism was considered to be the biggest obstacle to the cooperation with business associates, followed by the goal coordination.

2.2.2 Integration of business unit capabilities

It as high as 68% of hazardous chemicals companies did not achieved resource integration with similar external entities. Only 7% achieved capacity complementarity through resource integration, while the remaining 25% of companies were conducting capacity integration between business units.

2.2.3 Effect of business unit relationship coordination

From Figure 1, it can be seen that at present, over 75% of the business units in the hazardous chemicals industry communicated with each other according to regulations of the higher authorities, while only about 15% achieved coordination of the relationship through the implementation of contracts.

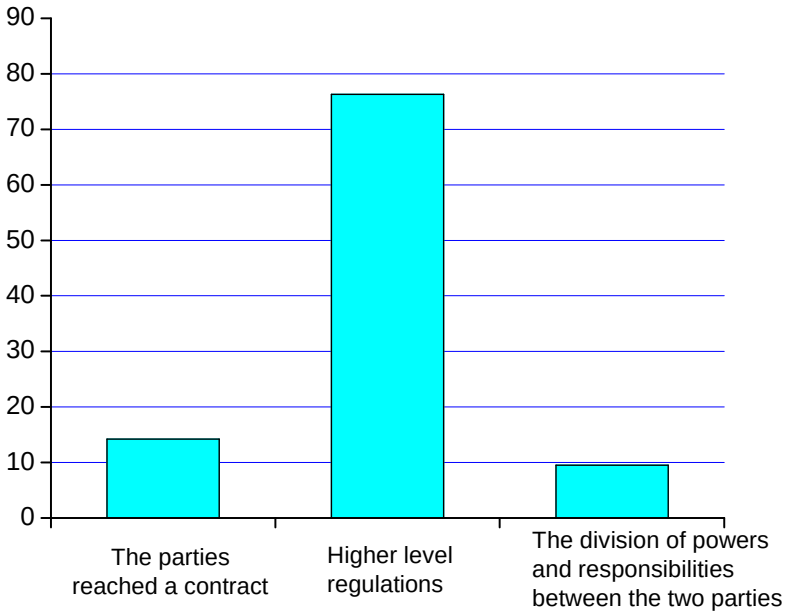

Figure 1: Business unit relationship coordination effect

2.2.4 Core business capacity development

Figure 2 shows the results of the survey on core business capacity building in the business unit operations. The results indicate that the core business capacity did not contribute significantly to most enterprises (51.2%), and only a few companies (32.2%) received most contribution from core business capacity building.

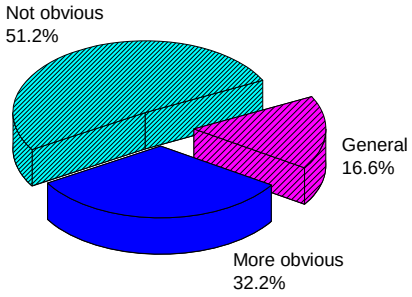

Figure 2: Core business capacity building

2.3 Characteristics of the supply chain of hazardous chemicals

Through the analysis of previous researches and the survey results, it is concluded that the supply chain of hazardous chemicals in China has the following characteristics:
(1) The hazardous chemicals industry is industrially clustered, with many nodes, long lines, complex contents in the regionally divided supply chain.
(2) The factors that affect the structure of the hazardous chemicals industry are complex. The internal and external environment of an enterprise impact on the structural change of the supply chain. In addition, long-term historical problems and path dependence are also important resistances to changes in the supply chain structure.
(3) The production process in the hazardous chemicals industry is characterized by uncertainty, nonlinearity, and time-varying nature.
(4) The supply chain node enterprises in the hazardous chemicals industry are affected by the restructuring of enterprises and the reform of the mechanism.
(5) Because the hazardous chemicals industry, due to flammable, explosive and toxic nature, have strict requirements for safety and professionalism, leading to the prevailing internal integration model of supply chains in the hazardous chemicals industry.

2.4 Main Issues in the supply chain of hazardous chemicals

The obstacles to the supply chain reengineering for hazardous chemicals are mainly reflected in the following aspects (Puigjaner and Guillén-Gosálbez, 2008). 1) As the establishment of the supply chain management system is in its infancy, the construction and coordination of enterprise nodes lacks the guidance of modern supply chain management ideas. 2) The development of the supply chain management practices lags behind, mainly manifested in the serious islanding phenomenon in information management and knowledge management, bad customer relationship management (unawareness of changing customer needs, lack of customer awareness), and improper logistics management (closed-door self-service, low resource utilization, insufficient awareness of logistics costs saving and creating value.
In general, the relationship among supply chain nodes is the main problem facing supply chain reengineering for hazardous chemicals. Therefore, combining the experience of domestic and international supply chain reengineering, this paper proposed strategies for the supply chain reengineering for hazardous chemicals with Daqing Oilfield as an example to solve the existing problems in the supply chain.

