

Survey The impact of knowledge transfer and product complexity on supply chain flexibility: “Case study of SAPCO Company”

Abulfazl SOHRABI¹, Ali SOURI², Mohammad KALANTAR³

¹ Faculty member of Qom Paradise University, Qom, Iran

² Ph.D. candidate of business management, Marketing management, Islamic Azad University of Qom, Qom, Iran

³ Ms of business management, Islamic Azad University, Electronic Branch, Iran

Abstract

This study aims to evaluate the effect of knowledge transfer and product complexity on flexibility of supply chain of SAPCO Company. The study population is employees of SAPCO Company. In this study, the data with sample size 234 are collected using a questionnaire and simple random sampling method. To evaluate the normality of questions, Kolmogorov-Smirnov method was applied. To evaluate the relationship, Pearson correlation test was used and to test the hypotheses, structural equations method is applied. The results show that internal knowledge transfer and external knowledge transfer have positive and significant impact on supply chain flexibility but the complexity of product has no impact on supply chain flexibility. This study showed that the effect of external knowledge transfer was higher than the impact of internal transfer. Finally, it is proposed that companies should provide the conditions in which the employees can increase supply chain flexibility outside the discussion sessions on proposes, new products ideas with other internal and external sectors, brain storming sessions formation with the presence of external organizational experts and take good strategies to manage the effect of products complexity.

Keywords: Internal knowledge transfer, External knowledge transfer, Flexibility, Supply chain

1. Introduction

The ability of supply chains to flexibly adjust to changing demands and environments is of great importance, namely in our current reality indicated by increasing global complexity. The great current complexity arises from the shorter life of product, much intense competition and the increasing expectations of customer. The recent complexities imply that the customers emphasize on the demands of “faster, better and cheaper” on products and services. The knowledge-based theory of companies provides a theoretical support of the positive internal and external impact of knowledge transfer on supply chain. In this view, knowledge indicates a valuable source helping the competitive advantage of companies. Therefore, knowledge

application at first depends upon its transfer, if this transfer is facilitated; great impact on performance is expected. Thus, high efficiency of knowledge transfer leads to high level of supply chain flexibility. With effective processes of knowledge transfer, desirable knowledge can guide the activities of companies effectively and this increases supply chain flexibility. Supply chain flexibility is a complex and multi-dimensional concept, which have been described as being difficult to perceive. Supply chain flexibility is necessary for companies in case of increasing global complexity (Blome et al., 2013). Today's complexity arises from the shorter life of product, much intense competition and increasing customer expectations. Today, customers attempt to achieve their demands "faster, better and cheaper" (Lummus et al., 2015, p. 2707). Knowledge management is a process that helps the organizations identify, select, organize, disseminate and transfer important information that are part of the organization's memory. Thus, problem-solving, dynamic learning, strategic planning and decision making can be efficient and effective (Turban and McLean, 2003). The knowledge management process is composed of various sections. At the beginning of knowledge transfer, at first we should identify the existing knowledge in organization and its sources (e.g. explicit and tacit knowledge, database) and then store it. In order to transfer the exiting knowledge to value-added, synergy and regeneration, it should be shared among people (Rohollah and Noruzi, 2014, p.130). Supply chain flexibility has become an important component to remain competitive in adjusting to increasingly changing environment. Supply chain flexibility is defined as the ability of supply change to respond to the environment changes. This feature refers to the speed with which the companies can adjust production processes, capacity, stock turnover and cycle time. Supply chain flexibility is thus seen as a means to reduce uncertainty and to ensure the smooth flow of products through the supply chain (Lummus et al.,2015, 2701). A comprehensive definition of supply chain flexibility is the ability of supply chain for successful meeting of the customer demands. Supply chain activities include moving goods from the raw-materials stage through to the end user, parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, delivery to the customer and the required information systems to control all activities. Supply chain flexibility requires flexibility inside the organization and all of the partners in the chain (departments within an organization) and the external partners (suppliers, carriers, third-party companies etc.) (Armon, 2006, p. 16). Supplying Automotive Parts (SAPCO) was established in 1993 with the aim of creating the basis of automotive parts construction in Iran based on a historical necessity. Now, this company is responsible for supply chain management of automotive parts. SAPCO Company produces products with high complexity, lack of ability in external and internal knowledge transfer can lead to inability of supply chain flexibility and leads to supply chain inefficiency. This study evaluates the knowledge transfer activities as vital capabilities to create such supply chain flexibility. Specifically, this study responds these questions "How does external and internal knowledge transfer and product complexity influence supply chain management?"

