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Knowledge Management and Supply Chain Flexibility Performance in Indian Manufacturing Industry: An Empirical Study

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Abstract

In today's scenario, knowledge is regarded as the most important strategic resource in organizations, and therefore, knowledge management (KM) process is considered critical for organizational success. Simultaneously, value creation through supply chain management has become a potentially valuable way of achieving competitive advantage and improving organizational performance. Considering flexibility as an essential component of supply chain success, this paper analyses the effects of KM processes on supply chain flexibility performance with the help of data collected from top and middle level mangers of 88 firms in Indian manufacturing organizations. In line with Gold *et al.* (2001) this study identified four key factors of KM process such as knowledge acquisition, knowledge conversion, knowledge application and knowledge protection. Our hierarchical regression results indicated that all factors of KM process are significantly related to supply chain flexibility performance.

Keywords: knowledge, knowledge management process, supply chain flexibility performance, supply chain management.

1. Introduction

Nonaka (1991) stated that in an economy where the only certainty is uncertainty, one of the vital sources of achieving competitive advantage is knowledge. New knowledge creation and knowledge sharing across organizations have become key determinants of organizations' success in dynamic environment. Davenport and Klahr (1998) emphasized knowledge as a vital element in organization's efforts to satisfy customer needs for customized products and services as well as improved service. Managing turbulent economic environment, organizations create unique knowledge that derived from their employees through establishing knowledge supportive environment to acquire, share, and create knowledge among employees (Birasnav *et al.*, 2009; O'Dell and Grayson, 1999).

Knowledge Management Process

Though numerous attempts have been made to define and describe KM processes, some significant and relevant contributions include the work of Leonard (1995), Teece (1998), Davenport and Grover (2001), and Darroch (2003). From an organizational capabilities perspective, Gold *et al.* (2001) described that

the KM processes consists of four dimensions, namely knowledge acquisition (KA), knowledge conversion (KC), knowledge application (KAP), and knowledge protection (KP). This model is considered to be sufficiently broad to facilitate the analysis of organizational KM capabilities. This study adopts KM processes from the work of Gold *et al.* (2001) for two main reasons. First, their work has wide acceptance in various management areas, such as learning organizations, multinational corporations, and information systems (Cui *et al.*, 2005; Lin and Lee, 2005; Ju *et al.*, 2006). Second, their work emphasize that organizations must develop an 'absorptive capacity', which is the ability to use available knowledge to recognize the value of new information, assimilate it, apply it, and protect it to create new knowledge (Lin, 2007).

Supply Chain Performance

Supply chain management refers to how firms utilize their suppliers' processes, technologies, and capabilities to enhance competitive advantage (Farley, 1997), and how the manufacturing, logistics, materials, distribution and transportation functions are coordinated within the organizations (Lee and Billington, 1992). Chen and Paulraj (2004) have argued that measurement of supply chain performance can facilitate a better understanding of the supply chain capabilities. The process of choosing appropriate supply chain performance measures is difficult due to the complexity of these systems, which arises from the number of members in the chain and the number of facilities at each stage (Beamon, 1999). Most of the research studies on measurement of performance are based on the use of cost as primary criteria of supply chain performance as it was easier to measure in quantitative terms. Therefore, distinguishing cost and non-cost measures (time, quality, flexibility, and innovativeness) is important since relying exclusively on cost measures can produce vague results (Chen and Paulraj, 2004). Also, researchers have considered flexibility and innovativeness as important strategic drivers of supply chain development (Lee, 2004; Morgan, 2004). Therefore, considering the flexibility identified as vital component for supply chain success, we attempted to empirically investigate the impact of KM processes on supply chain flexibility performance in Indian manufacturing industries.

2. Research Constructs

Knowledge Acquisition: It refers to the business process involving the accumulation of knowledge and the creation of new knowledge from existing knowledge. Many terms have been used to describe acquisition processes such as acquire, seek, get, generate, create, capture, and collaborate. Inkpen and Dinur (1998) also argued that improved use of existing knowledge and more effective acquisition of new knowledge are crucial to knowledge acquisition. Important examples of knowledge acquisition are searching and organizational learning (Lee and Yang, 2000; Huber, 1991), and benchmarking and collaboration (O'Dell and Grayson, 1999). Alternatively, knowledge can also be acquired from relationships between the firm and its strategic suppliers and customers (Darroch, 2003).