3. Strategies for supply chain reengineering for hazardous chemicals—Daqing oilfield

3.1 overview of Daqing oilfield

Daqing Oilfield Co., Ltd. is a wholly-owned subsidiary of PetroChina, with its business concentrated in the four fields of oil exploration, development, refining, and crude oil storage and transportation. The company has 22 exploration and development units, 5 technical service units, 3 oil and gas chemical units, 1 engineering construction unit, 6 mine service units, and 3 equipment manufacturing companies. Currently, the problems are mainly the decentralized industrial structure, weak primary businesses, structural maldistribution of industrial teams, limited self-development and coordination capabilities of the business units of branches, and failure in the integration with external resources for complementary capabilities.

3.2 Strategies for supply chain reengineering for hazardous chemicals—Daqing Oilfield

The supply chain reengineering for hazardous chemicals is to improve the ability of node enterprises to create value, and to integrate internal and external resources of node enterprises for capability complementarity through informatization construction and business reorganization.

3.2.1 Supply chain node formation and division model

Figure 3 shows the supply chain node formation and division model (Berning et al., 2002). In the model, the performance of the supply chain consists of consumer surplus and supply chain profit. The supply chain nodes are reengineered by the specialized management of business units and market price mechanism to reduce costs and eventually achieving the goal of maximizing the value created in the entire supply chain.

3.2.2 The formation framework of reengineering strategies for supply chain nodes

The reengineering of supply chain nodes (Li and Wang, 2016) is realized through learning from the supply chain node management experience in the domestic and international chemical and manufacturing industries, combining the evolution and status quo of supply chain nodes of the chemical industry and hazardous chemicals enterprises, based on the basic theoretical analysis (transaction cost theory, resource/capacity theory, and division of labor theory), historical progressive search, and empirical analogical reasoning (Laínez and Puigjaner, 2012), as shown in Table 1.

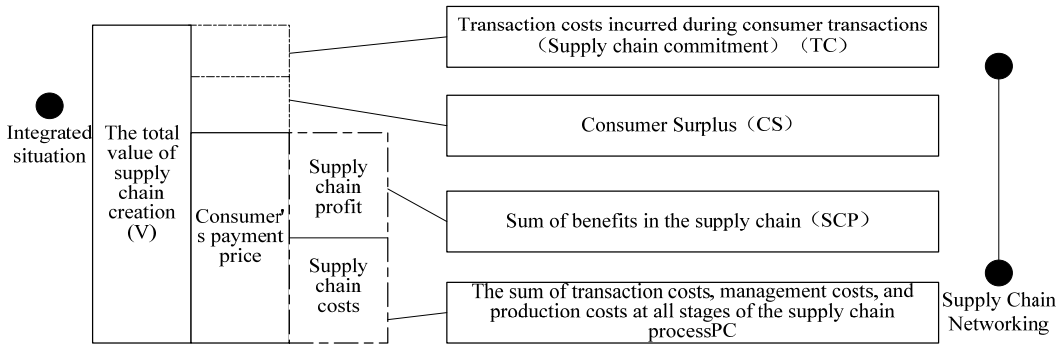

Figure 3: Supply chain node formation and division model

Table 1: Formation framework of supply chain node integration strategy

——	Strategy Exploration	**Search path**	Strategy inspiration
Supply Chain Node Integration Strategy	Theory-based rational analysis	Transaction cost theory	The formation and division of decision nodes based on asset specificity, uncertainty, and transaction frequency
		Resource/Capability Theory	Integrate resources, complement each other, and use efficiency of knowledge as the basis for decision-making
		Division of labor theory	Use professional knowledge as the basis for decision making
	History-based progressive search	Hazardous chemical industry supply chain node evolution	In order to deepen the market, the need for competition and cooperation is the basis for decision-making
		Status of Supply Chain Nodes in Hazardous Chemical Industry	Based on the development of core business capabilities for decision-making
	Analogical reasoning based on experience	Domestic and Foreign Supply Chain Node Management for Hazardous Chemical Industry	Based on business nature and professional management
		Domestic and Foreign Manufacturing Supply Chain Node Management	Focusing on the core business and the marketization of main and auxiliary businesses as the basis for decision-making

3.2.3 Supply chain node reengineering strategy for Daqing oilfield

Figure 4 shows the supply chain node reengineering strategy for Daqing Oilfield based on Daqing Oilfield's actual conditions, combined with the supply chain node formation and division model and the supply chain node reengineering strategy (Frohlich and Westbrook, 2001). After the reengineering, Daqing Oilfield Exploration Bureau lead 4 subsidiaries. Each subsidiary company has a clear scope of business, realizing professional operations and identifying and strengthening the core business, and enhancing the market competitiveness. The company's internal business units are market-oriented in operations, and four companies operate and account independently.

