THE RELATIONSHIP BETWEEN PRODUCT INNOVATION AND SUSTAINABLE SUPPLY CHAIN: A CASE STUDY

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Abstract- In recent years with the globalization of the economy, industrial development has given way to a sustainable development and in between sustainable supply chain management has been proposed as the key to success of organization. Very rapid changes in public needs and the need to create changes in products and processes, has created conditions that innovation as one of the most important factors is organizational competitiveness. According to importance of issue, this study is conducted to evaluate the impact of product innovation on sustainable supply chain factors. According to studies for sustainable supply chain four dimensions of environmental, economic, social and operational detected. Also for innovation in six different dimensions include pioneering product in the market, the introduction of innovative products, flexibility in the face of market demand, new product ideas, new products, and continuous improvement in the quality of the products have been considered. 250 questionnaires have been distributed randomly among employees in studied company. As well as data analysis has been done by using statistical software SPSS 18 and LISREL 8.8. To assess the overall relationship between product innovation and sustainable supply chain a structural equation model is used. According to the result product innovation has a positive and significant impact on sustainable supply chain.

Index Terms- Supply chain, Factor analysis, Innovation, Structural equation modelling, Sustainable supply chain.

I. INTRODUCTION

In recent decades, with the globalization of the economy, industrial development has been replaced with sustainable development. The industry executives, especially in developed countries, are searching for effective procedures to satisfy their customers' needs, and to improve the performance of their organizations and gain competitive advantage among the competitors. The strategy used to gain sustainable competitive advantages is supply chain management as the key to the success of organizations. Today, the use of new methods and leadership in recognizing the new needs are a requirement on supply chain sustainability of any organization.

Some reasons such as customers' interest in environment-friendly products, entering the new markets, increasing government regulations, and gain a competitive have expanded competitors' sustainable supply chain management. In general, to use sustainable supply chain as a strategic key to gain competitive advantage, the organizations need to consider the concepts of innovation and supply chain. In this regard, given the growing situation of scientific, manufacturing, and service levels and creation of a fertile ground for improving company processes, it is essential to analyze the impact of product innovation on different environmental, economic, social, and operational dimensions within an enterprise.

II. LITERATURE

In today's constantly changing and developing world, the only thing that is immune to change is the change itself. To survive in today's competitive world, the organizations should prepare themselves to act competitively (Porter, 2005). On the other hand, in today's economy, the competition does not happen either in the form of the competition of a company vs. another company, rather these are supply chains that compete with each other. Supply chain includes all of the stages that are directly or indirectly involved in fulfilling customer needs, and encompass a widespread spectrum ranging from initial suppliers to final customers. In this chain, three main processes including information, physical and financial flow are in action. This is information and knowledge flow that governs financial and physical trends. Thus, a review of knowledge management and the ways to apply it in organization is of utmost significance (Woolliscroft, 2013).

Innovation in supply chain can provide a cooperative atmosphere that enables such chain to act more responsively and adaptively in order to achieve an advanced strategic competitive situation in market (Patil and Ravi Kant, 2014). Widespread changes occurred in public needs and necessity to incur changes in processes and products create a situation in which innovation can act as one of the most important organizational competitive factors. Technological and academic empowerment and capability to incur prompt changes in these empowerments in a knowledge-based environment through innovation as a driver of economic growth is highly important. Innovation is considered to be a very important concept for economic growth and can provide the firms with competitive advantage. This concept was introduced based on Schumpeter's body of research in 1934 (Schumpeter, 1934). Innovation plays a critical part in economic development (Castro. 2011).

Innovation can be an improvement in the current product (commodity/service) or creation of new

product. Innovation can be defined under different levels as well. The presented definitions consider innovation at an organizational level. Gorter and Vanderlinde allege that "neglect" and "statistic subjectivity" prevents a firm from understanding the fact that environmental (and social) environment can be improved with a reduction in costs, thus it can lead to the constricted development of the actions taken in the area of supply chain management (Gualandris and Kalchschmidt, 2014).

In contrast, it appears that innovative thinking is a key to the challenges relevant to sustainability. For example, Christman (2000) suggested that innovation is a supplementary asset that enable companies to overcome trade-offs between costs and highlighting the issues relevant to the environment. Although mere presence of innovation may not be sufficed to achieve high performance, its absence can act as a limiting and constricting barrier to the environment.

Based on the data obtained from data analysis, Zailani et.al (2012) state that "while innovation was long considered to be a necessity to other operational performance such as cost and quality, it can be also a valuable factor in the area of social issues relevant to operation. Supporting this idea, other researchers allege that innovative firms have the optimal performance in the area of sustainability (Nidomola et al. 2009; Pagell and Wu, 2009; Wu and Pagell, 2011). Despite this initial inference, the recent research presented in this area requires more experimental evidence regarding the powerful function of innovation in the area of supply chain management (Van Bommel, 2011).

The current article seeks to examine the impact of innovation on sustainable supply chain in studied Company as an industrial and manufacturing company that acts in a competitive market. Given the above, the company seeks to find optimal ways to avoid causing harm and pollution in the environment (pay attention to environmental dimension). As a developing company, it seeks to recruit new efficient and experienced staff, and holds instructive training classes to enhance the staff's academic level (pay attention to social dimension). Given the fact that the company supplies its products from a manufacturer in China, this supplier should create a sustainable mutual relationship and provide high quality products.

As the company mainly seeks to provide after-sale service and necessary components, it is better to choose a sustainable supplier because most of customer complaints is due to the paucity of widely used components (pay attention to economic dimension). The company should regularly monitor the inventory of the products and components in the warehouse, and as soon as a product or component is finished, it should order new ones to be able to maintain the customers effectively (pay attention to operational dimension).

