

Studying the impact of supply chain complexity on competitiveness capabilities

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Abstract: The extant paper aims at studying the impact of supply chain complexities on competitive capabilities of great automobile manufacturers in Iran, using supply chain complexity model and empirical studies. The obtained results indicated that upstream complexity, internal manufacturing complexity and downstream complexity have all negative significant impacts on discussed companies. In order to propose a definition for supply chain complexity, and to provide empirical tests for measuring it, the present paper has related the literature review of system's complexity with the literature review of supply chain.

Key words: Supply chain management; System complexity; Supply chain complexity; Competitiveness

1. Introduction

In recent years, understandings about improvement of social and environmental competitive capabilities have changed drastically (Jose, M. Cruz., 2009). Increasing process of globalization has strengthened commercial competitiveness and has resulted into reduction of global gross profit in many industries. In global economy, managers of supply chain should be competent in controlling integrated relations that link supply chains (Cantor David, E., Macdonald John R, 2009). Based on supply chain management prospective, it is not appropriate for different businesses to use operational management, sourcing, and supporting contexts separately or in an integrated way as an advantage. They should expand and manage data, physical and relational streams that link these contexts and connect them with partners of higher or lower ranks. The nature of these activities has become more challenging. For example, life cycles of products have been reduced; variety of products has increased as well as production based on the customers' orders; and partners of supply chain have been geographically scattered more than ever. Therefore, companies try to be connected to their partners in the supply chain in order to achieve competitive advantage, flexibility and better efficiency. It is clear that supply chain management is a challenging issue. Most of scholars believe that supply chain is a complex system. Though significance of expanding supply chain activities in companies has received a great attention; it has been a short while that university researchers and managers of companies have Figure out the disadvantages of increased complexities (Hoole, 2006).

Complexity of supply change has always been a concern of managers. Therefore, with a comprehensive understanding of complexity patterns and their impacts on competitive capabilities, an organization can provide contexts for industrial, marketing and economic growth and expansion in the society. Therefore, a full understanding of research results seems vital.

In the present paper, some of the concepts and terms of literature review of science of systems have been used in order to define complexity of supply chain and its various aspects. Also, efforts have been made in order to study the impact of various complexity sources including upstream complexities, internal manufacturing complexities, and downstream complexities on competitiveness capabilities of Iran's automobile manufacturing industries. The obtained results reveal the impact of complexity sources on competitive capabilities of automobile manufacturers in Iran.

2. Literature review

2.1. Supply chain and its management

Producers are always looking for developing long-term relations with some of their suppliers in order to supply their required technologies and sources, benefit from the skills and capabilities of the suppliers, control them, and improve their products (Kalwani and Narayandas, 1995). Companies that work with one another and have interactions have a better view, higher level of services, more flexibility, more customers' satisfaction and less demand cycles.

Economic environment is dynamic and ever-changing. Today, many companies have figured out that in order to have global access and domestic interactions, the traditional vertical integrated trade model needs to be evaluated again. This evaluation

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happens through increase in cooperation between the partners, sharing more knowledge during the exchanges in order to avoid lack of supporting currents. It is clear that cooperative companies are more successful compared to the working-alone ones. In new economics competition is led to supply chains. If the relations are more integrated, more sustainable competitive advantage is provided. Therefore, companies are trying to increase their control over the supply chain.

Supply chain is a network of processes and activities that provides value for the final customers as products and services. As previously said, companies require supply chain management in order to gain competitive advantage in today's dynamic economic environment.

Supply chain management is a concept that is rooted from productive industries. This concept is developed from innovations including Just in Time production and some fields of control and Total Quality Management. Supply chain management is a holistic and strategic method for managing demands, sale operations, and supply processes.

2.2. Supply chain complexity

Complexity has been discussed in various sciences including philosophy, physics, engineering and management. However, various definitions of the components of this system are still controversial. The obtained results were used in studying, predicting, controlling chaotic systems and the organizational theoretical framework. These issues are also used in the supply chain management field. In fundamental researches these theories were used in supply chain model of complex compatible systems.

Supply chain managers should accept that complexity is a key management issue. Though it has been discussed by many scholars; there are various definitions for it. In the organizational literature review, there are various fundamental researches based on studying, predicting and controlling chaotic systems (Choi and Krause, 2006).

In general a complex system is a system made on various components that cooperate with one another in a complex manner. A complex system one or a few of these 5 features: 1- significant interactions, 2- so many components, 3- being non-linear, 4- convergence 5- contradictory limits.