1.1. Study objectives

Main objective: Evaluate the impact of knowledge transfer and product complexity on supply chain flexibility

Minor objectives:

- The impact of internal knowledge transfer on supply chain flexibility
- The impact of external knowledge transfer on supply chain flexibility
- The impact of product complexity on supply chain flexibility

1.2. Theoretical basics

Supply chain management includes the materials flow management and information of the suppliers and buyers of raw materials to the end user. A network of institutes being involved in the production and delivery of a product to the end user is called supply chain. The aim is that all people in the chain collaborate with each other to reduce the general costs and improve the quality and delivery speed of the products and services. Supply chain management to a team approach requires some tasks including marketing, purchase, operation and engineering to collaborate with each other. Knowledge management process is composed of different sectors. At the beginning of knowledge transfer, at first the existing knowledge in organization and its sources (e.g. explicit and implicit knowledge, database, and documents) are identified and are stored suitably after acquisition. In order to transfer the exiting knowledge to value-added, synergy and re-generation, it should be shared among people (Rohollah and Noruzi, 2014). A comprehensive definition of supply chain flexibility is the required flexibility dimensions for all participants in supply chain for successful meeting of the customer demands. Based on the previous definitions of supply chain management, these activities involved in delivering a product from raw material through to the customer including sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, delivery to the customer, and the information systems necessary to monitor all of these activities. Supply chain management requires the flexibility of the partners in the chain including departments within an organization and the external partners including suppliers etc. This also includes flexibility in information collection, market demand and information exchange among the organizations. As a comprehensive definition, supply chain management is monitor of materials, information and financial flow moving in a process of supplier to producer and then wholesaler to retailer and consumer (Fortes, 2007). Intense competition in the present market and rapid change of customers preferences with rapid development of technology and globalization have obliged the organizations to work as a member of a supply chain instead of individual companies. The success of supply chain depends upon the integration and coordination of all its institutes to form an efficient network. An efficient network leads to saving in operation costs in the entire chain and helps it to respond the

customers' need faster. According to Simchi-levi&Kaminsky, the design of supply chain network is the basic decision in management influencing all other chain decisions and it has the extensive impact on chain capital return and its general performance. One of the common issues in supply chain management researches is key capabilities of company. According to the researches, the term "competitive priorities" is used extensively to select the company in competitive abilities (Chapra and Mindel, 2001). In this study, four competitive priorities that were accepted in the previous studies include: 1- Cost reduction: All manufacturers interested in a level of cost don't compete only on this priority and can use other priorities beside this priority. The companies that emphasize on cost as a competitive priority focus on reduction of production costs, increasing productivity, maximize the use of capacity and reduction of warehouse inventory (Ward et al., 1996). 2- Quality: The design, marketing and production process is defined as having different qualities (Ward et al., 1995). Garvin (1987) stated the difference of views by proposing eight components in a framework: performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality. What is accepted in the prior studies is that design, production, distribution, marketing and after sale services are used to measure the operation quality of a company. 3- Delivery efficiency (reliability and speed): The delivery ability is based on the given plan. For some customers, delivery speed is necessary to give orders. Although these two dimensions are separated from each other, the long-term success requires that the rapid delivery promise is performed with high level of reliability (Ward and Duray, 2000). 4-Flexibility. Garvin (1993) states seven components of flexibility including *mix*, *changeover*, *modification*, *rerouting*, *volume*, *and material* and *sequence*flexibilities. Flexibility in manufacturing companies is using high costs by multi-purpose machineries instead of single-purpose efficient machineries and using skillful workers (Ward and Duray, 2000). In recent years, the implementation of advanced technologies of production has reduced the costs of achieving flexibility effectively and it implies that more companies attempt to follow competitive advantage via quality (Jafarpour, 2014). The evaluation and follow up of supply chain is an important issue namely for the reason that some organizations are involved in a chain. To do this, different types of criteria are applied. One approach is using reference model of supply chain operation indicating the effort to standardize the assessment of supply chain performance in production sector (Hosseini and Sheikhi, 2013).

Internal and external transfer of knowledge has positive impact on supply chain flexibility. External knowledge transfer is defined as the ability of company to use external expertise to improve the products and processes of company. The product complexity is defined by customization, complexity and variety of products. There are a few studies on the intermediary effect of product complexity. From a practical perspective, studies regarding how to foster supply chain flexibility to respond to today's challenges is necessary.

Besides the incomprehensible human disaster of this event also showed companies such as Apple, Sony Ericsson, and many car manufacturers being unable to quickly adjust their supply chains and they were unable to compensate for the lost supplies resulting in significant losses

(Schoenherr et al., 2010, 631)). Complexities inherent in the product impede the effectiveness of knowledge transfer activities in generating supply chain flexibility (Blome et al., 2013).

Knowledge is the main foundation of organizations as knowledge enables the companies to develop their main competencies and cope up with the challenges and changes and manage the complexities. Knowledge is implicit or explicit. The different aspects considered by researchers include learning process, knowledge creation and knowledge transfer. Knowledge transfer can be defined as “the process through which one unit is affected by the experience of another” (Argote and Ingram, 2000, p. 151). Increasing globalization, the trend towards source extraction, as well as the intense environmental complexity, the scope of investigation pertaining to flexibility has extended. This has led to the emergence of the more comprehensive concept of supply chain flexibility. Flexible plans had positive effect on agility of supply chain and performance of company (Swink et al., 2005). Vickery and Calantone (1999) delineated dimensions of supply chain flexibility regarding the dimensions of product, volume, launch, access and target market. Pujawan (2004) included delivery, production, product development, and sourcing as the dimensions. There are a few researches on integrating both internal and external dimensions increasing supply chain flexibility. Supply chain in production sector includes the activities with effective flow of materials and information. The purpose of this chain is timely supply of raw materials, required parts and their distribution. Due to its special features, knowledge management should be kept in supply chain of manufacturing companies. The investigation of the effect of knowledge transfer on supply chain and its flexibility is necessary.

