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ABSTRACT

This study builds a model of trust, based on joint operational activities and mass customization using theories of social capital and the resource-based view of the firm. Based on 208 responses from suppliers in the U.S. and China, this study empirically supports the notion that trust positively drives manufacturer-supplier activities in operations. It also supports the claim that joint operations activities contribute to mass customization capabilities in a significant way. Moreover, the level of trust and the degree of joint activities are different for the four types of suppliers used in the study: U.S. brands produced in North America, Japanese brands produced in China, U.S. brands produced in China, and Chinese brands produced in China.

Key Words: Trust, Joint Operations Practices, Mass Customization, Culture

1. INTRODUCTION

Mass customization serves consumers better with more product variety while maintaining low production costs (Tu et al., 2004). To successfully implement mass customization a producer must coordinate action, through its supply chain, with each participating company to achieve a commitment for overall success. A key factor in buyers and supplier relationships is trust (Akintoye et al., 2000). For the upstream portion of the supply chain, McCutcheon and Stuart (2000) and Li et al., (2006) state that trust is also important for successful joint operations activities between manufacturers and their suppliers. There are many articles on trust in the context of supply chain management. However, research on trust between different cultures in supply chain management is limited (Schoorman et al., 2007). This article aims to answer the following research questions: (1) Does greater trust lead to frequent joint operations activities in each of the dimensions of product development, manufacturing process, logistics, and quality management between manufacturers and suppliers? (2) Can frequent joint operations activities in each dimension lead to a high degree of mass customization? And (3) what is the relationship between culture and trust in the context of supply chain management?

Section 2 reviews prior literature on trust and joint operations activities in supply chain management and develops a research framework that includes hypotheses. Research methods are described in Section 3. The measurement model, hypothesis testing, and discussions are in Section 4 followed by conclusions in Section 5.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

Social capital theory considers the social relationships of individuals, groups, and organizations as well as the benefits that accrue to them because of these relationships (Alder and Kwon, 2001). Trust is an important building block in social capital theory because it is the basis for a positive working relationship (Mayer et al., 1995). Trust is "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party" (Mayer et al. 1995, p. 712). Trust has been researched at levels of teams (Mayer et al., 1995), within organizations (McEvily et al., 2003), and between organizations (McCutcheon and Stuart, 2000).

In the context of supply chain management, there are many research articles on trust including those on supply chain strategy (Ireland and Webb, 2007) and purchasing techniques (Gattiker et al., 2007). Trust between manufacturer and supplier is defined as that the "buyer is honest, reliable, open, and respects the confidentiality of information to a supplier" (Li et al., 2006). In order to gain the potential benefits from trust, researchers view joint operations activities between buyers and suppliers as critical (Lee, 2004). Joint operations activities have theoretical foundations in the resource-based view (RBV). RBV identifies four critical resource (i.e., value, rarity, imperfect imitability, and imperfect substitutability) for a firm to achieve competitive advantage (Barney, 1991; Wernerfelt, 1984). Lavie (2006) extends the resource-based view to encompass the interconnectedness of firms to gain competitive advantage from a network of firms or supply chain. Based on the extended RBV, the resources owned by partner firms, such as buyer or supplier in a supply chain, can also be viewed as critical ones for the firms. With trust, the resources of the supply chain can be shared. With solid foundations in both the social capital and resource-based view theories, this study proposes the research model in Figure 1. Trust between the manufacturer and the supplier increases the level of joint operations activities, which contribute to a higher level of mass customization.

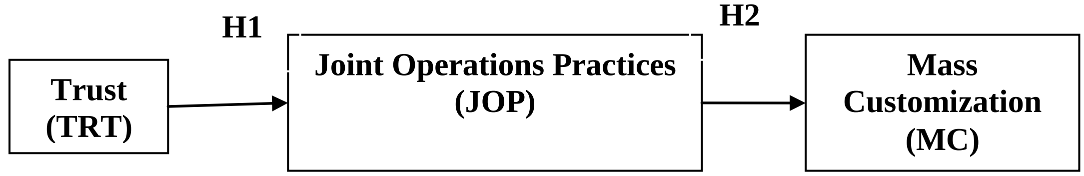

Figure 1: Research Model

Joint operations activities include joint problem solving and coordination in product development, manufacturing process, and quality management with frequent visits to other parties within a supply chain (Dyer et al., 1998). The following describes the relationship between trust and each type of joint operations activities, joint product design, joint manufacturing process, and joint quality management. First, benefits to manufacturers include shorter new product introduction time, lower cost, and the use of additional technology in joint product developments with suppliers (Handfields et al., 1999), which is important because product development is a knowledge intensive process. Involving suppliers with the product design process adds risks for both the manufacturer and the suppliers; the manufacturer is afraid of losing negotiation power if they depend on one supplier for the technology, while the suppliers might worry about losing control over know-how to the manufacturer. So, trust between the manufacturer and supplier is essential to lower the perceived risks for the manufacturer and the supplier, and thus to assure the quality of supplier involvement in new product development (Sobrero and Roberts, 2002). Second, joint manufacturing process includes sharing manufacturing technology and skills between the manufacturer and the supplier. During the joint manufacturing process, there exists intensive knowledge sharing. Firm knowledge acquisition and management is the foundation of its distinctive competence (Cantwell and Mudambi, 2005). Without trust, neither the manufacturer nor the supplier has any intention of sharing knowledge with the other party about their manufacturing processes (Politis, 2003). Liker and Choi (2004) find that high trust between the manufacturer and the supplier can increase the frequency and range of joint manufacturing activities based on their case study of automotive suppliers in North America. Third, joint quality activities include solving product and process quality problems. If there is mutual trust between the manufacturer and one supplier, the manufacturer and the supplier remove the fears and thus share knowledge that improve the quality of components and the final product (Bönte, 2008). Therefore, the following hypothesis is proposed:

