From e-Supply Chain Capability Generation to Information Technology Value Co-creation
A Perspective of e-Business Process

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Abstract: The firms have engaged in initiatives that link e-supply chain processes (e.g., e-procurement) across enterprises to create Information Technology (IT) value. However, it is not clear how IT is contributing to value creation across-organization process. The objective of this paper is to investigate the process from e-supply chain capability generation to IT value creation through e-business process across-organization. A model of e-supply chain value is developed to investigate what and how e-supply chain capabilities are realized by usage of inter-firm IT resources integration and how business value of IT is co-created in multi-firm environments. The paper tests the model using Structural Equation Modeling (SEM) with data collected from 196 manufacturers in China. Our results provide theoretical support for a dynamic process that distinctive e-supply chain capabilities embedded in e-business process lead to process performance first and then financial performance and network performance. We find that e-supply chain capabilities (ESCC) realize e-supply chain value for all partners (e.g. supplier and customer) via upstream and downstream e-business process.

1 INTRODUCTION

Over the last decade, e-business technologies, specifically the Web, have revolutionized supply chain design, management, and control. IT infrastructure, process integration and partner alignment can be blended with inter-organizational processes to develop higher-order capabilities for demand sensing, operations and workflow coordination, and global optimization of resources (Barua et al., 2004); (Devaraj et al., 2007); (Rai et al., 2006); (Wu et al., 2006). The firms have engaged in initiatives that link e-supply chain processes (e.g., e-procurement) across enterprises to create IT value (Boone and Ganeshan, 2007); (Dong et al., 2009). Consider the example of Haier Group (a world's fourth largest white goods manufacturer company and one of the world's top 500 companies in China) , which has automated and streamlined to seek its best suppliers in a globally competitive market with e-procurement platform, and processed customized orders with B2C platform. The effect of e-supply chain on Haier can be seen from their cycle times from sales order to procurement order being reduced, and from more than seven days in 2000 to less than one hour in 2002 (Li and Chang, 2004).

Despite the widespread adoption of e-business, it is not clear how IT is contributing to value creation in supply chain. There are a number of factors that we accept as important and necessary conditions in the chain of IT value creation (Kohli and Grover, 2008). From a resource-based perspective, prior literature has identified that e-supply chain capabilities can serve as a catalyst in transforming IT-related resources into higher value for a firm (Devaraj et al., 2007); (Rai et al., 2006). The thesis has expanded to examining complementary resources, capabilities and other mediating factors in the chain of IT value creation. However, it is unclear how IT value emanates from digital capabilities in across-organization process. It raises important new issues of co-create value from IT in across-organization process that cannot easily be addressed by current IT value research.

This paper investigates the process from e-supply chain capability generation to IT value creation through upstream and downstream e-business process. In this paper, the IT value co-creation in e-

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supply chain is viewed as that new e-supply chain capabilities (ESCC) drive value co-creation via e-business processes linked with different partners. We regard e-supply chain value as business value of IT, which consisted of process performance, financial performance and network performance. The model of e-supply chain value is proposed and tested using SEM with data collected from 196 manufacturing firms in China. Our results provide theoretical support for a dynamic process that distinctive e-supply chain capabilities embedded in e-business process lead to process performance first and then financial performance and network performance. We find that e-supply chain capabilities (ESCC) realize e-supply chain value for all partners (e.g. supplier and customer) via upstream and downstream e-business process.

2 LITERATURE REVIEW

Traditionally, IT impacts in the context of supply chain management (SCM) have been investigated with a focus primarily on specific technologies and innovations linked with partners, such as e-business (Boone and Ganeshan, 2007), electronic data interchange (EDI) (Chatfield and Yetton, 2000), and other inter-organizational information systems(IOS) (Iskandar et al., 2001). Recent studies using Resource-based view of the firm (RBV) as a theoretical base have focused on the relationships between resources, capabilities and business value (Kohli and Grover, 2008). These researches can be divided in two streams.

The first stream of research suggests that a firm's overall e-supply chain effectiveness is determined by its investment in e-business for creating unique Internet-enabled capabilities (Barua et al., 2004); (Dong et al., 2009). For example, Barua et al. (2004) study firms' abilities to deploy three resources - IT, processes, and readiness of customers and suppliers - to create business value. Their empirical results show that online informational capabilities have a positive impact on operational and financial performance.