The investigations show that knowledge management is a social issue and human being plays an important role in its success (Ghelichli, 2012, p.115). The knowledge management is examined from different views as follows: Business perspective: knowledge management is a commercial activity with two main components, considering knowledge element of business activities as the explicit component of business as reflected in strategy, policy and procedures in all levels of organization and there is a direct relationship between intellectual capital and positive business results (Barkleg and Moray, 1997). Thus, knowledge management is a combined and cooperative approach for creation, acquisition, organizing, access and use of intellectual capital of organization (Gary, 1996). Knowledge science perspective or science cognition: Knowledge, attitude, perception and applied technical knowledge is a basic source enabling us to act carefully (Wig, 1993). Process (technology) perspective: Knowledge management is a concept by which information is converted to applicable knowledge and it is used by little effort for the people using it (Ghelichli, 2011, 201).

In another grouping, organizations are distinguished based on five important dimensions of knowledge management by which a basis is provided for suitable classification of knowledge management; the levels in which knowledge management interactions in organization are employed; extension of knowledge activities being employed at any level; goal of knowledge management activities; is knowledge management intervention a social process or technological process; Are these interventions based on the policy or plan. The basic concepts in knowledge management include data, information, knowledge and relevant relationship (Fatehi, 2011).

Among knowledge management models, we can refer to the knowledge management model of Di Bella&Nevis and Ruggles knowledge management model. Di Bella et al. define organizational learning as the capacity or processes within an organization to improve performance based on experience. This process includes (1) knowledge acquisition (creation or development of skills, attitude and interpretations), (2) knowledge sharing (dissemination of knowledge learnt by a person to others), (3) knowledge transfer and application (knowledge integration as available as absorbed and extended and generalization to new conditions (Nadi et al., 2011). Rogels divides the processes of knowledge management in the company into four groups (1) Creation and achievement, (2) facilitation and presentation, (3) application, (4) transfer and calculation. The processes of knowledge management presented by him include a) new knowledge production, achievement of valuable knowledge of external resources (a creation and achievement process), b) Facilitation of knowledge growth via culture, motivation and presenting knowledge in documents, database and software (a presentation and facilitation process), c) Flowing knowledge in processes or services and using available knowledge in decision making (a placement and application process), d) The transfer of existing knowledge to other organizational sectors and calculation of the value of knowledge capital or the effect of knowledge management (a process of calculation and transfer)(Gholamian, 2010).

Knowledge effectiveness transfer has great advantages and for this reason, the companies pay considerable costs for effective knowledge transfer. In the design of knowledge transfer capacity, transfer cost should be compared and divided by the decision’s cost acquired in the absence of relevant knowledge and the knowledge cost considered by the people outside the organization should be compared (Askari, 2005, 3,31). Table 1 shows some examples of technologies enhancing the transfer and conversion of internal and external knowledge (Afraze, 2005).

Table 1: Some examples of technologies of transfer facilitation and internal and external knowledge conversion

Tacit to explicit Answering of questions and annotations	Tacit to tacit Electronic meetings, synchronous collaboration (chat)
Explicit to explicit Text search and documents classification	Explicit to tacit Visualization, browsable audio-visual representation

2. Review of literature (local and internal studies)

Wu, Chuang, Hsu (2014) performed a study to evaluate and identify the type of relationship of social exchange theory and supply chain performance. The result of study presented an interesting model and showed that the communication path between two mentioned variables shouldn’t ignore the effect of information sharing and participative behaviors.

Blome et al., (2013) in a study evaluated the impact of internal and external knowledge transfer on supply chain. They believed that product complexity is effective on the relationship between

knowledge transfer and supply chain. They found that complexity in probable conditions has negative or positive effect on supply chain performance.

Baghalian et al., (2013) designed a multi-product supply chain network by considering the demand uncertainty and supply uncertainty and applied robust method against uncertainty. They tested their models on agriculture food industry.

Ioannis et al., (2012) evaluated the effect of green supply chain on the network design and its cost. They developed strategic and tactical decisions to help the managers in evaluation of the effect of environmental issues. The results showed that in the majority of examples, using warehouses and common vehicles enhanced the environmental and expenditure performance of the company. Melo et al., (2009) presented a comprehensive review of the design of logistic network to support the variety of further studies. An extensive section of literature in the design of logistic network refers to the forward design problem with the aim of determining configuration of a direct network of suppliers to customers including manufacturing centers and distribution. A limited section of literature refers to the design of reverse logistic network with the aim of determining the number of collection centers, recovery plants, place and their capacity and reverse optimal flow from the customers to recovery centers.