H1: The trust between manufacturers and suppliers positively leads to frequent joint operations activities between manufacturers and suppliers.

Mass customization is "the ability of a firm to quickly produce customized products on a large scale at a cost comparable to non-customized products" (Tu et al., 2001). Each dimension of joint operations activities can result in higher customer services in the form of customized products. Joint product design by a manufacturer and their suppliers allows the voices of customers to be transferred to the suppliers, which lead to better new products with greater variety that more closely match customer expectations (Alford et al., 2000). Joint manufacturing processes allow the manufacturer and their suppliers to have balanced production capacities, which would result in the lower overall cost of manufacturing by eliminating unnecessary equipment investments. In addition, sharing knowledge of time-based manufacturing practices between the manufacturer and their suppliers can largely eliminate some costs and enable faster responses to customer demands (Tu et al., 2001). Quality is a key issue for product and process management. Joint quality improvement allows a manufacturer and their suppliers to find the causes quickly and fix the problems easily with more knowledge or expertise, resulting in lower cost, higher variety, and shorter lead time (Ouyang et al., 2007, Li et al., 2005). Guest engineers are engineers who are sent to work on product development or process improvement programs at other companies within a supply chain (Lewis et al., 2001, Liker and Choi, 2004). Sending employees between a manufacturer and a supplier helps to coordinate operations in production planning and logistics and to solve problems in product design and process improvement (Fawcett et al., 2006, Petersen et al., 2005). These efforts facilitate mass customization, which drives product variety, and they reduce costs in the supply chain. Therefore, this study proposes the following hypothesis:

H2: More frequent joint operations activities between manufacturers and suppliers lead to higher level of mass customization.

3. RESEARCH METHODOLOGY

The measurement for Trust is adopted from Li's study (Li, 2002). The measurement for Mass Customization is adopted from Tu et al. (2004). The measurement of Joint Operations Activity is developed as part of this research. The methods to develop this instrument included a review of the relevant literature, structured interviews with executive, a pre-test with faculty experts, and a pilot study that involved thirty industry executives. Details of the pilot study are available from the authors. The final survey instruments are provided in Appendix A. The response rate is 45.6%. There is no non-response bias using Chi-square test (Jitpaiboon, 2005). Therefore, our respondents represent an unbiased sample.

4. MEASUREMENT MODEL, HYPOTHESIS TESTING, AND DISCUSSIONS

The dataset is randomly divided into two samples, each of which has 104 responses. One is the calibration sample and the other is for validating the measurement model (Koufeteros, 1999). Measurement and hypotheses are tested using structural equation modeling (AMOS) software. Measurement instruments are assessed for convergent validity with item reliability, discriminant validity, and construct reliability using confirmatory factor analysis (CFA) methodology (Koufeteros, 1999). The trimmed measurements are validated using the validation sample (n=104). The factor loading, error term, t-value, R2, and overall fit indices are listed on Table 1. The range of t-value is from 5.35 to 7.53, thus, all indicators are significant related to their specified constructs indicating good convergent validity of all three constructs. The item reliability for two items (i.e., TRT2 and JOP1) are slightly less than 0.5. The overall model fit can be measured by $\chi 2/df$, NNFI, and CFI (Koufeteros, 1999). In the study, $\chi 2/df$ is 1.77, lower than the criterion of 2.0. NNFI (0.90) and CFI (0.95) are both satisfied with the criterion of 0.9. In sum, the measurement model is validated to be fit, and the measurements have acceptable convergent validity and item reliability. The next step is to validate discriminant validity and construct reliability of the measurements using the validation dataset (n=104). Discriminant validity can be assessed using $\chi 2$ difference of fixed and free solutions between each pair of latent variables. All differences of $\chi 2$ are significant at 0.001 level (i.e., the minimum $\chi 2$ =31.3, $p < 0.001$, 1df). These indicate good discriminant validity for the measurements in this study. Reliability is estimated by the indices of composite reliability and average variance extracted (AVE). The composite reliability for the trust, joint operations activities, and mass customization are 0.76, 0.81 and 0.82, respectively. All of them exceed the acceptable level. The values of AVE are 0.52, 0.59 and 0.61, respectively, for the trust, joint operations activities, and mass customization. The composite reliability and AVE for each construct in this study indicate a good reliability of each construct