Knowledge Conversion: It represents the business processes oriented towards making existing knowledge useful. Firms need to organize and structure knowledge to make it easier for employees to access (Nonaka and Takeuchi, 1995; O'Dell and Grayson, 1999). Storing knowledge in properly structured knowledge repositories can improve knowledge exploitation by making knowledge easily accessible (Gold *et al.*, 1991). Moreover, combining and integrating knowledge can reduce redundancy, improve

representational consistency, and enhance efficiency by eliminating undesirable excess volume (Davenport and Klahr, 1998).

Knowledge Application: It is the process of making knowledge active, accessible, relevant and useful for the firm's business operations. For example, Bose (2001) argued that knowledge application involves retrieving and using knowledge in support of organization's decisions, actions, and problem solving in the effort to generate and sustain competitiveness. Adopting knowledge involves interaction between tacit and explicit knowledge, leading to adjusted strategic direction, problem solving, and improved efficiency (Gold *et al*., 1991). Davenport and Klahr (1998) also noted that the effective application of knowledge has helped organizations improve the level of innovation, performance, and cost reduction. In practice, knowledge must be shared and disseminated effectively throughout an organization before it can be exploited at all levels in the organization (Nonaka and Takeuchi, 1995).

Knowledge Protection: This process refers to the ability to secure organizational knowledge from illegal and inappropriate use or theft both from inside as well as outside the organization. Protecting the organizational knowledge is essential to sustain its competitive advantage (Proter-Liebskind, 1996). From a legal perspective, firms can protect their knowledge through intellectual property rights such as copyrights, trademarks, and patents. Moreover, firms can develop a sophisticated information technology system that provides legitimate restrictions to access to vital knowledge. Lin (2007) argued that apart from legal and technology oriented protection, firms should also prepare legal contract with employees to safeguard its crucial and confidential information, and should also establish employee rules for code of conduct and design jobs so as to facilitate appropriate protection to KM processes.

Supply Chain Flexibility Performance: Flexibility is described as the ability to respond to the dynamic environment. It is the ability to adjust and accommodate the favorable changes in the business environment. In today's scenario it is imperative for the organizations to be flexible enough to achieve the competitive advantage. In a production system, flexibility is related to machine, process, routing, part, operator etc. With the advent of the supply chain management concepts, organizations have been realizing that being flexible in a production system only is not sufficient (Pujawan, 2004). In line with this, Pujawan (2004) suggested that the focus of flexibility concepts should be broadened from the perspective of a production system into a supply chain system. Supply chains should be evaluated based on their ability to respond to any changes in product designs, delivery commitments, production volume, and product mix. In this direction Bulent (2008) elaborated that flexibility measures include new product flexibility, delivery flexibility, mix flexibility and volume flexibility. A study conducted by Berry and Cooper (1999) implies that flexibility is an important competitive advantage a supply chain should pursue to win the intense competition. However, the study addressing supply chain flexibility performance is still limited in literature. This paper presents an empirical study for assessing supply chain flexibility performance in Indian manufacturing industries. The factors of supply chain flexibility performance measure from the work of Beamon (1999) are responding and accommodating the changes in seasonality, poor manufacturing performance, poor supplier performance, poor delivery performance, and new products, new markets, and new competitors.

Hypotheses: Artail (2006) has emphasized that KM processes such as ability to communicate, capture, organize and disseminate knowledge enable organizations to improve upon their key parameters of performance that includes effective decision making, process efficiency, commitment to delivery schedule, as well as improved quality at reduced cost, subsequently leading to achieve the desired performance effectively (Lubit, 2001; Modi and Mabert, 2006). Some researchers have asserted that the basic economic resource is no longer capital or natural resource but knowledge. Therefore, knowledge-based assets have emerged as primary forms of organizational competence and the key to improved performance (Lubit, 2001). In other words, through reusing, refining and sharing information and knowledge, organizations can improve business practices which will ultimately lead to achieving competitive advantage and performance (Ingram and Simons, 2002).