Supply chain is extremely complex. Though complex, a supply chain can be executed in three different parts: supply chain processes, the structure of supply chain network and management components¹⁶.

Downstream complexity is defined as a level of dynamic complexity and a description of industrial facilities of downstream markets. Potential factors of development of downstream complexity include the number of customers, heterogeneity of customers' needs, the average of life cycles of products and variability of demands.

Upstream complexity is determined by dynamic complexity and a description of industrial facilities in regards with the demands. Potential factors of development of upstream complexity include the number of interactions with the suppliers that should be manage, the time that should be waited before the delivery, reliability on the suppliers and the range of finding sources (Bozarth et al, 2009).

Internal manufacturing complexity is defined as dynamic complexity and a description of industrial facilities that can be found in the products, processes, control systems and company's scheduling. Potential factors of development of internal manufacturing complexity include the number of sections, the number of covered products, various industrial processes, and the stability of industrial scheduling.

Demand variability is an important source for dynamic complexity in supply chain. Because activities similar to supply chain that depend on the level of demand can have different outcomes. The classic explanation of this phenomenon is bullwhip effect. It explains how expanded fluctuations happen in ordering patterns of the upstream due to lack of homogeneity in ordering policies in different stages of supply chain, while demands change subtly in time (Forrester, 1961).

2.3. Supply chain and competitiveness capability

Studying the ideas of various scholars and researchers displays that competitiveness does not have a single definition. In general, competitiveness can be defined as capabilities and abilities a business, an industry, a zone or a country has and use in order to survive in the competitive market and be in a good position there. In other words, competitiveness is the ability of profitability, increase in value added and survival in the competitive domestic and international markets for a long while.

Competitiveness is made of a combination of assets and processes. Assets may be natural (like natural resources) or human-made (like infrastructures). Processes change assets to economic profits that are achieved by selling products to the customers and develop competitiveness.

Competition is increased in the markets and has been transferred from single institution to the supply chain and the business environment of the entire industry. In fact, supply chain is a set of all the institutions that work directly or indirectly for fulfilling the final customers' needs.

In the past, institutions worked individually and had weak relations with other institutions and considered all the companies as rivals. Due to this mindset, institutions focused their decisions on internal processes and explore them regardless of other institutions (marginal optimization strategy). Due to changes in the environment (increased competitiveness) and technological advancements, institutions should consider external processes

besides internal processes in order to gain competitive advantage. Therefore, stages of supply chain and the relation among its practitioners have important roles in the competitiveness of the final product. In each stage, some decisions are made that their results will affect the other components of the

chain. In fact, competitiveness is a multi-dimensional concept in the organization level (Akimova, 2009).

3. Research hypotheses

Research hypotheses are proposed as the following conceptual model.

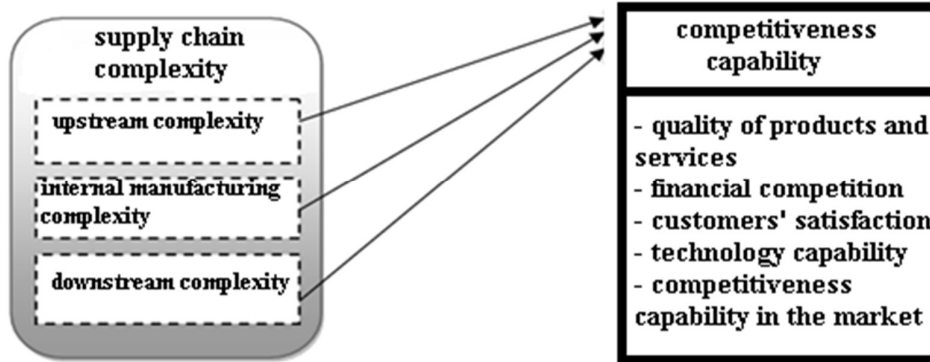


Fig. 1: The impact of supply chain complexity on companies' competitiveness capability

- 1- Upstream complexity has negative impacts on competitiveness capability of car manufacturing companies.
- 2- Internal manufacturing complexity has negative impacts on competitiveness capability of car manufacturing companies.
- 3- Downstream complexity has negative impacts on competitiveness capability of car manufacturing companies.

4. Methodology

In order to study the impact of supply chain complexity on competitive capability of industrial factories we chose a population which has the features of traditional factories as well technological features. In order to make sure there is a supply

chain, the population was chosen as great car manufacturing companies in Iran. The sample included six car manufacturing companies (Iran Khodro, SAIPA, Bahman group, Zamyad, Iran Khodro Diesel and Kerman Khodro) that were chosen randomly.