The second stream of literature suggests that firms derive e-business benefits through intermediate business processes (e.g., e-procurement, CRM) (Ray et al., 2005). Ray et al. (2005) argue that adopting the effectiveness of business process as a dependent variable is a more appropriate way to test resource-based logic than adopting overall firm performance as a dependent variable. For these reasons, it is important to focus on process performance as a feasible path to e-business value. Also, this perspective is used for analyzing e-supply chain integration, e.g., Rai (2006) and Barratt and Oke (2007).

However, the literature is scarce with studies of the complex process regarding co-creating business value of IT in e-supply chains. Prior works lack research for these intermediate factors forming the linkage and impacting business value of IT in supply chain.

3 RESEARCH MODEL AND HYPOTHESE

In this paper, we use RBV together with e-business process view to explain how focal firm and partners' IT resources integrated in across-organization process applications to create e-supply chain capability and further gain co-creation value. The research model of e-supply chain value will be developed to investigate the process of e-supply chain capabilities generation and e-supply chain value creation. We characterize this model with three dimensions and six constructs. The definitions of constructs in the model are summarized in Table 1. These dimensions include Inter-firm IT Resources Integration, e-Supply Chain Capability and e-Supply Chain value.

In order to study in depth the process from e-supply chain capability generation to value creation through e-business process, we divide the process into three stages: (1) Generation of e-supply chain capability; (2) Creating e-supply chain process performance; (3) Generation of e-supply chain value. A series of hypotheses are developed to test the relationships between constructs.

3.1 Creating e-Supply Chain Capability

In this stage, the generation of e-supply chain capability (ESCC) is related to usage of inter-firm IT resources integration via e-business process. Melville et al. (2004) ague the IT and non-IT resources and the business processes of electronically connected trading partners shape the supply chain ability to generate operational efficiencies impacts via IT. In this paper, Inter-firm IT resources integration includes Internal IT resources integration for focal firm and Partner Resources for supply chain partners. Concerning Internal IT resources integration, prior SCM studies

Table 1: Definitions and constructs in the model.

Construct		Definitions	References
Internal IT Resources Integration (IITR)		The extent to which a firm integrates its Internal -organizational IT resources (including information systems, employees and managers knowledge) to construct e-business processes in e-supply chains for online information sharing and transaction execution across the value chain.	Melville et al. (2004)
Partner Resources (PR)		The degree to which a firm's partners (e.g., suppliers, retailers and customers) are willing and ready to conduct business or service activities electronically via e-business processes in e-supply chains.	Melville et al. (2004)
e-Supply Chain Capability (ESCC)		The ability that a firm uses e-business technology to share information and accomplish transaction and coordinate activities electronically with partners (e.g., suppliers, retailers and customers) through e-business processes in supply chains (e.g., e-procurement, e-ordering, and CRM). In this paper, e-Supply Chain Capability consists of three parts in upstream and downstream supply chain. They are called e-Procurement capability (EPC), e-Ordering Capability (EOC) and e-CRM Capability (CRMC).	Zhao et al.(2008)
e-Supply chain value	Process Performance	IT value at e-supply chain process level and emanates from e-supply chain capabilities via e-business process. In this paper, Process Performance consists of three parts in upstream and downstream supply chain. They are called e-Procurement Process Performance (EPPF), e-Ordering Process Performance (OPPF) and CRM Process Performance (CRMPF).	Dong et al. (2009) Dehning et al. (2007)
	Financial Performance (FPF)	Improvement in financial performance attributable to e-supply chain applications	Barua et al. (2004) Dehning et al. (2007)
	Collaborative Network Performance (CNPF)	Aggregate performance t of collaborative network in e-supply chain	Straub et al. (2004)

have realized that IT technology contribute to e-supply chain capability(Rai et al., 2006); (Wu et al. 2006), For an organization with a high level of information systems, it should be able to transmit, combine and process data from business partners, such as, suppliers/vendors. As noted by Wu et al. (2007), the organizational learning ability associated with IT professional knowledge is positively related to the use of both coordination and transaction e-procurement applications capability (Wu et al., 2007).Together these studies suggest the critical role of IS integration technology and IS application knowledge in improving the effectiveness of e-supply chain capability in their e-procurement, e-ordering, and CRM. This leads to the following hypothesis:

H1: Internal IT resources integration in focal firm has a positive impact on the level of e-procurement capability.

