

INVESTIGATING SUPPLY CHAIN RELATIONSHIPS WITH SUPPLIERS AND CUSTOMERS FOR MASS CUSTOMIZATION

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ABSTRACT

The influence of information technology (IT) is exceeding the providing of financial and operating support to including strategic initiatives in knowledge management and long-range planning. IT is being used to facilitate customer and supplier involvement in designing specialized product offerings, implementing process improvements, enhancing manufacturing flexibility, and controlling manufacturing operations. Together, these advances are enabling firms to customize their product offerings - mass customization (MC) and marketing at prices close to those quoted by traditional mass producers. While much research on MC has been reported in the literature, empirical studies investigating the impact of IT on creating cooperative and integrative relationships with customers and suppliers and the impacts of these relationships on the level of MC, are sparse and represent a missing link in manufacturing research. Using data collected from 220 manufacturers, this study finds that firms with higher levels of cooperative relationships with suppliers and customers enjoy higher levels of mass customization than firms that do not.

Keywords: Mass Customization, Supply Chain Management, Supply Chain Relationships, Hierarchical Linear Modeling (HLM), Small and Medium Enterprises (SME)

1. INTRODUCTION

Mass customization (MC) results when a firm produces a variety of customized products quickly, on a large scale at costs comparable to those of traditional mass producers (Pine, 1993). MC is a way for firms to address new market realities while duplicating the efficiencies of traditional mass production (Pine, 1993; Tseng and Piller, 2003; Piller, 2003; Frank and Piller, 2003). Currently, the literature reports three important points regarding MC which are of interest to this study: (1) the degree to which a firm coordinates activities with suppliers and customers (e.g., Supply Chain Relationships) and MC capability; (2) the relationship between MC capability and organizational performance (OP); and (3) the relationship between supply chain relationships and OP. Concerning the first issue, O'Grady (1999) reports the existence of three powerful forces driving the success of MC: (1) the accelerating rate of technological change, (2) the increasing sophistication of products, and (3) empowered customers demanding greater product variety due to increasing global competition and growing disposable incomes. Many companies are increasingly using information technology (IT) to directly connect with their customers; thus

enabling them to know individual customer preferences for tailoring products accordingly, and producing them in a timely manner at reasonable costs (O'Grady, 1999; Sophie Lee et al., 2000). IT also allows firms to work closely with suppliers to coordinate product designs, process improvements, and on-time deliveries so that strategic goals and customization objectives are achieved (Tracey et al., 1999). IT can facilitate customer involvement in designing specialized products that enhance flexibility, implement process improvements, involve suppliers, and control manufacturing operations. Firms are then able to customize products and sell them at lower prices. Customers reap the benefits from using the specialized products (Duray et al., 2000; Tu, Vonderembse, and Ragu-Nathan, 2001; Tu, Vonderembse, and Ragu-Nathan, 2004). In this MC effort, IT becomes the backbone of an integrated supply chain by helping synchronize the actions of many diverse companies that increase customer value. The literature reports the existence of many examples of supply chain relationships and resulting MCs. For example, Piller et al. (2004) asserted that a firm's offering customized products to acquire profits is largely due to the higher degree of interaction among a firm and its partners including both customers and suppliers. Gilmore and Pine (1997) suggested that one of four approaches for achieving customization is through collaboration. Yassine et al. (2004) investigated the role of IT affecting customized product design. In their theoretical framework, coordination was found to influence product development capability for customization.

The literature has reported a higher degree of association between MC capability and OP. Moving from a traditional mass production paradigm to a mass customization paradigm, firms can enhance their ability to satisfy customized demands and improve performance by involving customers and suppliers at early stages in their product design and manufacturing processes (Rabinovich, Dresner, and Evers, 2003). Information gained from data provided by customers and suppliers can help firms 1) avoid exclusively relying on forecasting methods, 2) reduce the value of their inventories and the cost of carrying them by postponing the final configuration of the product until customer requirements become clearer, and 3) reduce the costs associated with the avoidance of product obsolescence (Pine, 1993; Alderson, 1957). The literature also reports a higher degree of association among supply chain integrated (SCI) relationships and OP. For example, optimizing linkages among value-adding activities is the core purpose of SCI and such integration should engender superior performance (Tan et al., 1998; Frohlich and Westbrook, 2001). Having an integrated supply chain relationship provides significant competitive advantages including the ability to outperform rivals on both price and delivery (Lee and Billington, 1992). Frohlich and Westbrook (2002) and Frohlich (2002) confirmed this relationship by studying the effects of web-based integration on demand affecting supply chain management's OP.

