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Supply Chain Business Process And IT Infrastructure Support For Cultivating Absorptive Capacity Capability: A Cluster Analysis Study

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SUPPLY CHAIN BUSINESS PROCESS AND IT INFRASTRUCTURE SUPPORT FOR CULTIVATING ABSORPTIVE CAPACITY CAPABILITY: A CLUSTER ANALYSIS STUDY

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Abstract

This study looks at organizations' perceptions of the importance of absorptive capacity attributes in the deployment of radio frequency identification (RFID) in a supply chain and their relationships with supply chain process integration and information technology infrastructure support. Data for this pilot research study was collected using a survey questionnaire administered online to members of the Council of Supply Chain Management Professionals (CSCMP). Both two proposed hypotheses were supported in this study using the cluster data analysis procedure. The ability to cultivate absorptive capacity attributes, indeed, are positively associated with both IT infrastructure integration and supply chain process integration.

Keywords: *Supply Chain Management, Radio Frequency Identification, Absorptive Capacity Capabilities, It System Deployment Outcomes*

1 INTRODUCTION

Organizational learning within the supply chain context using radio frequency identification technology (RFID)-enabled systems is of great interest nowadays when mandates for RFID used are being issued by powerful channel masters. It behooves trading partners who participate in value networks that initiate the adoption of RFID to learn from their channel masters, other trading partners (e.g., retailers learning from distributors or wholesalers), and vendors providing RFID infrastructure support.

This study looks at firms' perceptions of the importance of absorptive capacity attributes in the deployment of RFID in a supply chain context and their relationships with information technology infrastructure integration and supply chain process integration. RFID initiatives are interenterprisewide system applications that require mutual buy in and learning experiences between and among value chain participants. As value chain trading partners seek to pursue initiatives of this scale, they would be embarking in knowledge gaining experiences, with the "conscripted" trading partners following the lead of and learning from the hub firm introducing the use of RFID such as the case of Wal-Mart. This study, though, will make the case that firms' ability to achieve desired RFID system outcomes is dependent on certain elements of its technology platform --- specifically IT infrastructure integration and supply chain process integration capabilities.

Forward-looking supply chains are evolving from supporting interorganizational systems with a pure transactional focus on operational efficiency to one that intends to leverage supply chain partnerships for sharing information and ultimately, creating market knowledge, the latter of which is part of the organizational learning perspective (Eisenhardt & Schoonhoven, 1996). Absorptive capacity capabilities are well within the purview of knowledge management within supply chains that now are increasing their focus on the integration of knowledge resources and on knowledge creation in collaboration with partners for longer-term advantage (Majchrzak et al., 2000; Malhotra, et al., 2001). To achieve this higher-order level of performance, electronic partners need to (1) engage in interdependent business processes that support information sharing and (2) build information technology infrastructures that enable them to gather, process, and make meaning out of the information obtained from partners.

2 LITERATURE REVIEW

2.1 Four Dimensions of "Absorptive Capacity"

The following are the four dimensions of the concept of "absorptive capacity:" 1) acquisition: the firm's capability to identify and acquire knowledge critical to its operations from sources external to the firm (Zahra & George, 2002); 2) assimilation: the use of routines and processes that support the analysis, interpretation, and comprehension, of the external knowledge obtained by the firm (Kim, 1997a; Kim, 1997; Szulanski, 1996); 3) transformation: the firm's capability to combine the firm's existing knowledge base with the newly acquired and assimilated information; and 4) exploitation: the firm's capability to refine, extend, and leverage its existing competencies by incorporating acquired external knowledge and using the combination for the benefit of its operations.

2.2 Concepts Supporting Absorptive Capacity Used in This Study

In 2005, Malhotra, Gosain, and El Sawy conducted a study that explores how firms engaged in supply chain networks configure their business processes and IT infrastructures to build absorptive capacity to acquire, assimilate, transform, and exploit information resources. They worked with the group of concepts to represent the application of absorptive capacity attributes within a supply chain context, which they operationalized as well and tested in the study: (1) integrative interorganizational process mechanisms enabling acquisition and assimilation consisting of: (a) joint decision making; (b) interorganizational business process modularity; and (c) standard electronic business interfaces; (2) partner-interface-directed information systems: enabling assimilation and transformation: (a) memory systems for interorganizational activities and (b) interpretation systems for interorganizational information; and (3) rich information exchange: mediating absorptive capacity outcomes: (a) extent of coordination information exchange; (b) breadth of information exchange; (c) quality of information exchange; and (d) privilege information exchange (Malhotra, Gosain, & El Sawy, 2005). In this study, the questionnaire items for all absorptive capacity attributes were borrowed from the study conducted by Malhotra, Gosain, and El Sawy (2005).