H2: Internal IT resources integration in focal firm has a positive impact on the level of e-ordering capability.

H3: Internal IT resources integration in focal firm has a positive impact on the level of CRM capability.

Electronic integration of supply chain processes across organizations requires the development of IT resources by both the focal firm and its trading partners (Melville et al., 2004); (Zhao et al., 2008). Hence, partner resources support (includes suppliers, retailers) is considered an external resource to support process connection (Dong et al., 2009) and develop e-supply chain capability from collaborative partner relationship perspective (Dewan et al. 1998). Even if a firm has the necessary IT applications to do business online with customers and suppliers, a lack of partner's readiness on the part of customers or suppliers will impede the adoption of the technology and IT value creation (Barua et al., 2004). Thus, we hypothesize the following:

H4: Partner resources have a positive impact on the level of e-procurement capability.

H5: Partner resources have a positive impact on the level of e-ordering capability.

H6: Partner resources have a positive impact on level of CRM capability.

3.2 Creating e-Supply Chain Process Performance

In this paper process performance refers to inter-organizational IT-based value co-created by e-supply chain capabilities via upstream and downstream e-business processes. More and more literatures suggest that process performance should be considered as a critical competitive power measurement in recent SCM studies (Dehning et al., 2007); (Dong et al., 2009). e-Supply chain capability can improve process performance in operations by sharing key planning and schedules information and coordinating fulfilling orders and customer services (Dehning et al., 2007); (Gunasekaran and Ngai, 2004a). From e-supply chain process level, it is optimal perspective to take an in-deep look at co-creation value emanates from robust collaborative relationships among firms. Therefore, we propose the following hypotheses:

H7: e-Procurement capability has a positive impact on e-procurement process performance.

H8: e-Ordering capability has a positive impact on e-ordering process performance.

H9: CRM capability has a positive impact on CRM Process performance.

3.3 Generation of e-Supply Chain Value

In this paper, generation of e-supply chain value combines two relationships between process performance, financial performance and collaborative network performance. On the one hand, focal firm can capture effects of e-supply chain process performance improvement to the direct overall firm financial performance. On the other hand, through e-supply chain process integration and collaboration, focal firm also improves collaborative network outcomes together with their partners to gain new competitive advantages.

e-Supply chain can improve financial performance in operations by coordinating marketing forecasts, production schedules, and inbound logistics through the availability of enhanced informational support for operations planning and control resulting in reduced levels of work-in-process and higher capacity utilization (Gunasekaran et al., 2004b). It may be important to simultaneously consider measuring the full direct impact of e-supply chain process use on financial performance. Therefore, we propose the following hypotheses:

H10: e-Procurement process performance has a positive impact on firm financial performance.

H11: e-Ordering process performance has a positive impact on firm financial performance.

H12: e-CRM process performance has a positive impact on firm financial performance.

In this paper, co-creation of value focuses on overall e-supply chain operations effectiveness due to each firm in this network benefits from such relationships. Collaborative network performance can be associated with e-supply chain has recently been demonstrated by Straub et al. (2004). They argue that degree-symmetric information sharing and dependence in e-supply chain are positive related to networked organizational performance. The greater the degree of process applications between partners via e-supply chain, the greater its share of net value from deployment of the usage. This leads to the following hypothesis:

H13: e-Procurement process performance has a positive impact on collaborative network performance.

H14: e-Ordering process performance has a positive impact on collaborative network performance.

H15: e-CRM process performance has a positive impact on collaborative network performance.