Latent variable	Item	Unstandardized Factor Loading	Standardized Factor Loading	Standard Error	t-value	R2 (item Reliability)
ξ1	TRT1	1	0.774	- [a]	- [a]	0.599
	TRT2	0.844	0.583	0.158	5.352	**0.340**
	TRT3	0.996	0.779	0.151	6.602	0.607
ξ2	JOP1	1	0.659	- [a]	- [a]	**0.434**
	JOP2	1.218	0.777	0.206	5.906	0.604
	JOP3	1.334	0.861	0.185	7.219	0.741
ξ3	MC1	1	0.808	- [a]	- [a]	0.653
	MC2	0.91	0.729	0.121	7.53	0.531
	MC5	0.909	0.801	0.129	7.022	0.642

[a] Indicate a parameter fixed at 1.0 in the original solution

Fit Indices: $\chi 2$=45.53, df=24, $\chi 2$/df=1.77, NNFI=0.90, CFI=0.95.

Table 1: Convergent Validity and Item Reliability (Validation Sample, n=104)

AMOS structured equation modeling (SEM) framework was used to test the hypotheses of the current study. The structural model fit was very good with all indices meeting the recommended criteria: $\chi 2$/df=2.0, NNFI=0.919, CFI=0.957 and RMSEA = 0.07 (LO90=.041and HI90=.098). The AMOS path coefficients resemble those derived through multiple regressions. The path coefficients for H1 is 0.61, which is significant at the 0.001 level, indicating that high trust leads to high joint operations activities in product development, manufacturing process, and quality management. The path coefficient for H2 is 0.44, which is also significant at the 0.001 level, supporting that high joint operational activities lead to high mass customization capacity.

The responses (n=208) are from suppliers for four types of auto makers: US brand (e.g., GM, Ford, and Chrysler) manufactured in North America (n=40), Japanese brand (e.g., Honda and Toyota) manufactured in China (n=63), US brand (e.g., GM) manufactured in China (n=41), and Chinese brand (e.g., Yuchai) manufactured in China (n=64). It would be interesting to explore the differences of trust, joint operations activities, and mass customization capability among these four groups of suppliers. A two-step analysis of mean differences is conducted for the constructs of trust, mass customization, and each of the three types of joint operations activities. First, the mean of each group for trust, mass customization, and each of the three types of joint operations activities are listed in Table 2.

Second, ANOVA was conducted for the construct of trust for the four groups. The result of ANOVA is also shown in Table 2. Each of the two groups of eastern brands (i.e., Japanese brands and Chinese brands) has a higher trust level than each of the two other groups of the U.S. brands. This is consistent with the observations by Liker and Choi (2004) who find that the trust level within U.S. brand auto supply chains is much lower than that within Japanese auto supply chains based on their field study of the automotive industry in the U.S. One possible reason for this result might be the culture difference between the eastern and western buyer-supplier relationships. Culture includes four dimensions: power distance, collectivism versus individualism, femininity versus masculinity, and uncertainty avoidance (Hofstede, 1991). Buttery and Leung (1998) add a fifth dimension of long-term versus short-term orientation. They conducted empirical research between Chinese culture and western culture; they also found that there are significant differences in individualism, long-term orientation, and power distance between Chinese culture and western culture. Compared to western people, Chinese people tend to be group oriented, have a long-term orientation, and accept larger power distance differences. Trust is closely related to the group and long-term orientations for the buyer and the supplier. Therefore, the culture difference between eastern supply chains and western supply chains affects the different levels of trust in these two types of supply chains.

Group*	Sample Size	TRT	MC	JOP1	JOP2	JOP3
1	40	4.16	3.86	3.73	3.42	3.88
2	63	4.29	3.61	3.83	3.81	4.10
3	41	**3.66**	**3.07**	3.87	**3.40**	**3.78**
4	64	4.24	3.71	4.07	3.96	4.30
Total	208	4.13	3.58	3.89	3.70	4.05
ANOVA Significance		.000**	.000**	.129	.001**	.002**

* US Brand in North America [1], Japanese Brand in China [2], US Brand in China [3], and Chinese Brand in China [4]
** Significant

Table 2: ANOVA for Each Measurement

5. CONCLUSION

This study empirically tests the relationship of trust between manufacturers and suppliers for three types of joint operations activities using 208 responses from suppliers in the U.S. and China. The empirical results show that high trust can lead to higher joint operations activities including quality interactions between suppliers and manufactures in product development, manufacturing process, and quality control. Also, the results support the need for frequent operations activities between suppliers and manufactures in product development, manufacturing process, and quality control that will lead to greater mass customization. A further in-depth comparison of trust and joint operations activities for each of the four groups of suppliers within the sample is conducted. The two groups of suppliers in the eastern (e.g., Chinese and Japanese) supply chains have higher levels of trust and more frequent activities joint activities than the two groups of suppliers within western supply chains. This raises an interesting finding related to the culture difference.

Appendix and references available upon request from Kun Liao at LiaoK@cwu.edu