In the present research questionnaires were used in order to gather data. The questionnaire was Likert scale. In order to check its validity; it was given to some company managers. They confirmed its validity. In order to study its reliability, before distributing it among the managers of the selected companies, some questionnaires were distributed in smaller factories (including Rafsanjan Industrial Park). As observed in Table 1, the reliability of the questionnaire was confirmed.

Table 1: Reliability of the questionnaire

Factors	Competitiveness capability	Supply chain complexity (total)	Downstream complexity	Internal manufacturing complexity	Upstream complexity
Reliability	0/842	0/894	0/731	0/803	0/731

The questionnaire included 31 questions, containing 5 questions about upstream complexity (0/731), 8 questions about internal manufacturing complexity (0/803), 5 questions about downstream complexity, and 13 questions about competitiveness capability (0/842).

In each of the factories, 8 questionnaires were distributed among different managers. 48 questionnaires were distributed in 6 factories. Since some of the managers did not cooperate, 33 questionnaires were filled and gathered.

Since this research studies the impact of one factor on the other, correlation analysis and

regression analysis were used in order to analyze the data.

5. Discussion and results

Pearson correlation coefficient was used for determining the correlation between the independent variables and the dependent variable. According to Table 2, negative correlation between all the three parts of complexity (upstream complexity, internal manufacturing complexity and downstream complexity) and the competitive ability is observable.

Table 2: Correlations

		X ₁	X ₂	X ₃	Y
X ₁	Pearson Correlation	1	0/761**	0/615**	-0/801**
	Sig. (2-tailed)		0/000	0/000	0/000
	N	33	33	33	33
X ₂	Pearson Correlation	0/761**	1	0/662**	-0/781**
	Sig. (2-tailed)	0/000		0/000	0/000
	N	33	33	33	33
X ₃	Pearson Correlation	0/615**	0/662**	1	-0/666**
	Sig. (2-tailed)	.000	0/000		0/000
	N	33	33	33	33
Y	Pearson Correlation	-0/801**	-0/781**	-0/666**	1
	Sig. (2-tailed)	0/000	0/000	0/000	
	N	33	33	33	33

** . Correlation is significant at the 0/01 level (2-tailed).

X₁ = Upstream complexity (independent variable)

X₂ = Internal manufacturing complexity (independent variable)

X₃ = Downstream complexity (independent variable)

Y = Competitiveness capability of the factory (dependent variable)

6. Analyzing the first hypothesis

First hypothesis: “High levels of upstream complexity have negative impacts on competitiveness capability of car manufacturing companies”.

H₀: High levels of upstream complexity do not have negative impacts on competitiveness capability of car manufacturing companies

H₁: High levels of upstream complexity have negative impacts on competitiveness capability of car manufacturing companies.

The first hypothesis states that high levels of upstream complexity have negative impacts on competitiveness capability of car manufacturing companies. As observed in the table, the significance level of the sample is less than 0/01 (Sig=0/000). In other words, the null hypothesis is rejected and the alternative hypothesis is confirmed.

Table 3: Regression model for the first hypothesis

Model		Unstandardized Coefficients		Standardized Coefficient	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8/950	.0/513		/44117	0/000
	X ₁	-0/687	0/092	-0/801	-7/451	0/000

a. Dependent Variable: Y

Since the equation of the regression line of the population is $y = \alpha + \beta x$, it is clear that β displays the relation between the dependent and independent variables. If $\beta > 0$, the relation will be direct. If $\beta < 0$, the relation will be inverse. If $\beta = 0$, it means there is no linear significant relation between dependent and independent variables. As observed in Table 3, the coefficient of independent variable is negative. It reveals that as the upstream complexity increases, competitiveness capability of car manufacturing companies decreases and vice versa.

Increase in the number of suppliers adds to the procedures and relations that are managed by the country. Changes in the number of suppliers or the waiting time before delivering the goods disturb the scheduling plans. This issue is effective in continuity of the process. In mass production factories, all the sections are dependent on one another just like a chain. If the primary material supply section dysfunctions, production lines will encounter problems, work force will be wasted and the factory

will be damaged. Therefore, efficiency is decreased and the company will not be able to fulfill the customers’ needs.

It is clear that expanding the range of finding sources, dispersion of suppliers and reduction of on time delivery result to lack of certainty in the scheduling and make managing these complicated relations.