While much research on MC reports that the significant contribution of integrated supply chain relationships to the success of MC is the providing of evidence that supply chain relationships and MC may lead to better OP. The purpose of this study is to extend this research further by investigating the effects of hierarchical levels (size?) of organizations on these relationships. This study seeks to explore the various ways in which Small and Medium Enterprises (SMEs) and Large Enterprises (LEs) affect these relationships. Fisher (1997) argues that these two types of firms inadvertently fall into the trap of mismatching desired supply chain objectives which may lead to their adopting different mass customization strategies. The study contends that SMEs and LEs adopt different mass customization strategies largely due to two conflicting perspectives: (1)

LEs are better at providing mass customization according to (the proponents of LEs) and (2) SMEs are better at providing mass customization according to (the proponents of SMEs).

First, Quayle (1999) reported that only about twenty-five percent of SMEs give significant attention to improving supply chain issues affecting them because of a perceived inability to shape or influence these supply chain systems. Several studies have reported that SMEs do understand the importance of SCI; however, because of lacking financial resources and/or the market knowledge, they choose not to implement supply chain management (SCM) systems (Barringer, 1997; Caskey et al., 2001). As a result SMEs may resist offering products to customers because of having limited power and capital to control the required resulting supply chain relationships. Therefore, with this view, SMEs may choose to offer limited options instead of full options. On the other hand, large enterprises (LEs) have been at the forefront of initiating and implementing supplier-customer relationships (Harrison, 1992; Blenckhorn & Noon, 1990; O'Neal & Bertrand, 1991). LEs are more likely to form stronger relationships with their customers and suppliers through greater purchasing power as they are mainly interested in minimizing risk by using single or dual-sourcing (Sinclair, Hunter, & Beaumont, 1996). As a result, LEs are likely to perform better in offering MC to customers because of having enough purchasing muscle to force suppliers to adopt detailed product specifications, certain quality management techniques and practices as a contractual condition (Lascelles & Dale, 1989). LEs in some situations force their suppliers to implement systematic forms of supplier-customer relationships that help enhance the process of MC (Zipkin, 1991). For example, suppliers are expected to invest in such technologies as E-commerce, ERP systems, flexible machines, and CAD equipments that help expand the ability of their customers to customize their choices (Matthyssens & Bulte, 1994). Suppliers seldom take a proactive role in initiating or implementing a supplier-customer relationship (Bertrand, 1986). Rather they concentrate on complying with LEs' requirements in order to remain in the shrinking LEs' supplier base.

The second view point favors SMEs in providing better MC. This study speculates that because SMEs lack power to initiate supply chain relationships, they choose to form strategic alliances with customers and suppliers rather than being aggressive. Several studies report that SMEs gain significant benefits of closer customer-supplier relationships (Kalwani & Narayandas, 1995; Giunipero & Brewer, 1993; Akacum & Dale, 1995). Research by Bradley, Meyer, & Gao (2006) shows that the SME's attitude toward supplier-customer relationships may enhance the longevity of the relationship, the strength of the supplier-customer bonds, the number of its supplier-customer relationship customers, and the likelihood of winning new customers aboard. Although SMEs might not be able to influence the suppliers and customers to implement systems that enhance the process of MC, achieving higher levels of MC is possible. Because of being part of small supply chains, SMEs are able to devote resources to identify customer needs and work closely with suppliers to fine tune products to match those needs. Suppliers are willing to work with SMEs as opposed to LEs because they have a sense of security in sustaining their supplier-customer relationship. Working with SMEs, customers also enjoy the sense of commitment and fast response time. SMEs are able to offer a greatly detailed product that is customized to fit the customer needs.

There is no definite answer to this paradox; however, this study may shed some light on the issues regarding:

- (1) Is the level of MC-driven performance different for SMEs than for LEs?
- (2) Is the extent of supply chain relationships-driven MC different in SMEs compared to LEs?
- (3) Is the extent of supply chain relationships-driven performance different in SMEs compared to LEs?

Figure 1 provides visualized depiction of these research questions.

Although SMEs might not be able to influence supply chain systems as a whole, their participation in SCI processes is crucial for the success of a given supply chain given that they are supporters of LEs. Therefore; understanding how managers from SMEs and LEs perceive differently on the issues of supply chain relationships, MC, and organization performance may shed some light for managers to adjust their integration strategies appropriately. This study will contribute to the research and practice in the areas of MC because of being the first that takes into account the differences between SMEs and LEs on issues regarding supply chain relationships, MC, and OP. Understanding the supply chain relationships concept is important to the survival of companies that implement MC as well as understanding differences between SMEs and LEs which may help firms choose appropriate strategies to implement based on their environment.