Lin and Wu (2005) showed that relationship and collaboration with customers and supplier create new knowledge. Hult et al., (2007) found that knowledge development culture had positive effect on supply chain management. Hernández-Espallardo et al. (2010) demonstrated the importance of knowledge sharing and learning in supply chains. One of the first scientific contributions on supply chain complexity is Wilding (1998), which was later extended by Vachon and Klassen (2002). The researchers showed that complexity, consisting of numerousness, interconnectivity, and unpredictability, has a negative effect on delivery Performance. The further researches on complexity have primarily focused on the benefits achievable via reduced levels of complexity.

Giménez and Lourenc (2008) conducted a study “Electronic supply chain management: The influence of internet on supply chain processes”. This study explains the impact of internet on different processes of supply chain management.

Zhu and Benton (2007) studied the effect of information sharing on supply chain performance. They found that information sharing is affected considerably by supply chain activity and has considerable impact on delivery method on delivery performance.

Lee et al., (2006) showed that IT capabilities and information sharing have significant impact on integration of supply chain of procurement systems and is effective indirectly on its performance. Wu et al., (2006) applied resource-based perspective and showed that chain capabilities distinguished the company from the competitors and they are inimitable by the competitors. This study evaluates the impact of supply chain progress and marketing and financial performance. The results provided a new view in evaluation of investment in TI of supply chain process. They evaluated the role of supply chain capabilities as a moderating variable between organizational

performance and progress and believed that IT capabilities can transfer supply chain to higher level of value.

Noruzi and Abdollahi (2014) in a study “Pathologic attitude to knowledge transfer implementation in supply chain management” evaluated 90 employees of one of the army force centers. They found that four dimensions of externalizing and internalizing (sociability, externalization, knowledge dissemination and internalization) are more successful than other dimensions that are applied in supply chain.

Jozani et al., (2013) in a study “The location of dairy facilities and optimization of supply chain under traffic congestion and lack of assurance of demand” found that: The proposed model reduced traffic, transfer costs and parameters change and changed the production of this process. For time and non-demand processes for dairy products in each period, meta heuristic algorithms were designed and efficient plans and new solutions were created.

Aghajani and Maleki (2012) in a study “Present a framework to evaluate supply chain performance by a combination of balanced scorecard and hierarchy analysis process” found that after evaluation of supply chain performance at the strategic level with the highest significance, operating level and tactical levels were in the next ranks. This issue indicates that performance criteria reflecting performance in the long-term are much important in expressing supply chain conditions. At strategic level, customer aspect and then internal and financial processes are on the priority.

Nazemi and Kharidar (2012) in a study “The impact of integrated supply chain dimensions on competitive capabilities in food and drinking industry of Mashhad city” tested the mediating role of external integration. It was supported that internal integration was effective on competitive capabilities via internal integration but the direct effect of internal integration on competitive capabilities was higher than the indirect effect of these two factors via external integration.

Javadian, Khani and Mahdavi (2011) in the paper “effective factors on supply chain performance and its improvement by systems dynamics method” based on the initial assessment; the simulated model of chain was designed based on dynamics method using Vensim software. Based on the high adjustment of the performance of simulated model with the real chain performance, we can say the identified variables are the main and effective variables on the behavior of chain performance.

Hosseini and Sheikhi (2011) in a study “Explain the strategic role of supply chain management operation in improvement of company performance” showed that production operation leads to performance enhancement. In other words, considering the operation of production and package operation can have positive impact on financial performance and company market. Keeping long-term growth of company is possible based on production management and states that distribution operation has direct effect on the company performance.

Mohammadi et al., (2011) in a study “Evaluation of the impact of IT on capabilities and performance of supply chain of companies in Fars province” found that using IT tools is effective on supply chain capabilities and the supply chain performance is also affected.

Poya (2010) in a study “Supply chain management and information technology support” found that there are some solutions for supply chain problems including vertical integration, suitable inventory, strategies of reduction of environmental uncertainty and using suitable techniques of planning and production.

Manian et al., (2010) conducted a study “Identification of effective factors on supply chain performance in Iran parts industry” showed that the identification of the following factors are the main indices of supply chain performance: Customers, process, costs, flexibility, supplier and time. Poursoleimani et al., (2010) in a study “Supply chain performance of petrochemical industry (The impact of production location factors, supply chain uncertainty and production and manufacturing actions) found that managers in decision making about production place should consider energy costs (e.g. water, electricity and other required energy in petrochemical industry) and business costs such as transportation and communication cost in the required places and select the place with the lowest cost. In production location, we should consider the availability of land and energy. Also, we should select a place closer to the sale market and have access to the suppliers.

SeyedHosseini and Yadranji (2009) in a study “Knowledge management –based model in supply chain distribution, logistic transportation” evaluated the requirements of implementation of knowledge management and extraction, refinement, evaluation and application processes to reduce logistic, purchase, distribution and marketing costs.