7. Analyzing the second hypothesis

Second hypothesis: “High levels of internal manufacturing complexity have negative impacts on competitiveness capability of car manufacturing companies”.

H₀: High levels of internal manufacturing complexity do not have negative impacts on competitiveness capability of car manufacturing companies

H₁: High levels of internal manufacturing complexity have negative impacts on

competitiveness capability of car manufacturing companies.

The second hypothesis states that high levels of internal manufacturing complexity have negative impacts on competitiveness capability of car

manufacturing companies. As observed in the table, the significance level of the sample is less than 0/01 (Sig=0/000). In other words, the null hypothesis is rejected and the alternative hypothesis is confirmed.

Table 4: Regression model for the second hypothesis

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	8/294	0/457		/16618	000/0
	X ₂	-0/686	0/098	-0/781	-6/970	000/0

a. Dependent Variable: Y

According to Table 4, the coefficient of the independent variable in the population was found out to be negative. In other words, as the complexity of internal manufacturing complexity increases, the competitiveness capability of car manufacturing is reduced.

The reason for the inverse relation between internal manufacturing complexity and competitive capability is that increase in the numbers of sections and covered products result into increase in diversity of activities and relations that need to be managed. A quick glance at organizational diagram of studied factories before and after the new product reveals everything. Obviously complexity of products and process as well as increase in production of commodities results into complexity of the relation between them and make managing these relations a harder thing to do. The obtained results revealed that subsequently the competitiveness capability of industrial unit is reduced.

8. Analyzing the third hypothesis

Third hypothesis: “High levels of downstream complexity have negative impacts on competitiveness capability of car manufacturing companies”.

H₀: High levels of downstream complexity do not have negative impacts on competitiveness capability of car manufacturing companies

H₁ : High levels of downstream complexity have negative impacts on competitiveness capability of car manufacturing companies.

The third hypothesis states that high levels of downstream complexity have negative impacts on competitiveness capability of car manufacturing companies. As observed in the table, the significance level of the sample is less than 0/01 (Sig=0/000). In other words, the null hypothesis is rejected and the alternative hypothesis is confirmed.

Table 5: Regression model for the third hypothesis

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.118	0/599		13/553	0/000
	X ₃	-0/536	0/108	-0/666	-4/977	0/000

a. Dependent Variable: Y

In today’s competitive world, customer is considered as a very important part of the supply chain. The final users of the products are the profit source of all the supply chain. Therefore, Customer Relationship Management is of great importance. The companies that encounter a great amount of customers’ demands due to the type of their activity or the condition of the market place, have already Fig.d out the effect of diversity in their needs and the impact of heterogeneity of these needs on their competitiveness capability and the efficiency of their supply chain. Even subtle changes in the demands cause drastic changes by moving from the downstream to the upstream of the supply chain. Competitiveness capabilities of factories are reduced due to changes in demands, the number of

customers and lack of heterogeneity among them. Also, reduction of average life cycle of the products adds to this complexity. The results of the extant paper confirm these sayings.

9. Conclusion

In today’s economics, competitions have led to supply chains. It means that competitions happen in supply chains and overall business environments instead of single institutions. In today’s competitive environment, successful companies are the ones capable of supply chain management. Industrial companies should manage their relationships with suppliers and customers, in order to remain competitive. This reduces complexity in their supply

chain and therefore increases their competitive advantage. High complexity in supply chain hinders effective activity and makes the obtained results indeterminate. A company may have a high capacity but cannot increase its efficiency due to confusing relationships with customers and suppliers. It means that increased complexities in internal manufacturing, upstream and downstream competitiveness of the company is reduced.

The extant research indicates the negative impact of complexity on competitiveness of automobile manufacturing companies in Iran. The results confirmed this fact and will be found helpful for the future researchers. We have come up with the following suggestions.

- Considering that various industries have various levels of complexity, it is suggested that future researches focus on differences between complexity in various industries and how these differences affect competitive capabilities.
- It is clear that activities in uncertain environments require proper strategic decisions. Since uncertainty increases complexity, we suggest that other researchers study the impact of making different strategic decisions by companies on the level of complexity in supply chains.
- Are decision-makers familiar with complexity of supply chain in the factory level? Future researches can focus on the impacts of decisions of company managers on supply chain as well as the impacts of their ignorance of the results of these decisions.

We suggest other researchers study the impact of geographical dispersion, different cultures and different policies regarding macroeconomics on complexity of supply chain and subsequently on competitiveness of industrial units.

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