2.2.1 Routinization

By routinizing tasks, the firm is able to spend just enough time to the process of transforming inputs into outputs (Galunic & Rodan, 1998; Perrow, 1967). Repetitive and structured tasks are ideal for routinization (Hage & Aiken, 1967; Perrow, 1967; Withey, Daft, & Cooper, 1983). In this study, routinization is expressed in a number of ways: a) use of interorganizational business process modularity, b) use of standard electronic business interfaces, and c) the exchange of coordination information. "Modularity" allows the breaking up of business processes into subprocesses so that those who support them need conduct only the minimum amount of coordination communication while maximizing rich information exchange (Malhotra, Gosain, & El Sawy, 2005). The exchange of information among firms is facilitated by the use of standard electronic business interfaces to handle the interoperability of both the data and business processes.

2.2.2 Interpretation systems

After collecting a considerable amount of information across trading partners, there is a need to organize, rearrange, process, and interpret this information. "Data mining," or the process of analyzing data to reveal useful patterns and relationships hidden in the data could help here (Rupnick, Kukar, & Krisper, 2007).

2.2.3 *Memory systems for interorganizational activities*

"Organizational memory," refers to the saving, representation, and sharing of corporate knowledge (Croasdell, 2001) that can be used by members of the firm in carrying on regular operations and responding to environmental challenges as well (Stein, 1995; Huber, 1991; Walsh & Ungson, 1991; Pralahad & Hamel, 1990). In the context of today's complex supply chain activities, organizational memory embedded in electronic datawarehouses, databases, filing systems, and manuals, could support multiple interrelated tasks spanning diverse corporate environments (Ackerman, 1996).

2.2.4 *Partner interaction*

"Partner interaction," is defined as the extent to which the partnering firms interact with each other in terms of trust, adjustment, and conflict (Chen, 2004). Prior studies have recognized the importance of trust to the alliance performance during the interfirm cooperation period (Casson, 1991; Buckley & Casson, 1988; Larson, 1991). In this study, "partner interaction" will be operationalized in terms of: joint decision making, exchange of privileged information, quality of information, and breadth of information. As trading partners move closer to each other, the nature of the information exchanged also changes and they are far more willing to share "privileged" information that is specific to the trading partner (Malhotra, Gosain, & El Sawy, 2005). To achieve "breadth of information," firms should share more than the standard, transactional, operational data and be willing to exchange information that informs trading partners of higher-level issues such as changes in marketplace conditions, shifting customer tastes, new product/service attributes, emerging technologies, competitive opportunities (Anand, Manz, & Glick, 1998; Child & Faulkner, 1998; Austin, Lee, & Kopczak, 1997; Fites, 1996).

2.3 Supply Chain Infrastructure Variables

2.3.1 *IT infrastructure integration capability*

IT infrastructure integration is defined as the degree to which a focal firm has established IT capabilities for the consistent and high-velocity transfer of supply chain-related information within and across its boundaries. This study closely looks at the IT infrastructure integration requirements needed to support the use of RFID within a supply chain context. The formative construct introduced by Rai, Patnayakuni, and Seth 2006) was adopted in this study. They define IT infrastructure integration in terms of two subconstructs, data consistency and cross-functional SCM application systems integration. The IT infrastructure needed to support RFID systems should be able to provide real-time information visibility, made possible by collecting data at much lower levels of granularity made possible by RFID.

The extent to which data has been commonly defined and stored in consistent form in databases linked by supply chain business processes is referred to as data consistency (Rai , Patnayakuni, & Seth, 2006). Data consistency is a key requirement in creating a data architecture that defines the structure of the data and the relationships among data entities that is fundamental in establishing interorganizational data sharing (Van Den Hoven, 2004).

