Empirical Research on Associations among Information Technology, Supply Chain Robustness and Supply Chain Performance

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Abstract

Supply chain reliability and ability to do with risks are important research fields in SCM. Although it is intuitive that supply chain's ability to resist risks is likely to have a positive impact on supply chain performance, there is little systematic analysis and documentation of the magnitude of these impacts in the literature. This paper empirically documents the associations among information technology, supply chain robustness, and supply chain performance. Based on a sample of 186 questionnaires, the results show the positive impact of information technology on supply chain robustness and supply chain performance, and also the positive impact of supply chain robustness and supply chain performance.

Keywords: Information technology, Supply chain robustness, Supply chain performance

1. Introduction

Information technology (IT) has been the fundamental infrastructure of competition and cooperation for today's enterprises, and the positive effects of IT on supply chains' performance have been approved by many researchers (Zhao X, Xie J, *et al.*, 2002; Lin, F.-r., S.-h. Huang, *et al*., 2002; Yee, S. T., 2005), some researcher also pointed out that IT needs to be combined with other enterprises' resources to improve the supply chain outcome (Powell, T. C., and A. Dent-Micallef., 1997; Wade, M., and J. Hulland, 2004).

Meanwhile, with more and more complicated environment and fast changing customer requirements, today's supply chain has to be more agile which in turn enhances the likeability of the disruption and risks in supply chain. Researchers have proved the negative effects of supply chain disruption on the supply chain's performance(Lee, H. L., and S. Whang, 2005; Hendricks, K. B., and V. R. Singhal, 2005) therefore, how to improve the supply chain robustness with IT is an important and interesting topic to research.

IT plays a very important role in improving supply chain performance (Sambamurthy, V., & B. Anandhi, *et al.*, 2003), but this paper tries to understand the relationship between IT and supply chain robustness, and how IT affects supply chain performance through supply chain robustness based on the data collected from 186 companies.

2. Variables and Hypothesis

Supply chain robustness means the supply chain's ability to resist disruptions and risks to keep operating normally. There are many different kinds of supply chain risks, like price fluctuating, supply disruption, quality problems, wars, nature disasters (Williams Grey, & Dailun Shi, 2003). Manuj and Mentzer classified supply chain risks into the following four types after making an intensive literature review: supply risks, such as unsmooth supply, store storage, quality problem, and price fluctuating; operation risks, like production disruption, and technology changing; demand risks, like new products emerging, demand fluctuating, and bullwhip effects; security risks, such as information system security, infrastructure security, and terrors (Ila Manuj, & Jonn T Mentzer, 2008). According to the SCOR 8.0 model published by Supply-Chain Council, supply chain management is composed by 5 processes, planning, procurement, production, delivery, and return. Thus, combine Manuj and Mentzer's classification and SCOR 8.0 model, this gives the following 20 variables to measure the supply chain's ability to resist risks: number and quality of backup supplier (RD1), information sharing level with partners (RD2), collaboration ability with partners (RD3), long time cooperation relationship with partners (RD4), ability to collaborate with customers (RD5), ratio of information infrastructure breakup (RD6), the advanced of supply chain information systems (RD7), the variousness of supply chain IT (RD8), agility of the supply chain planning(RD9), agility of the supply chain purchase (RD10), agility of the supply chain manufacture(RV11), agility of the supply chain delivery (RD12), agility of the supply chain customer service(RD13), ability of responding emergency (RD14), products quality (RD15), ability of supply chain

strategy adjust to business strategy (RD16), ability of making emergency plan and execute (RD17), ability of changing business model (RD18), simplicity of the supply chain structure (RD19), and stability of the supply chain structure (RD20).

It is always took for granted that IT can enhance supply chains' ability to resist risks, but there is few empirical study on this topic, this paper tempest to using the following variables to measure the effects of IT on supply chain risk-resist ability: number and quality of backup supplier(ITRD1), information sharing level with partners(ITRD2), collaboration ability with partners(ITRD3), long time cooperation relationship with partners(ITRD4), ability to collaborate with customers(ITRD5), agility of the supply chain planning(ITRD6), agility of the supply chain purchase(ITRD7), agility of the supply chain manufacture(ITRD8), agility of the supply chain delivery(ITRD9), agility of the supply chain customer service(ITRD10), ability of responding emergency(ITRD11), products quality(ITRD12), ability of supply chain strategy adjust to business strategy(ITRD13), ability of making emergency plan and execute(ITRD14), ability of changing business model(ITRD15), simplicity of the supply chain structure(ITRD16), and stability of the supply chain structure(ITRD17).