The positive effect of internal and external knowledge transfer on supply chain flexibility and knowledge-based view of companies is theoretical support of this study. In this view, knowledge indicated a valuable source useful in the competitive advantage of the companies. The knowledge application is primarily dependent upon its effective transfer and it is used in a special field. If the knowledge transfer is facilitated, we can expect high impact on performance. This study is evaluated with two mechanism of knowledge transfer regarding the internal and external capabilities of company to do this task. Thus, it is expected that high efficiency of knowledge transfer lead to higher level of supply chain flexibility. By effective knowledge transfer processes, desirable knowledge can guide the activities of companies effectively and this increases supply chain flexibility. In this view, internal and external knowledge transfer processes represent an infrastructure for the translation of general

Knowledge into context-specific action (Blome et al., 2013). Lin and Wu (2005) showed that collaborative relationships with customers and suppliers create new knowledge, and Hernández-Espallardo et al. (2010) demonstrated the importance of knowledge sharing and learning in supply chains. Hult et al. (2007) found that culture of knowledge development has a positive effect on supply chain performance. This study attempts to evaluate the explicit knowledge transfer within the domain of supply chain management. In addition, while existing researches on knowledge management infers that learning can arise from integration and collaboration, most studies have not highlighted this aspect to knowledge transfer directly (Blome et al., Lumus

et al., 2015). One of the first scientific researches on supply chain complexity is Wilding (1998), which was later extended by Vachon and Klassen (2002). The researchers showed that complexity, consisting of numerousness, interconnectivity, and unpredictability, has a negative effect on delivery performance. The further researches on complexity have primarily focused on the benefits achievable via reduced levels of complexity (Swink et al., 2005, Stivenson and spring, 2007).

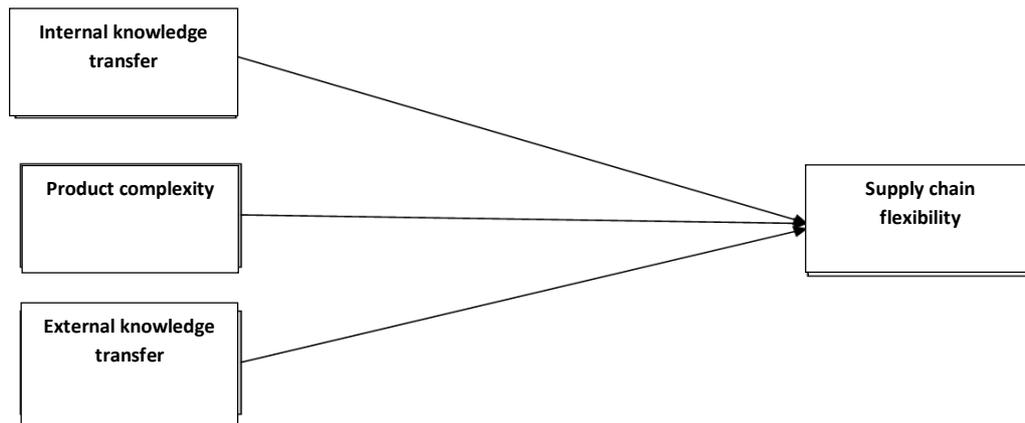


Figure 2: Conceptual model of study based on the studies of Blome et al., (2013)

3. The framework of study methodology

3.1. Study hypotheses

Main hypothesis: Knowledge transfer and product complexity are effective on supply chain flexibility.

Sub-hypotheses:

- Internal knowledge transfer is effective on supply chain flexibility.
- External supply transfer is effective on supply chain flexibility.
- Product complexity is effective on supply chain flexibility.

3.2. Study methodology

This study is applied in terms of purpose and it evaluates the internal and external knowledge transfer and products complexity on supply chain flexibility. This is a descriptive-survey design in terms of data collection in which population parameter are evaluated and by selection of sample and questionnaire, the study variables are evaluated. This study is field-correlation study.

3.3. Study measures

Based on the type of data and required information, library studies and internet world web and field study (questionnaire distribution) are used for data collection. The researcher –based questionnaire includes 18 questions base don Likert scale evaluates internal knowledge transfer, external knowledge transfer, flexibility and product complexity.

3.4. Study variables

The independent variable is internal and external knowledge transfer and product complexity. The dependent variable is supply chain flexibility.

Study population, sampling method and sample size

The study population is employees of SAPCO Company in Tehran city as 600. To determine sample size, Cochran’s formula is used. As the study population is 600, the good sample size is 234 through Cochran’s formula. 234 questionnaires are distributed by simple random sampling method.

3.5. Validity and reliability of measures

In this study, to support content validity, the questionnaire is distributed among the supervisors and 5 lecturers of management and 5 executive managers of SAPCO Company. It was assigned to apply some corrections on the questionnaire. To evaluate reliability, an initial sample with 30 people was pre-tested as simple random method. Then, by the data achieved, reliability was achieved 0.881 in pre-test by Cronbach’s alpha and this value is above 70%. Thus, the scale has good reliability.