Cross-functional supply chain management applications systems integration is defined by Rai, Patnayakuni, and Seth (2005) as the level of real-time communication of a hub firm's functional applications that are linked within an SCM context and their exchanges with enterprise resource planning (ERP) and other related interenterprise initiatives like customer relationship management (CRM) applications. At the lowest level, an ERP system is essential in enabling the seamless integration of information flows and business process across functional areas of a focal firm --- this is normally referred to as "ERP I" (Law & Ngai, 2007). ERP functionalities are important control and management mechanisms that are connected with the ERP systems of the firm's trading partner --- referred to as "ERP II". To obtain optimum results, supply chain trading partners have to inevitably approach a collaborative posture in their relationships which would rely heavily on cross-functional interenterprise integration.

2.3.2 Supply chain process integration capability

In this study, supply chain process integration is defined following the construct used by Rai, Patnayakuni, and Seth (2006): the degree to which a hub firm has integrated the flow of information (Lee et al., 1997), physical materials (Stevens, 1990), and financial information (Mabert & Venkatraman, 1998) with its value chain trading partners. This formative construct has three subconstruct components: information flow integration, physical flow integration, and financial flow integration (Mangan, Lalwani, & Butcher, 2008).

This study uses the construct, information flow integration, to mean the degree to which a firm exchanges operational, tactical, and strategic information with its supply chain trading partners (Rai, Patnayakuni, & Seth, 2006). The instrument used in this study measures the sharing of production and delivery schedules, performance metrics, demand forecasts, actual sales data, and inventory data, for information flow integration.

Rai, Patnayakuni, and Seth (2006) define physical flow integration as the level to which the hub firm uses global optimization with its value chain partners to manage the flow and stocking of materials and finished goods. In this study, physical flow integration is measured in terms of multi-echelon optimization of costs, just-in-time deliveries, joint management of inventory with suppliers and logistics partners, and distribution network configuration for optimal staging of inventory.

Financial flow integration is defined as the level to which a hub firm and its trading partners exchange financial resources in a manner driven by workflow events. In this study, the financial flow integration items measure the automatic triggering of both accounts receivables and accounts payables. The questionnaire items for both IT infrastructure integration and supply chain process integration were borrowed from Rai, Patnayakuni, and Seth (2006).

3 PROPOSED HYPOTHESES

This study draws its theoretical underpinnings from the emerging IT-enabled organizational capabilities perspective that suggests that firms that develop IT infrastructure integration for SCM and leverage it to create a higher-order supply chain integration capability generate significant and sustainable performance gains (Rai, Patnayakuni, & Seth, 2006). Market knowledge creation, for instance, is a key performance gain enabled by the cultivation of absorptive capacity capabilities. But digital platforms play a critical role in managing supply chain activities. The results of Rai, Patnayakuni, and Seth’s study (2006) demonstrate that integrated IT infrastructures subsequently lead to supply chain process integration, a capability, which, in turn, allows supply chain partners to unbundle information flows from physical flows, and to share information with their supply chain partners to create information-based approaches for superior demand planning, for the staging and movement of physical products, and for streamlining voluminous and complex financial work processes. These information-based activities that are enabled enhance a firm’s absorptive capacity capabilities. Thus, a positive association between absorptive capacity attributes and both IT infrastructure integration and supply chain process integration is anticipated. Thus, the two hypotheses proposed here are:

H1: Higher levels of different absorptive capacity attributes will be positively associated with higher levels of IT infrastructure integration.

H2: Higher levels of different absorptive capacity attributes will be positively associated with higher levels of supply chain process integration.

4 RESEARCH METHODOLOGY

Data for this pilot research study was collected using a survey questionnaire administered online to members of the Council of Supply Chain Management Professionals (CSCMP). The data analyzed for this paper was drawn from a convenience sample of 104 organizations that responded to a certain part of the survey questionnaire --- these are organizations that had not yet implemented RFID but are knowledgeable about it or may be implementing RFID in the future. Since the organizations have not yet implemented RFID, the survey respondent was asked to indicate their perceptions of the importance of the nine absorptive capacity attributes using multiple items per construct. The same approach was used in anticipating their perceptions of the use of the RFID system in achieving data consistency, cross-functional application integration, and supply chain process integration. Seven-point Likert scales were used with minimum-maximum anchoring points appropriate to the construct being measured.