Therefore recognizing the essential roles of SCM and KM in manufacturing organizations, an important issue that arises in this context is how KM processes are related with supply chain flexibility performance. As the empirical evidence for establishing the relationships of KM processes and supply chain flexibility performance is very much limited in the literature, the research findings reported in this paper have attempted to shed some light on this important issue. Two major hypotheses have been formulated to facilitate the investigation of the issues raised by the research question:

Hypothesis 1**:** Facets of KM process (KA, KC, KAP, and KP) are positively related to Supply chain flexibility performance.
Hypothesis 1a: Knowledge acquisition is positively related to flexibility performance.
Hypothesis 1b: Knowledge conversion is positively related to flexibility performance.
Hypothesis 1c: Knowledge application is positively related to flexibility performance.
Hypothesis 1d: Knowledge protection is positively related to flexibility performance.
Hypothesis 2: The interactive effects of KM processes (KA, KC, KAP, and KP) are positively related to flexibility performance.

2. Methodology

Data and Sample: A structured questionnaire was designed based on the theoretical constructs from literatures previously described. Respondents were asked to indicate, using a five-point Likert scale (1 = Strongly disagree, 5 = Strongly agree), the importance of 27 KM processes, in their organization's KM efforts. To elicit information on supply chain flexibility performance, respondents were asked to indicate, using a similar five-point Likert scale (1 = Low, 5 = High), their firm's performance relative to that of major industry competitors in terms of supply chain flexibility performance. The questionnaire was sent to about 1,500 top and middle level managers and senior engineers related to supply chain in the manufacturing organizations. The respondents represented manufacturers of automobile and auto-component products, textile products, petroleum products, machine and precision tools, leather, electronic equipment, sugar, heavy machines, tyre, soya oil, pharmaceutical products, bags, steel, and other manufacturing industries. Two kinds of mailings (postal and email) and subsequent follow-up yielded 357 usable returned responses.

Data Analysis: The 357 cases in the data file met the acceptable sample size of above 100 for factor analysis; and were more than the minimum requirement of sample size of 300, that was five times as many subjects as the variables to be analyzed in the concepts. (Hair

et al., 1998). To provide statistical support for the research hypotheses, collected data were analyzed using a number of statistical techniques such as data examination, factor analysis and multivariate regression analysis processed through SPSS version 15.0 standard procedures. As the number of scale items was reduced and descriptions modified, exploratory factor analysis was needed to assess the degree to which the data meet the expected structure. As Table 1 presents, the factor analysis identified four factors for the concept of KM processes.

Table 1: Factor Analysis of Knowledge Management Process Measures

S. No.	Items	KA	KC	KAP	KP
1	Generating new knowledge…	0.40			
2	Exchanging knowledge between employees…	0.49			
3	Acquiring knowledge about new products…	0.42			
4	Acquiring knowledge about competitors…	0.73			
5	Acquiring knowledge about our customers…	0.72			
6	Acquiring knowledge about our suppliers…	0.68			
7	Filtering knowledge…		0.39		
8	Absorbing knowledge from employees…		0.43		
9	Integrating different sources and types…		0.52		
10	Organizing knowledge…		0.52		
11	Replacing outdated knowledge…		0.49		
12	Converting knowledge into the design…		0.68		
13	Apply knowledge learned from mistakes…			0.71	
14	Applying knowledge learned from experience…			0.58	
15	Using knowledge to solve new problems…			0.58	
16	Makes knowledge accessible…			0.32	
17	Takes advantage of new knowledge…			0.61	
18	Using knowledge in development of new products…			0.63	
19	Uses knowledge to improve efficiency…			0.64	
20	Locate and apply knowledge to changing competitive...			0.46	
21	Protect knowledge from inappropriate use inside…				0.66
22	Protect knowledge from inappropriate use outside…				0.62
23	Protect knowledge from theft from within…				0.62
24	Protect knowledge from theft from outside…				0.67
25	Incentives that encourage the protection…				0.54
26	Technology that restricts access…				0.69
	Eigen value	2.728	2.732	3.401	2.975
	Percentage of variance	45.478	45.535	45.514	49.591
	Cronbach alpha	0.76	0.77	0.80	0.80