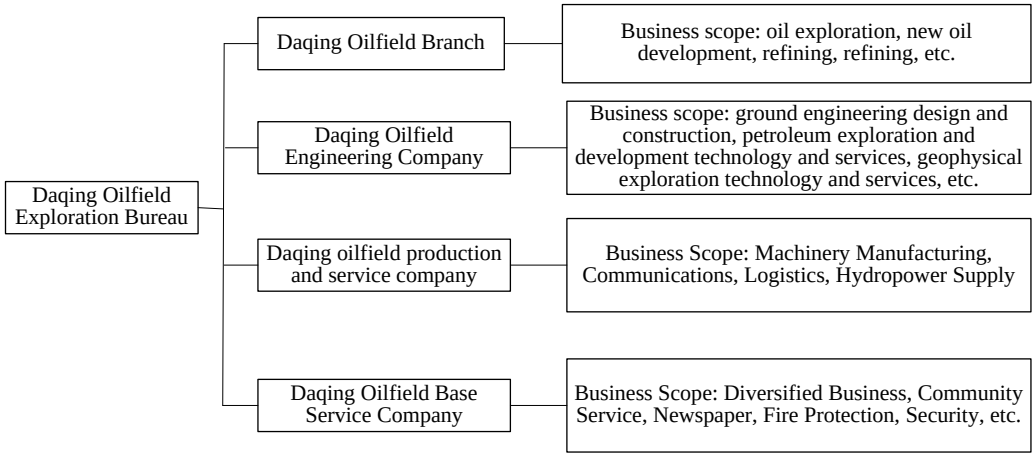

Figure 4: Daqing oilfield supply chain node reengineering strategy

3.2.4 Supply chain nodes relationship reengineering strategy for Daqing oilfield

In order to further optimize the supply chain reengineering model, the market-oriented supply chain nodes relationship strategy for Daqing Oilfield was proposed based on Daqing Oilfield's actual conditions, Daqing Oilfield's supply chain node integration strategy, and the game theory, as shown in Figure 5. The careful design of the formal contract can reduce the potential risks in the transaction process, and relationship governance can promote contract refinement. Also, continuous cooperation can reduce transaction costs. The supply chain node relationship rebuilding can support more cooperation and improve corporate performance.

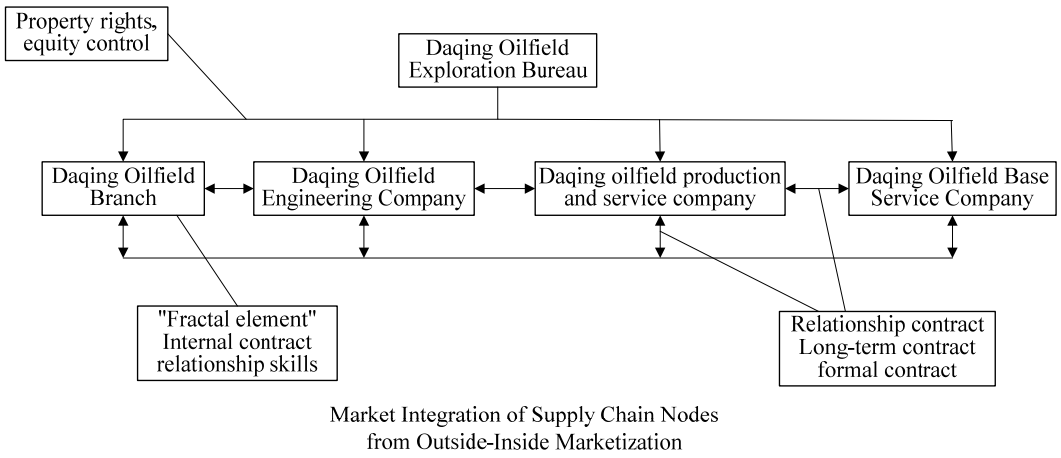

Figure 5: Reengineering strategy of supply chain nodes in Daqing oilfield

4. Conclusion

In the spirit of problem identify and solving, this paper, based on the survey and study of the status quo of the supply chain of hazardous chemicals, conducted research on the supply chain reengineering for hazardous chemicals. The specific conclusions are as follows:

(1) Through the survey and research on the current status of the supply chain of hazardous chemicals, the characteristics of the supply chain of hazardous chemicals and the existing problems were summed up.
(2) Based on the survey results of the status quo of the supply chain of hazardous chemicals and the supply chain related theory, a supply chain node formation and division model was proposed.
(3) Taking Daqing Oilfield as an example, a specific implementation plan for the reengineering of the supply chain nodes and inter-node relations of hazardous chemicals was put forward.

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