4 RESEARCH METHODOLOGY

4.1 Data Collection

This study used the survey method to collect primary data from senior IS managers and business managers of manufacturing firms in China. A five-point Likert scale (from very well to very bad) was used to collect most responses. The data collection involved manufacturing firms engaged in e-supply chain that had the ability to interact with suppliers and customers over the Web. During the whole process, we have sent out 600 surveys and received 233 back. Ten responses had too many missing data and were discarded. Twenty-seven companies were discarded because they didn't adopt information systems for SCM except Internet access. There were 196 usable responses and the usable response rate was about 33%. In the sample, 65% of firms belong to traditional manufacturing group, such as China Petroleum & Chemical Corporation (Sinoper),

Shanghai Volkswagen and Honda China. About 35% firms belong to high-tech manufacturing group, example include Lenovo, Samsung China, Benq, Foxconn, Chinabird Huawei and et al. We found no significant differences of organizational size and sales in the two groups by using one-way ANOVA.

4.2 Data Analysis

A covariance-based Structural Equation Model (SEM) analysis was used for data analysis. Exploratory factor analysis (EFA) was first conducted using SPSS 16.0 to validate the proposed factor structures. EFA showed the presence of ten factors in the data and the factor structures matched the ones we identified in the research model. The results of measuring IT related resources and e-supply chain capability represented two and three factors solution with 64% and 77% cumulative percent of variance extracted respectively. These items employed in multi-level performance revealed five factors with 85% cumulative percent of variance extracted. The values of KMO are all above 0.85 with significant Bartlett's test of sphericity at 0.05 levels. The factor structures suggested by the EFA match the one proposed in the research model.

Next, confirmatory factor analysis (CFA) was conducted to check the reliability and validity of the measurement model using Lisrel.8.72. Construct reliability was measured using Cronbach's alpha and composite reliability. The Cronbach's alpha ranges from 0.79 to 0.92 for the 10 constructs, indicating a high internal consistency (Straub et al., 2004). Further, composite reliability was evaluated and found to be similar, based on which we may conclude that the reliability for these constructs is adequate (Straub et al., 2004). Convergent and discriminant validities were examined by both factor loadings and a correlation matrix. All estimated standard loadings are significant ($p<0.001$), suggesting good convergent validity. All square root of AVEs were above 0.707 (AVEs were above 0.50), and they are much larger than all cross-correlations. In sum, the results indicate good convergent and discriminant validity.

The research model was tested with Lisrel 8.72, results are presented in Fig. 1. Several GFI indexes of the structural model have been widely used in IS research arena. The normed $\chi 2$($\chi 2$ to degree of freedom) is 2.4, which is within the recommended level of 3.0Barua et al. 2004). The incremental fit indices include the normed fit index (NFI), Non-Normed Fit Index(NNFI), comparative fit index (CFI), and incremental fit index (IFI), which are all higher than 0.9. This implies a good model fit (Hu and Bentler, 1999). Results suggested that the structural model fit the data adequately.