Note- Factor loadings less than 0.30 have been deleted.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was greater than 0.60, ranging from 0.61 to 0.71, well above the acceptable level of 0.5 (Hair *et al.*, 1998). With the sample of 357, a factor loading of 0.30 and above was considered significant at 0.05 level (Hair *et al.*, 1998). Moreover, the reliability coefficient of all measures was above 0.70, indicating good consistency of the scales for the concepts and their factors (Hair *et al.*, 1998). Since the measures were conceptually defined based on a combination of the literature review, previous empirical studies, these scales were considered to have face validity and they sufficiently measure the key practices of KM processes and supply chain flexibility performance within the research context.

4. Results

Factor Analysis: In the factor analysis for KM processes a two stage factor rule was used to categorize items to factors (Nunnally, 1978). At first, to ensure unidimensionality, that a given item represented the construct underlying each factor; a factor loading of 0.30 is used as the minimum cut-off (Hair *et al.*, 1998). Three items did not meet this criterion and were deleted from the final scales. Subsequently examining these items we saw that their values of communalities were low, indicating infrequent usage. And at second stage, to avoid problems with cross-loadings, we required each item to clearly define only one factor. Operationally, if the difference between weights for any given item was less than 0.10 across factors, we deleted it from the final scale (Hair *et al.*, 1998).

Correlation: The mean, standard deviation and intercorrelations for all variables under study are shown in Table 2. It is observed that flexibility performance (FP) is positively and significantly ($p<0.01$) correlated with all KM process variables. Significant correlation is also found among all the KM process variables. It is interesting to note that firm size in terms of employee strength is significantly related with knowledge acquisition, knowledge application, and knowledge protection as well as supply chain flexibility performance.

Table 2: Summary Statistics

Variable	Mean	SD	Correlation							
			1	2	3	4	5	6	7	8
1. Year	21.26	14.6	1							
2. Position	--	--	0.16**	1						
3. Size	--	--	-0.02	-0.21**	1					
4. Knowledge Acquisition	3.74	0.62	0.03	-0.08	0.12**	1				
5. Knowledge Conversion	3.61	0.61	0.03	-0.07	0.1	0.62**	1			
6. Knowledge Application	3.81	0.57	-0.02	-0.18**	0.15**	0.61**	0.67**	1		
7. Knowledge Protection	3.48	0.71	0.01	-0.08	0.14**	0.53**	0.55**	0.55**	1	
8. Flexibility Performance	3.59	0.69	0.03	-0.09	0.15**	0.52**	0.45**	0.51**	0.52**	1

Note: ** $p<0.01$.

Regression Analysis: Multicollinearity was absent from the selected models where tolerance values were in the range of 0.4 to 0.9 (higher than 0.10) and variation inflation factor (VIF) values were much less than 10.0 (Hair *et al.*, 1998). Additionally, the Durbin-Watson statistic did not indicate multicollinearity as a serious problem. To test the hypotheses, hierarchical multiple regression was used to predict each supply chain performance variable with the set of knowledge management variables (Hair *et al.*, 1998). Table 3 shows the effects of KM process variables on supply chain flexibility performance.

Table 3: Hierarchical Regression Analysis for Flexibility Performance

Variables	Step 1	Step 2	Step 3	Tolerance	VIF
Year	0.04	0.02	0.02	0.97	1.03
Position	-0.07	-0.01	-0.02	0.93	1.07
Size	0.13 *	0.05	0.04	0.96	1.05
Knowledge Acquisition (KA)		0.25**	-0.23	0.51	1.96
Knowledge Conversion (KC)		0.01	-0.78	0.45	2.22
Knowledge Application (KAP)		0.20**	0.86	0.44	2.25
Knowledge Protection (KP)		0.27**	0.86	0.60	1.66
KA x KC			1.70*		
KA x KAP			-0.18		
KA x KP			-0.69		
KC x KAP			-0.58		
KC x KP			0.42		
KAP x KP			-0.64		
F	3.20*	31.32**	17.89**		
ΔF	-	51.06**	1.75 †		
R^2	0.03	0.39**	0.40 †		
ΔR^2	-	0.36**	0.02 †		

N= 357, ** p<0.01, * p<0.05, † p<0.10.