4.1 Data Measurement Properties

The internal consistency of the items constituting each construct was assessed using Cronbach's alpha and the results are in conformance with Nunnally's (1978) guidelines of getting values of .70 or above. Generally speaking, the items have internal consistency with values beyond the .70 threshold recommended. The nine absorptive capacity attributes showed the following reliability results: joint decision making (Cronbach alpha=.973); business process modularity (Cronbach alpha=.964); standard electronic business interfaces (Cronbach alpha= .916); organizational memory systems (Cronbach alpha=.977); interpretation systems (Cronbach alpha=.953); breadth of information exchanged (Cronbach alpha=.961); quality of information exchanged (Cronbach alpha=.974); privileged information exchanged (Cronbach alpha=.944); and coordination information exchanged (Cronbach alpha=.906). The following are the reliability results for IT infrastructure integration which consists of data consistency (Cronbach alpha=.944) and cross-functional application integration (Cronbach alpha=.923), and supply chain process integration, which consists of financial flow integration (Cronbach alpha=.880), physical flow integration (Cronbach alpha=.945), and information flow integration (Cronbach alpha=.952). To establish convergent and divergent validity, the item-to-total correlations of the constructs were examined and, in general, the specific items have a stronger correlation with the construct than with other items (Rai, Patnayakuni, & Seth, 2006).

4.2 Sample Profile Description

The convenience sample consists of a total of 104 firms from the membership of the Council of Supply Chain Management Professionals that responded to a certain part of the survey questionnaire --- these were the firms that constitute the convenience sample of organizations that are knowledgeable about RFID or may be implementing RFID in the future. About 51.06 percent of the firms had 1,000 or less employees and 32.62 percent had more than 1,000 employees. The following profile shows the membership of the firms in different industry sectors: service (78.57 percent), manufacturing (21.43 percent). A total of 98 firms identified their firm by nature of industry and number of employees out of the 104 firms; there were missing values for six firms for this descriptive data.

5 FINDINGS

There was no need to standardize the measurements of the variables as all theoretical constructs used in study were measured on a seven-point Likert scale, using appropriate low and high anchor points. The hierarchical cluster analysis procedure using the Euclidean distance as a measure of similarity or distance was run initially. This was appropriate since all the variables used in this study are continuous variables (Norusis, 2009). A second round of cluster analysis was performed using a non-hierarchical procedure called the K-means clustering method which required specifying a number of clusters (Norusis, 2009). This method begins with an initial set of means and each case in the sample pool is associated with a cluster where the distance between itself and the cluster mean is the smallest. Cluster means are recomputed and the cases are reclassified based on the newly emerged set of means. Several iterations of this procedure take place until cluster means stop changing significantly in successive rounds. Finally, the means of the clusters are recalculated in a final round and the cases are, again, reassigned to their permanent clusters based on the least distance. The cluster analysis procedures used confirmed both hypotheses H1 and H2.

In running the cluster analysis procedures, two-, three-, four-, five-, and six-cluster solutions were generated. In the three-cluster solution, significant differences among the means of the clusters were observed. The discriminatory power of the constructs was weaker for the remaining cluster solutions. As a result, the three-cluster solution is presented here as the best solution (Table 1). The findings for the three viable clusters: low-, medium-, and high value clusters across the different absorptive capacity attributes and IT infrastructure integration and supply for the variables: joint decision making (mean=.8061; SD=1.19471); interorganizational business process modularity (mean=.4048; SD=.70624); standard electronic business interfaces (mean=.3929; SD=.68440); memory systems for interorganizational activities (mean=.4286; SD=.75593); use of interpretation systems (mean=.4286; SD=.75593); breadth of information exchange (mean=.3929; SD=.68440); quality of information exchanged (mean=.4286; SD=.75593); privileged information exchange (mean=.4643; SD=.84271); coordination information exchanged (mean=.4643; SD=.84271); IT infrastructure integration (mean=.9613; SD=1.34515); and supply chain management process integration (mean=.9274; SD=1.33349).

The medium-value cluster has the following values for the variables: joint decision making (mean=3.8658; SD=1.43745); interorganizational business process modularity (mean=.3.6465; SD=1.33837); standard electronic business interfaces (mean=3.8030; SD=1.29264); memory systems for interorganizational activities (mean=4.1364; SD=1.18765); use of interpretation systems (mean=4.0202; SD=1.28814); breadth of information exchange (mean=3.9697; SD=1.36467); quality of information exchanged (mean=4.8636; SD=1.35366); privileged information exchange (mean=3.5758; SD=1.60137); coordination information exchanged (mean=3.5152; SD=1.40582); IT infrastructure integration (mean=4.2601; SD=1.06373); and supply chain management process integration (mean=4.2662; SD=1.25557).