3.6. The data analysis method

To evaluate the demographic condition of the sample, descriptive statistics is used and to evaluate normality of data distribution, Kolmogorov-Smirnov test (K-S) is applied. To evaluate the relationship between variables, correlation test is used. The hypotheses analysis is performed by structural equations modeling method with LISREL, version 8.8.

4. The results analysis

4.1. Descriptive analysis

In the present study, of 234 sample size, the highest number of respondents is men 62.4% and women 37.6%. Also, 40.1% are ranging 20-30 years, 31.2% ranging 31-40 year, 23.9% ranging 41-50 year and 4.8% above 50 years. 26.9% with associate degree, 55.2% with BA, 14.6% MA and 3.4% Ph.D. degree. According to the statistics, 10.6% of people have experience below 5 years, 22.6% with the experience 5-10 year, 28.3% with the experience of 10-15 year and 18.8%

with the experience of 15-20% and 19.7% above 20 years. Table 2 illustrates the descriptive statistics of independent and dependent variables.

Table 2: The descriptive statistics of study variables (n=324)

SD	Mean	Max	Min	F	Study variables
1/13	3/16	5/00	1/00	234	Internal knowledge transfer
1/16	3/96	5/00	1/00	234	External knowledge transfer
1/20	3/01	5/00	1/00	234	Supply chain flexibility
1/09	3/42	5/00	1/00	234	Product complexity

Table 3: The relationship between the gender of respondents and responding method to questions

		Leven's test for variances equality		Independent two-sample test						
		F	Significance level	t	Degree of freedom	Significance value	Mean difference	Standard error	Confidence interval 95%	
									Lower	Upper
Internal knowledge transfer	Variances equality	0.831	0.363	-0.707	233	0.480	-0.312	0.44	-1.18	0.55
	Variances inequality			-0.724	232.29	0.469	-0.312	0.43	-1.16	0.53
External knowledge transfer	Variances equality	1.456	0.227	-1.301	233	0.309	-0.437	0.42	-1.27	0.39
	Variances inequality			-1.050	232.23	0.294	-0.437	0.41	-1.25	0.38
Supply chain flexibility	Variances equality	0.269	0.640	-1.562	233	0.119	-0.652	0.41	-1.47	0.16
	Variances inequality			-1.573	232.04	0.117	-0.652	0.41	-1.47	0.16
Product complexity	Variances equality	1.550	0.214	-1.883	233	0.060	-0.728	0.36	-1.48	0.03
	Variances inequality			-1.931	232.88	0.054	-0.728	0.37	-1.46	0.013

To evaluate the relationship between gender and responding to questions, t two-sample t-test is used. As shown in Table 3, equality of means (Sig. (2-tailed) and variance equality assumption (Sig) for two groups of women and men is above 5%. This shows that there is no significant difference between men and women in responding the questions.

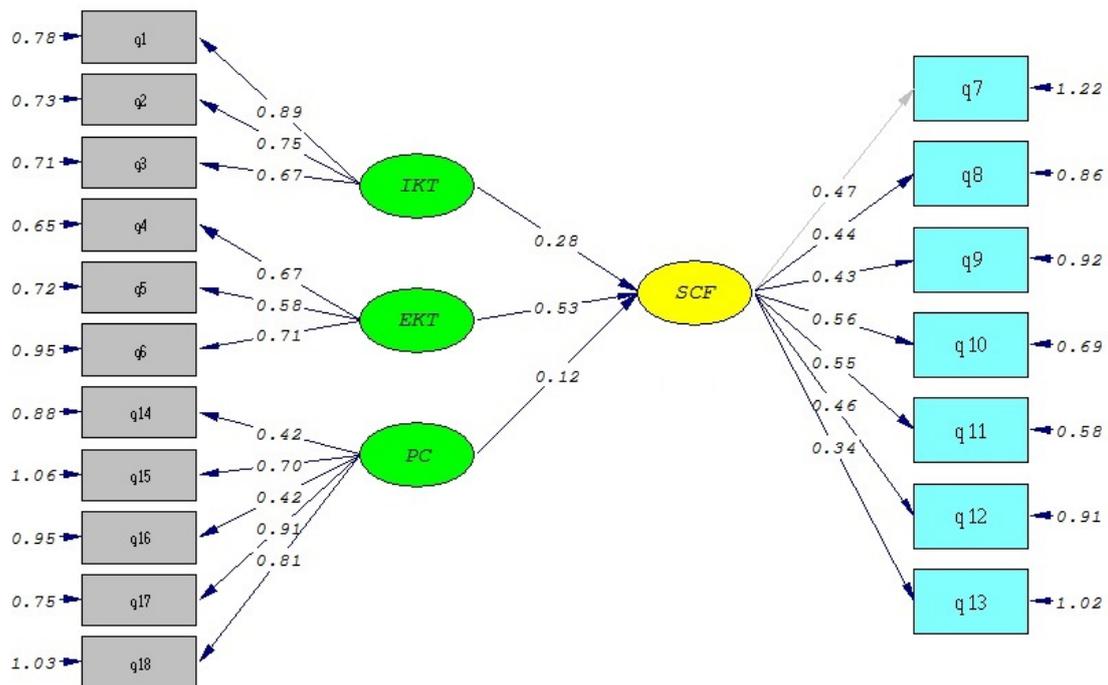
4.2. Study hypotheses test

Before testing the relationship between variables, it is required to evaluate the normality of variables. One of the methods to evaluate the normality of distribution of variable is using Kolmogorov-Smirnov test. The results of this test are shown in Table 4.