After controlling for exogenous variables i.e. year, size, and position, in step 2, we found that KA was positively related to FP (b=0.25, p<0.01) supporting hypothesis 1(a) which states that 'knowledge acquisition is positively related to flexibility performance'. KAP was positively related to FP (b=0.20, p<0.01) significantly providing support for hypothesis 1(c) that says, 'knowledge application is positively related to flexibility performance'. Hypothesis 1(d) stating 'knowledge protection is positively related to flexibility performance', is also strongly supported as KP was significantly related to FP (b=0.27, p<0.01). Therefore, these findings provide significant support for Hypotheses 1 and 1(a)-1(d) except hypothesis 1(c) which was not been found supported. In step 3, some of the two-way interaction terms indicated significant incremental effect in flexibility performance. The interactive effects of KA x KC have shown significant relationship with FP (b=1.70, p<0.05). None of the three-way as well as four-way interactive effects were

found significant with FP. Overall; these findings partially support Hypothesis 2 stating that the interaction of parts of KM processes positively affects supply chain flexibility performance.

5. Discussion and Conclusion

In order to exploit complementarities in knowledge and capabilities, in the knowledge economy, collaboration among organizations leading to the creation of supply chains is increasingly becoming a necessary and important factor in organizational decision making (Teece, 1998). Bulent (2008) emphasized that flexibility performance is related with supply chain information sharing. Zhao *et al.* (2002) also indicated that knowledge-sharing influences supply chain performance. By taking the information available and sharing it with members of the supply chain, an organization can speed up the knowledge flow in the supply chain, improve the efficiency and effectiveness of the supply chain, and respond to customer changing needs quicker.

Therefore, it can be said that knowledge sharing will bring the organization competitive advantage in the long run and can lead to supply chain performance in terms of both total cost and service level. According to Lin *et al*. (2002), the higher level of information and knowledge sharing is associated with the lower total cost, the higher order fulfillment rate and the shorter order cycle time, thereby enabling the organization to achieve higher levels of flexibility in its supply chain.

Heiman and Nickerson (2004) highlighted that the integrated knowledge potential of all members in the supply chain can create greater value than the sum of the knowledge if stays apart in various places of the supply chain. It is worth to be noted that Hill and Scudder (2002) emphasized KM practices as a system that can synchronize the information that resides in both formal and informal KM system of different companies, facilitate new knowledge creation, transferring and application, thus increase market response rate, shorten product and services cycle time, and deliver greater value to both its internal and external customers to facilitate the entire supply chain a competitive advantage.

Birasnav and Rangnekar (2010) reported that Indian firms encourage brainstorming sessions for their managers and engineers for improving the level of creativity and innovation. They encourage flexibility in the form of autonomy, participation in decision making, and freedom to experiment.

Our study has revealed that KM processes have been implemented significantly in Indian manufacturing organizations and impacted well on their supply chain flexibility performance. The empirical findings reported herein show significant positive relationships among the facets of KM processes and supply chain flexibility performance in the context of Indian manufacturing industries. These findings explicitly indicate that the capabilities of manufacturing organizations to adopt and apply KM process measures help them to achieve higher level of supply chain flexibility performance.

With higher level of knowledge sharing, organizations are more likely to create better and innovative practices to manage the whole supply chain which can lead to improved performance. In this perspective it can be concluded that the more KM processes embodied within a supply chain, the less time it takes to make any changes under unforeseen circumstances, and therefore, the more flexible the business operations, products, product mix, and deliveries. According to the implications of this study, supply chain flexibility performances can be improved by practicing KM processes effectively.

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