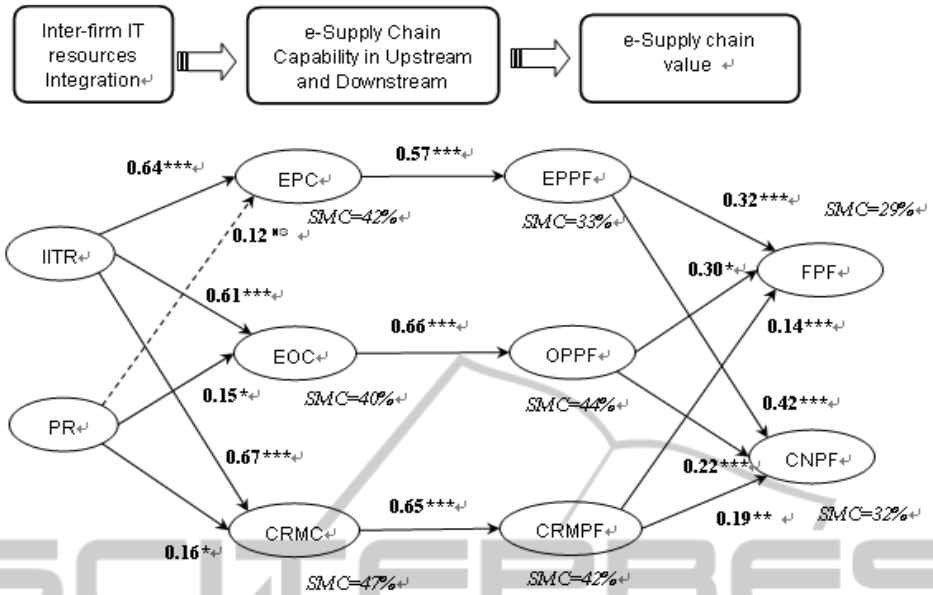
4.3 Hypothesis Tests

Out of 15, 14 hypotheses are supported in our study; we also provide an overall validation of the model of e-supply chain value shown in Fig. 1.

Since our model proposes that e-supply chain capability(ESSC) are intermediate transferring capabilities between inter-firm IT resource integration and process performance, we test these effects in three upstream and downstream processes at the same time. In the e-procurement process, only Internal IT resources integration of a focal firm have a positive effect on e-procurement capabilities (EPC) ($\beta=0.64$, $p<0.001$), while partner resources does not have a significant impact ($\beta=0.12$, $p>0.05$). Thus, H2 is not supported. In the e-ordering process, the results indicate the Internal IT resources integration ($\beta=0.61$, $p<0.001$) is more likely to be associated with the development of e-ordering capability (EPC) than partner resources ($\beta=0.15$, $p<0.05$). Similarly, the results also predict the impact of Internal IT resources integration ($\beta=0.67$, $p<0.001$) and partner resources ($\beta=0.16$, $p<0.05$) on the generation of CRM capability (CRMC). Therefore, these results support the hypothesis that firms have engaged in integrating inter-firm IT resources together with partners to create unique e-supply chain capability through upstream and downstream e-business processes.

We further tested the e-supply chain process performance co-create by e-supply chain capability in upstream and downstream e-business processes. Hypotheses H7, H8, and H9 are all strongly supported at 0.001 significance level, demonstrating that ESSC involving in procurement ($\beta=0.57$, $p<0.001$), ordering ($\beta=0.66$, $p<0.001$), and the CRM process ($\beta=0.65$, $p<0.001$) leads to improved individual process performance respectively.

We also identify the role of process performance in transforming from e-supply chain capability to financial performance (FPF) and collaborative network performance (CNPF). The model shows a significantly positive linkage between e-supply chain process performance and financial performance in the e-procurement ($\beta=0.32$, $p<0.001$) with higher magnitude and greater significance than in the e-ordering ($\beta=0.30$, $p<0.05$) and CRM ($\beta=0.14$, $p<0.001$). Therefore, H10, H11, and H12 are supported in this study. H13, H14, and H15 predicted that process performance also would



IITR: Internal IT Resources Integration; PR: Partner Resources; EPC: e-Procurement capability; EOC: e-Ordering Capability; CRMC: CRM Capability; EPPF: e-Procurement Process Performance; OPPF: e-Ordering Process Performance; CRMPF: CRM Process Performance; FPF: Financial Performance CNPF: Collaborative Network Performance

* p<0.05; ** p <0.01; *** p <0.001; NS: Non-significant

Figure 1: Structural model results.

impact on collaborative network performance.

5 CONCLUSIONS

The empirical results provide strong overall validation of causal relationships between the constructs in the three stages, forming a dynamic chain among inter-firm IT resources integration, e-supply chain capabilities and e-supply chain value. The results indicate that firms use collectively of inter-firm IT resources to gain e-supply chain capabilities which via implementing the e-business process more efficiently and effectively. We argue that the core competencies of the e-supply chain, as associated with e-supply chain processes, are achieved by e-supply chain capabilities, which are as integrated process enablers between upstream and downstream processes to realize benefits for focal firms and all partners (e.g. supplier and customer). Furthermore, the impact of financial performance and collaborative network performance are mediated by process performances in procurement, ordering, and CRM process. This research expands our understanding of the dynamics and completeness of transformation for the e-supply chain implementation success.

Finally, we want to point out limitations of this study. Our data relies on a single Asian country. Sample data from one or more western countries are needed to further generalize the findings. This cross-national comparison may reveal the potential impact of national differences (e.g., national culture and country-specific e-supply chain practices).

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