III. METHODOLOGY

A. Research setting and sample

The data used to test the research hypotheses have been gathered in a tools Company. The company is a well-known production and industrial company which is located in Tehran. It has 500 employees and also 78 agencies after-sales services and 70 sale products. We prepared a four-page questionnaire to be completed by personnel with the objective of evaluating the impact of product innovation on sustainable supply chain factors 250 questionnaires distributed randomly among employees. The response covered all geographical data and included a respondent sex, age and education. The sample profile is shown in the Table 1. The questions were mainly answerable by five-point Likert scales, ranging from totally disagree (point 1 on the scale) to totally agree (point 5 on the scale).

Table 1: Sample framework

Sample characteristics		Frequency (N=250)	Percent (%)
Respondent Sex			
	Male	149	59.6
	Female	101	40.4
Respondent Age			
	Less than 30	31	12.4
	31-40	79	31.6
	41-50	115	46
	More than 51	25	10
Respondent Education			
	Less than diploma	18	7.2
	Diploma	70	28
	Bachelor	103	41.2
	Master	49	29.6
	PhD	10	4

B. Development of measures

The sustainable supply chain questionnaire has four dimensions of environmental, economic, social and operational (Carter and Rogers, 2008) and each dimension has four, three, four and six question to be evaluated, respectively. In addition, product innovation questionnaire was designed in six different dimensions, including pioneering product in the market, the introduction of innovative products, flexibility in the face of market demand, new product

ideas, new products, and continuous improvement in the quality of the products. Product innovation measured using twenty items. The first four dimensions of product innovation have three items and the couple of last dimensions have four items to be answered. Descriptive statistics of the research variables is presented in Table 2.

Table 2: Descriptive statistics

Construct	Variable	Item	Mean	Median	Mode	Std. dev.	Minimum	Maximum
Sustainable Supply Chain	Environmental	250	4.169	4.333	4.333	0.565	1.677	5.000
	Economic	250	3.753	4.000	4.000	0.677	1.333	5.000
	Social	250	3.595	4.000	4.000	0.735	1.677	5.000
	Operational	250	3.749	4.000	4.000	0.708	1.333	5.000
Product Innovation	Pioneering Product in the Market	250	3.863	4.000	4.000	0.555	1.000	5.000
	Introduction of Innovative Products	250	3.766	3.750	4.000	0.593	1.000	5.000
	Flexibility in the Face of Market Demand	250	3.848	4.000	4.000	0.549	1.000	5.000
	New product Ideas	250	3.816	4.000	4.000	0.617	1.000	5.000
	New Products	250	3.975	4.000	4.250	0.600	1.000	5.000
	Continuous Improvement in the Quality of the Products	250	3.841	4.000	4.000	0.532	1.000	5.000

C. Measurement model validation

In our study, in order to assess the validity of questionnaires, we used content validity method and construct validity. In content validity, the questionnaires were given to some experts to be evaluated. After being approved by them, in order to evaluate data and make any statistical test, first of all we have to make sure of what if constructs are normal or not. So according to result of Kolmogorov-Smirnov test which was applied to our data, in all constructs $p>0.05$, so our data followed normal distribution. Afterward, a confirmatory factor analysis (CFA) was carried out to determine the construct validity of the measures. Two separate measurement models were run, consisting of related constructs. The first sub-model consisted of the product innovation constructs, while in the second sub-sample; we analyzed the sustainable supply chain constructs. In the CFA for sustainable supply chain and product innovation, the chi-square statistic was significant ($p<0.001$) and their RMSE were 0.035 and 0.033 respectively, which suggest that all measures had sufficient validity. On the other hand, the indicators were very good measures and had reliability as in all variables, the Cronbach's alphas exceeded the recommended threshold of 0.70. These results indicate that for both constructs, the measurement adequately agrees with the sample data and is appropriate for use (Table 3).

Table 3: Evaluation of Reliability

Construct	Variable	Item	Cronbach alpha
Sustainable Supply Chain	Environmental	4	0.785
	Economic	3	0.759
	Social	4	0.706
	Operational	6	0.788
Product Innovation	Pioneering Product in the Market	3	0.707
	Introduction of Innovative Products	3	0.753
	Flexibility in the Face of Market Demand	3	0.733
	New product Ideas	3	0.706
	New Products	4	0.734
	Continuous Improvement in the Quality of the Products	4	0.708
Sustainable Supply Chain		17	0.853
Product Innovation		20	0.873

D. Measures

After the measurement model validation by CFA, a structural equation model (SEM) was applied to the research model by using LISREL 8.8. The structural model was first evaluated for its goodness of fit. Although chi-square was significant at $p<0.00$, other fit indices suggesting a good fit are RMSEA value<0.05. The model fit statistics suggest a good fit (IFI=0.96; NFI=0.96; NNFI= 0.98; GFI=0.96; AGFI= 0.96; SRMR= 0.019). All the factor fit indexes to the indicator variables were highly significant, which supports the overall factor structure of the model. Therefore, our proposed structural model is strongly supported by the data.

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CONCLUSION

We found the main hypothesis is supported by the data. Product innovation has a significant effect on sustainable supply chain (t-value=6.23; $p<0.05$; RMSEA= 0.03). Moreover, the results support all four

secondary hypotheses. Therefore, product innovation has a significant effect one environmental
(H1), by t-value=7.20. Similarly, empirical evidence suggests economic (H2), social (H3) and operational (H4) dimensions of sustainable supply chain individually by t-value=6.23; t-value=6.23 and t-value==7.94, respectively. In addition, based on Table 2, as all variable's means are more than 3 (the middle point in Likert scales) and also their t-value is more than $t_{0.05}$ =1.96 individually, all variables including product innovation and sustainable supply chain's dimensions are in a desired stand.

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