Table 4: The results of test of Kolmogorov-Smirnov distribution

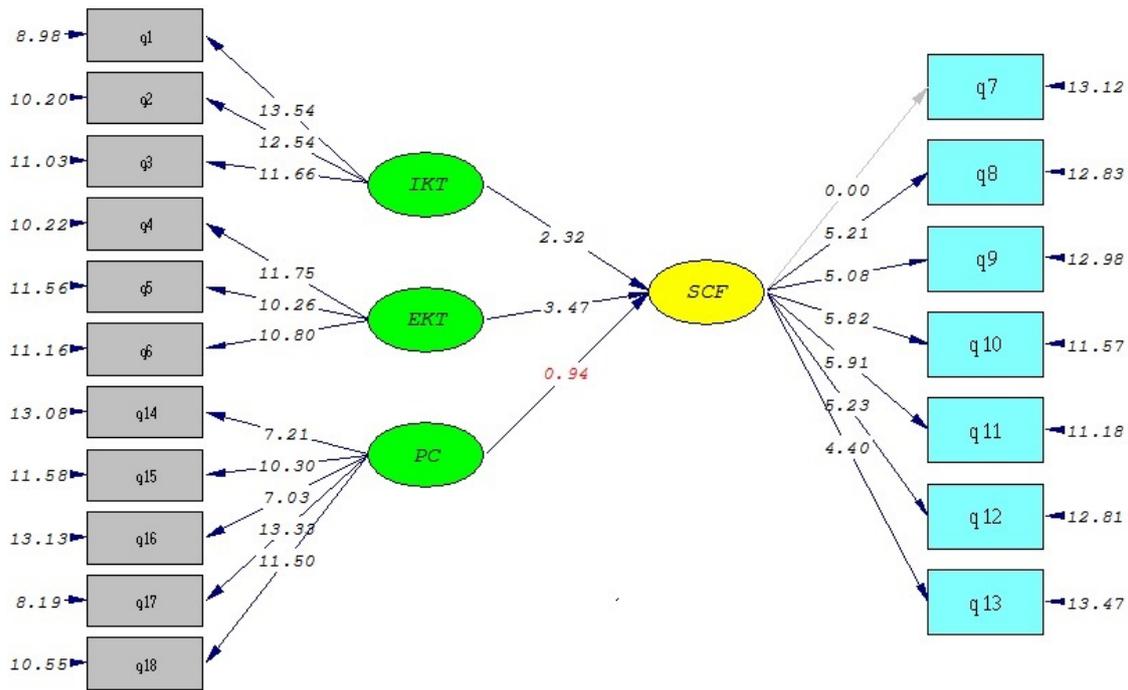
		Internal knowledge transfer	External knowledge transfer	Supply chain flexibility	Product complexity
Number		234	234	234	234
Normal parameter	Mean	22.1275	17.8050	18.0675	20.0025
	SD	4.31716	4.14970	4.08837	3.79189
Value difference	Absolute	0.186	0.104	0.183	0.090
	Positive	0.186	0.104	0.183	0.090
	Negative	-0.186	-0.039	-0.083	-0.054
Statistical test		0.186	0.104	0.183	0.090
Significance level		0.225	0.140	0.170	0.071

The results of this test show the significance level of the study variables higher than 0.05. By confidence interval 95%, we can say the study variables have normal distribution. After determining the measurement models, to evaluate the conceptual model of study and assurance of the presence or absence of the causal relationship between study variables and observed data consistency with the conceptual model, the study hypotheses are tested by structural equations model. The results of hypotheses test are shown in charts (1) and (2).



Chi-Square=569.24, df=329, P-value=0.00000, RMSEA=0.062

Chart 1: The measurement of final model and the hypotheses results at standard condition



Chi-Square=569.24, df=329, P-value=0.00000, RMSEA=0.062

Chart 2: The measurement of final model and hypotheses results at significant state

The summary of first hypothesis test is shown in Table 5.

Table 5: The summary of results of hypotheses test

Result	Significance	Standard coefficient	Hypotheses
Supported	2.32	0.28	Internal knowledge transfer is effective on supply chain flexibility.
Supported	3.47	0.53	External supply transfer is effective on supply chain flexibility.
Rejected	0.94	0.12	Product complexity is effective on supply chain flexibility.

In the first hypothesis, it was claimed that internal knowledge transfer was effective on supply chain flexibility. As shown in charts 1 and 2, standard coefficient between internal knowledge transfer and supply chain flexibility (0.28%) and as significance value of the path of two variables is 2.32, this value is bigger than 1.96. Thus, the first hypothesis is supported.