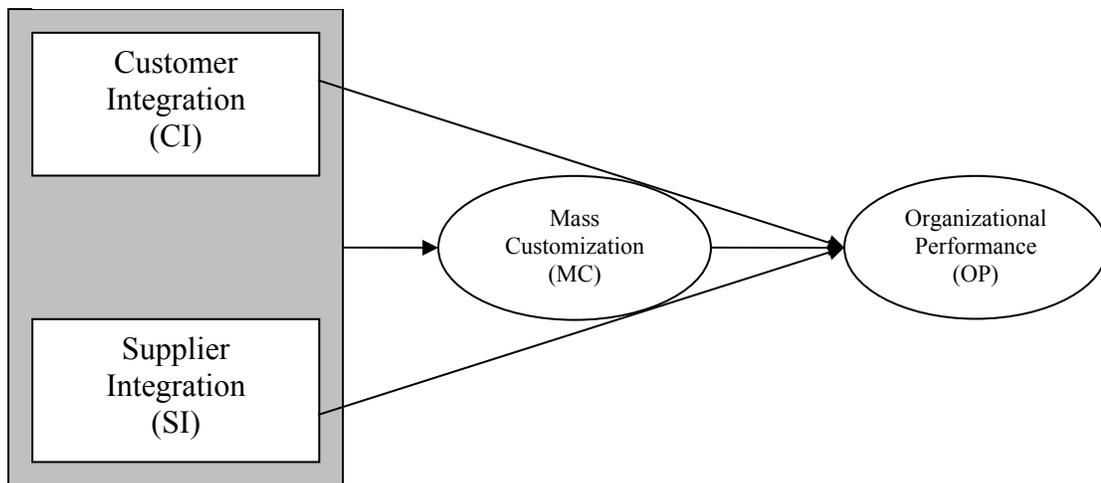
2. THEORETICAL FRAMEWORK

A theoretical framework can be formulated based on an extended literature review. Lau (1995) states that MC may be the basis for the next “industrial revolution” as it encourages and enables firms to design and produce specialized products on a large scale without sacrificing efficiency. Pine (1993), Tu et al. (2001), and others claim that MC is the ability to design, produce, and deliver products quickly to meet specific customer needs at prices close to those of traditional mass production. The foundation of MC is the ability to achieve customer responsiveness, cost efficiency, and high volume production, simultaneously.

Researchers suggest that MC is possible because of the use of such technologies as flexible manufacturing systems, modular product structures, and the Internet to reduce the tradeoffs between variety and productivity and provide transparent communications between a firm and its trading partners (Ahlstrom and Westbrook, 1999; Jiao and Tseng, 1996; Tu et al., 2001). However, the current literature does not provide an explanation for the missing link regarding supply chain relationships a central firm has with its trading partners both upstream and downstream (e.g., supplier integration and customer integration). This paper argues that the success of MC is not from the central firm and its customers’ relationship alone. Rather it is largely dependent on the central firm’s effectiveness at fully utilizing its supply chain potential. Effective supply chain relationships enhance transparent communication, which is a key to a successful MC because information flows seamlessly from one supply chain entity to the next. Figure 1 illustrates that MC may be affected by the firm’s ability to build supply chain relationships with its trading partners (suppliers and customers). Zipkin (2001) argues that a firm must interact with its customers to gather specific information so it can define and transform customer expectations into product specifications. Simultaneously, a firm must communicate and coordinate activities with its suppliers, so they can respond quickly and effectively to the needs

of the ultimate customer (Petersen et al., 2005a; Petersen et al., 2005b; Sanders, 2005; Sanders and Premus, 2005). By developing enterprise-wide information systems that provide a seamless integration of data flows between the central firm and its trading partners, firms make better decisions. They participate in an integrated process built on cooperation and co-creation which results in a high degree of integration (Piller et al., 2004).

FIGURE 1: Supply Chain Relationships and Mass Customization Framework



The front-end of the framework explains a supply chain relationships construct. This study uses customer integration (CI) and supplier integration (SI) to measure supply chain relationships with the firm. The instruments for CI and SI were modified from previous studies to fit within the new context (Narasimhan and Kim, 2002; Frohlich and Westbrook, 2002; Frohlich, 2002). The supply chain relationships construct represents the extent to which a firm lets customers and suppliers take part in its supply chain activities and processes. In the supply chain context, both customers and suppliers are from all tiers in a supply chain including both industrial and individual entities. Customer integration (CI) can be defined as the extent to which a customer takes part in activities and processes that had been in the domain of a firm in a form of industrial value creation (Wikstrom 1996). Customer integration is assessing customer needs and tailoring internal activities to fulfill them. (Koufteros et al., 2005) As firms get to know their customers better and become committed to understanding and meeting their needs, a strong bond is forged. Integration ensures that the voice of the customer plays a vital role in the firm's innovative process. Supplier integration (SI) can be defined as the extent to which suppliers take part in activities and processes that had been in the domain of a firm in a form of cooperative relationship. SI is characterized by a long-term commitment among the collaborators involving open communication and mutual trust. Supplier partnerships involve participants early in the product life cycle; thus ensuring early supplier involvement in product design and access to superior supplier technologies (Narasimhan and Das, 1999; Petersen et al., 2005a; Petersen et al., 2005b).