H1: To apply IT will make reasonable positive effects on supply chain risk-resist ability.

Performance measurement is a set of meaningful indicator and the process of to use these indicators to track the enterprise's performance (Hugos, M, 2006). Chan points out that, performance measure is a key task of supply chain management, and it can help to find the weakness, improve the supply chain members' responsibility. Gunasekaran and Patel believe that to study the supply chain performance, people have to focus on strategic, tactic and operation level on both financial and non-financial views (Gunasekaran, A., C. Patel, *et al.*, 2001). Back on Gunasekaran and Patel's supply chain performance measurements, and also considering the five processes in SCOR8.0, this paper gives the following ten variables: financial performance(SCP1), non-financial performance(SCP2), operation performance (SCP3), static level performance(SCP4), strategic level performance(SCP5), plan performance(SCP6), purchase performance(SCP7), manufacture performance(SCP8), delivery performance(SCP9), and return performance(SCP10).

H2. The supply chain's ability of resisting risks has positive effects on supply chain performance.

H3. IT has positive effects on supply chain performance.

Figure 1 describes the relationship of the above three hypothesis.

3. Questionnaires and data analysis

Supply chain risk resist ability is a multi-dimensions variable; we use Likert 5 to design the 20 variables which describe it, in which 1 means very not important, while 5 means very important. Samely, we use Likert 5 to describe how much IT can improve the supply chain risk resist ability; in which 1 means IT can almost do nothing to improve the indicator and 5 means IT can improve the indicator evidently. In the questions of measure how much the supply chain risk resist ability can improve the supply chain's performance, we also use the following 5 answers to help the companies to describe the relationship: no relationship; has some relationship, but not very close; has directly relationship; has obvious relationship; and very close relationship.

From May 2007, we distributed 450 copies questionnaires, and 207 of them were returned, and remove 21 invalid copies, we totally received 186 copies. Table 1 describes the basic information about our investigated companies:

From table 1, we conclude that most of our investigated companies come from manufacture industry, it mainly because that, compared with other industries, China's manufacture industry is the earliest industry which emerge into global operation. More than 90% companies have operated more than 5 years, it means that these companies are running well and have their own market share, and they also noticed the importance of supply chain operation. More than 85% investigated companies' operation range expanded the local area, which means they need pay more attention on their supply chain operation.

Based on the CITC and proposed by Cgurchill (1979) and Cronbach (1951), we calculate the sample reliability index, the result shows that all the CITC and of supply chain risk resist ability exceeds 0.9, which means our sample data is reliable. Based on the same criteria, all the variable factors of IT effect on supply chain risk resist is reliable.

Table 2 show the average and standard deviation of supply chain risk resist factors, and table3 shows the average value and standard deviation of IT's impacts on supply chain risk resist factors.

Table 4 describes the relationship among IT, supply chain risk resist ability and supply chain performance:

Since our sample number is more than 30, we use Z test (α=0.05) to test our hypothesis, figure 2 shows the sample distribution of average value (μ=3.0), the static data shows that the sample standard deviation S=0.8279, and back on the table of standardized normal distribution, we find the $Z_{0.05}$=1.96, and the maximum and minimum value of μ are

μ-$ZS_{\bar{X}}$=3-1.96(0.8279/$\sqrt{186}$)=2.8810

μ+$ZS_{\bar{X}}$=3+1.96(0.8279/$\sqrt{186}$)=3.1190

Our hypothesis 1 is thus tested and proved to be true; similarly, hypothesis2 and hypothesis3 are all true.

4. Conclusions

From the sample data we collected and after analysis, we can conclude that IT plays an important role in helping enhance supply chain's ability of resisting risks, and thus help improve the supply chain's whole performance. Companies that want to do beater in the supply chain operation and decrease the risks of supply chain disruption should apply better IT strategy, and improve their ability of utilizing IT in their supply chain operation.