In the second hypothesis, it was claimed that external knowledge transfer was effective on supply chain flexibility. As shown in charts 1 and 2, standard coefficient between two variables

is (0.53%) and as significance value of the path of two variables is 3.47, this value is bigger than 1.96. Thus, the second hypothesis is supported.

In the third hypothesis, it was claimed that product complexity was effective on supply chain flexibility. As shown in charts 1 and 2, standard coefficient between two variables is (0.12%) and as significance value of the path of two variables is 0.94, this value is smaller than 1.96. Thus, the third hypothesis is not supported.

5. Discussion and Conclusion

The ability of supply chains to flexibly adjust to changing demands and environments is important (Blome et al., 2013). The recent complexities imply that the customers emphasize on the demands of “faster, better and cheaper” on products and services. The knowledge application is primarily dependent upon its effective transfer and it is used in a special field. If the knowledge transfer is facilitated, we can expect high impact on performance. This study is evaluated with two mechanism of knowledge transfer regarding the internal and external capabilities of company to do this task. Thus, it is expected that high efficiency of knowledge transfer lead to higher level of supply chain flexibility. By effective knowledge transfer processes, desirable knowledge can guide the activities of companies effectively and this increases supply chain flexibility. In this view, internal and external knowledge transfer processes represent an infrastructure for the translation of general knowledge into context-specific action (Blome et al., 2013). Today, customers attempt to achieve their demands “faster, better and cheaper” (Lummus et al., 2015). Supply chain flexibility is defined as the ability of supply change to respond to the environment changes. This feature refers to the speed with which the companies can adjust production processes, capacity, stock turnover and cycle time (Gunasekaran et al., 2001). The prior studies have shown that internal and external transfer of knowledge has positive impact on supply chain flexibility. External knowledge transfer is defined as the ability of company to use external expertise to improve the products and processes of company. The product complexity is defined by customization, complexity and variety of products (Schoenherr et al., 2010). Complexities inherent in the product impede the effectiveness of knowledge transfer activities in generating supply chain flexibility (Blome et al., 2013). Later, we evaluate the results of study:

First hypothesis: internal knowledge transfer is effective on supply chain flexibility. The statistical analyses showed that internal knowledge transfer had positive and significant effect on supply chain flexibility. The results are consistent with the study of Wu,., Chuang, Hsu (2014), Blome et al., (2013), Ioannis et al., (2012), Melo et al., (2009), Lin and Wu (2005), Hult et al., (2007), Hernández-Espallardo et al. (2010), Zhu and Benton (2007), Li et al., (2006), Wu et al., (2006), Noruzi and Abdollahi (2014), Jozani et al., (2013), Nazemi and Kharidar (2012), Javadian, Khani and Mahdavi (2011), Hosseini and Sheikhi (2011), Mohammadi et al., (2011) and SeyedHosseini and Yadranji (2009). In the second hypothesis: External knowledge transfer

is effective on supply chain flexibility. The statistical analysis showed that external knowledge transfer had higher effect compared to internal knowledge transfer on the increase of supply chain flexibility. Wu,., Chuang, Hsu (2014), Blome et al., (2013), Ioannis et al., (2012), Melo et al., (2009), Lin and Wu (2005), Hult et al., (2007), Hernández-Espallardo et al. (2010), Zhu and Benton (2007), Li et al., (2006), Wu et al., (2006), Noruzi and Abdollahi (2014), Jozani et al., (2013), Nazemi and Kharidar (2012), Javadian, Khani and Mahdavi (2011), Hosseini and Sheikhi (2011), Mohammadi et al., (2011) and SeyedHosseini and Yadranji (2009). In the third hypothesis, product complexity is effective on supply chain flexibility. The statistical analysis showed that product complexity was effective on supply chain flexibility. Wu, Chuang, Hsu (2014), Blome et al., (2013), Ioannis et al., (2012) and Melo et al., (2009).

6. Recommendations of study

The future studies can:

- Evaluate the role of organizational culture on internal and external knowledge transfer in supply chain.
- Evaluate the role of formal and informal knowledge transfer on the increase of supply chain flexibility.
- Identify the complexity reduction methods in the product.
- To achieve exact results, other methods including interview, neural network and multi-criteria methods are used.

6.1. Applied recommendations

- The companies create the conditions in which the employees can increase supply chain flexibility outside the discussion sessions on proposes, new products ideas with other internal and external sectors.
- Participating the employees in problem-solving process, encouragement of creative ideas and behavior, giving much power to the employees in problem-solving process, etc. developed creation morale and application of internal knowledge.
- For external knowledge transfer and its effective use, the companies can propose recommendations system to receive the opinion from providers and customers.
- Formation of brain storming sessions with the presence of external organizational experts.
- Educating the project managers and experts in external knowledge transfer and its management and acquired knowledge application methods.
- Rewarding and encouraging the employees facilitating great commitment and effort in development and share of external knowledge inside the organization and can facilitate external knowledge transfer and increase supply chain flexibility.

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