Lastly, the high-value cluster has the following values for the variables: joint decision making (mean=5.8972; SD=.80303); interorganizational business process modularity (mean=5.7895; SD=1.03439); standard electronic business interfaces (mean=5.6930; SD=1.08872); memory systems for interorganizational activities (mean=5.9561; SD=.92235); use of interpretation systems (mean=5.8012; SD=1.02326); breadth of information exchange (mean=5.7237; SD=1.00188); quality of information exchanged (mean=6.3509; SD=.76161); privileged information exchange (mean=5.5965; SD=1.06670); coordination information exchanged (mean=5.4649; SD=1.33249); IT infrastructure integration (mean=5.8538; SD=.89490); and supply chain management process integration (mean=5.6939; SD=.69584).

6 DISCUSSION OF FINDINGS

This study was motivated by need to understand ways in which firms participating in supply chains could advance their organizational learning capabilities through the cultivation of absorptive capacity attributes in order to remain competitive in the marketplace. However, the firm's ability to cultivate absorptive capacity attributes depends on both their IT infrastructure integration and supply chain process integration resources. These cluster analysis findings indicate that there is a positive association between absorptive capacity attributes and increasing levels of IT infrastructure integration and supply chain process integration (Table 1).

7 CONCLUSIONS AND IMPLICATIONS FOR MANAGERS

This study confirmed the two proposed hypotheses. Firms are advised that as they attempt to move from lower to higher levels of electronic integration with their trading partners, they need to implement the appropriate data architecture requirements that will enable them and their trading partners to achieve data consistency in their various information exchanges. Increasing levels of cooperation are needed to ultimately reach maximum levels of internal and external information visibility, which can only be enabled by data consistency that rests on the adoption of accepted data architecture standards throughout the supply chain. Once data consistency is achieved, the following elements of supply chain process integration could follow: information flow, physical flow, and financial flow integration could more easily follow. Firms should also strive to move to higher levels of supply chain business process maturity thereafter.

A major limitation of this study is that the data is based on firms' perceptions of the importance of absorptive capacity attributes and their likely implementation of the different elements of IT infrastructure integration and supply chain process integration. An obvious improvement to this method is to administer the questionnaire to firms that have actually implemented RFID --- but that would be far in the future when a critical mass of firms actually do so. A caveat in interpreting this study's results is that they are based on perceptions of a convenience rather than representative sample of firms and therefore, generalizability of results is not possible.

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	Means (S.D.) of Cluster Groups			
Variables	Cluster 1	Cluster 2	Cluster 3	F(d.f./sig)[+]

	(n=14)	(n=33)	(n=57)	
JointDecMake3	.8061 (1.19471)	3.8658 (1.43745)	5.8972 (.80303)	131.743 (2,101)***
InterOrgBusMod3	.4048 (.70624)	3.6465 (1.33837)	5.7895 (1.0343)	143.769 (2,101)***
StdElec BusInter3	.3929 (.68440)	3.8030 (1.29264)	5.6930 (1.08872)	133.055 (2,101)***
MemorySys3	.4286 (.75593)	4.1364 (1.18765)	5.9561 (.92235)	179.114 (2,101)***
InterpretSys3	.4286 (.75593)	4.0202 (1.28814)	5.8012 (1.02326)	142.460 (2,101)***
BreadthInfo3	.3929 (.68440)	3.9697 (1.36467)	5.7237 (1.00188)	136.935 (2,101)***
QualityInfo3	.4286 (.75593)	4.8636 (1.35366)	6.3509 (.76161)	203.188 (2,101)***
PrivilegedInfo3	.4643 (.84271)	3.5758 (1.60137)	5.5965 (1.06670)	103.913 (2,101)***
CoordInfo3	.4643 (.84271)	3.5152 (1.40582)	5.4649 (1.33249)	88.712 (2,101)***
ITInfrasIntegrate3	.9613 (1.34515)	4.2601 (1.06373)	5.8538 (.89490)	134.217 (2,101)***
SCMProcessIntegrat3	.9274 (1.33349)	4.2662 (1.25557)	5.6939 (.69584)	130.774 (2,101)***
Valid N (listwise)	104			

Note: Cluster groups were derived from hierarchical procedure using SPSS and the K-Means procedure was also used to confirm results. [+]Test of significant differences across cluster groups using one-way ANOVA. ***p<.000

Table 1. Cluster Analysis Results: Absorptive Capacity Attributes and IT Infrastructure And Supply Chain Process Integration