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Table 1. General information

Industry	%	**Location**	%
Electronic and Mobil	19.51%	Shanghai, Jiangsu	12.2%
Cloth and Toys	4.07%	Beijing, Tianjin, Hebei	71.5%
Machine and equipments	21.14%	Guangdong	11.2%
China, construction and chemical	10.57%	Shandong	3.1%
Other	44.72%	Other	2%
Total	100%	Total	100%
Company life time	%	**Employee**	%
1~5 years	11.4%	Less than 100 people	22.41%
5~10 years	21.31%	100 ~500 people	19.83%
Over 10 years	67.21%	500~1000 people	14.66%
		1000~2000 people	10.34%
		More than 2000 people	32.76%
Total	100%	Total	100%
Last year's sales (RMB)	%	**Operation range**	%
Under 10 million	10.74%	Local	8.26%
10 ~50 million	9.92%	Regional	17.36%
50 ~100 million	9.92%	China	28.1%
More than 100 million	69.42%	Global	46.28%
Total	100%	Total	100%

Table 2. The average value and standard deviation of supply chain risk resist factors

	R1	R2	R3	R4	R5	R6	R7
AV	3.7300	3.4167	3.6735	3.9082	3.7449	3.0842	3.2755
SD	1.09963	.95880	.87078	.92041	.92292	1.03824	1.03327
	R8	R9	R10	R11	R12	R13	R14
AV	3.1458	3.4792	3.3333	3.1158	3.5521	3.7234	3.9600
SD	1.03598	.84578	1.15747	.87352	.95001	.93215	.94195
	R15	R16	R17	R18	R19	R20	
AV	3.8646	3.7010	3.5895	3.1263	3.0105	3.4796	
SD	1.08210	.93725	1.02620	1.15999	1.06686	1.08627	

Table 3. The average value and standard deviation of IT's impacts on supply chain risk resist factors

	ITR1	ITR2	ITR3	ITR4	ITR5	ITR6	ITR7	ITR8	ITR9
AV	2.959	3.684	3.563	3.281	3.365	3.642	3.611	3.170	3.670
SD	1.346	1.061	1.074	1.271	1.180	1.129	1.142	1.188	1.051
	ITR10	ITR11	ITR12	ITR13	ITR14	ITR15	ITR16	ITR17	
AV	3.479	3.541	3.271	3.253	3.255	2.860	2.905	3.198	
SD	1.076	1.256	1.302	1.194	1.145	1.230	1.212	1.211	

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Table 4. The relationship among IT, supply chain risk resist ability and supply chain performance

	AV	SD	RSCP	ITSCP	ITSCR
Impact of supply chain risk resist ability on supply chain performance(RSCP)	4.0294	.77659	1.000		
Impact of IT on supply chain performance(ITSCP)	3.8218	1.12602	.908	1.000	
Impact of IT on supply chain risk resist ability (ITSCR)	3.3737	.82790	.817	.882	1.000

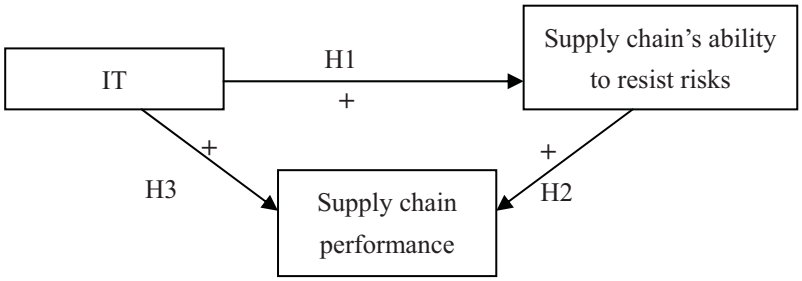

Figure 1. The hypothesis model

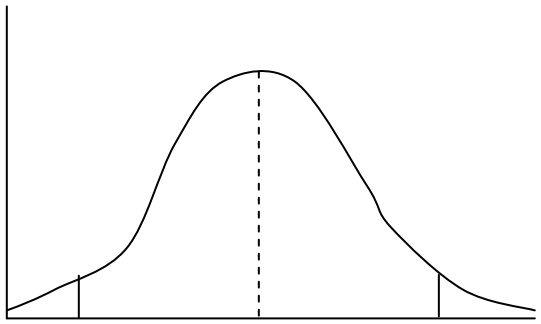

Figure 2. Sample distribution of average value (μ=3.0)