The middle of the frame shows the MC construct as the firm's ability to quickly produce customized products on a large scale at costs comparable to traditional non-customized mass-produced products. (Sophie Lee et al., 2000; Boynton et al., 1993; Kotler, 1989; Lau, 1995; Pine,

1993) An organization's MC is responsively, cost effectively producing large quantities of differentiated products. Based on a thorough review of MC research (Kotha, 1995, 1996; Duray et al., 2000; Silveira et al., 2001; Tu et al., 2001; Tu et al., 2004), MC in this study is a collective outcome measure adapted from previous studies. In this study, MC is defined as the ability to produce varieties of customized products quickly, on a large scale and at a cost comparable to mass-production through technical and managerial innovations.

The back-end of the framework shows the organizational performance construct. Organizational performance (OP) refers to the ability of a firm to fulfill its market and financial goals. The OP construct consists of customer retention rate, sales growth, return on investment, production throughput times, and overall competitive position, which are comparable to the measurement used in equivalent studies (Wisner, 2003; Rosenzweig et al., 2003; Frohlich, 2002; Narasimhan and Kim, 2002).

Table 1 provides a definition for each variable in Figure 1 as well as important references. The following sections discuss these variables and propose and support the hypotheses illustrated in the framework.

TABLE 1: Definition and References for Customer Integration, Supplier Integration, and Mass Customization

Variable	Definition	References
Customer Integration	Customer integration is the extent to which a customer takes part in activities and processes that had been in the domain of a firm in a form of industrial value creation.	Koufteros et al., 2005; Kim and Narasimhan, 2002; Narasimhan and Kim, 2002; Narasimhan and Jayaram, 1998; Narasimhan and Das, 1999; Frohlich and Westbrook, 2001; Frohlich and Westbrook, 2002; Frohlich, 2002; Wikstrom, 1996; Zipkin, 2001.
Supplier Integration	Supplier integration can be defined as the extent to which suppliers take part in activities and processes that had been in the domain of a firm in a form of cooperative relationship.	Piller et al., 2004; Sanders, 2005; Sanders and Premus, 2005; Tracey et al., 1999; Narasimhan and Das, 1999; Narasimhan and Jayaram, 1998; Kim and Narasimhan, 2002; Narasimhan and Kim, 2002; Petersen et al., 2005a; Petersen et al., 2005b; Johnson, 1999; Frohlich and Westbrook, 2001; Frohlich and Westbrook, 2002; Frohlich, 2002.
Mass Customization	Mass customization is the ability of a firm to produce a variety of customized products quickly, on a large scale, and at a cost of comparable to mass production	Pine, 1993; Pine, 1993; Tseng and Jiao, 2001; Piller, 2003; Frank and Piller, 2003; O'Grady, 1999; Sophie Lee et al., 2000; Lau, 1995; Tu et al., 2001.
Firm Performance	The ability of a firm to fulfill its market and financial goals.	Yamin et al., 1999; Frohlich, 2002; Narasimhan and Kim, 2002; Wisner, 2003; Rosenzweig et al, 2003; Tegarden et al., 2005.

3. HYPOTHESES DEVELOPMENT

3.1. Supply Chain Relationships in SMEs vs LEs

Numerous SCM studies have found that supply chain relationships affect a firm's levels of mass customization. Unfortunately, limited research exploring the subject exists from the perspective of SMEs vs LEs. This study contends that LEs have been originators at initiating and implementing supplier-customer relationships through the formation of supply chain tiers to guarantee their having enough purchasing muscle to force suppliers to adopt mass customization practices as a contractual condition (Harrison, 1992; Blenckhorn & Noon, 1990; O'Neal & Bertrand, 1991; Sinclair, Hunter, & Beaumont, 1996; Lascelles & Dale, 1989). With stable revenue and profit sources LEs can more easily justify implementing costly supply chain systems to enhance mass customization. For major original equipment manufacturers (OEMs), for example, establishing a supplier-customer relationship provides a MC advantage by reducing the overall cost of the final product (Bradley, Meyer, & Gao, 2006). Dilts and Prough (1989) observed that SMEs often face severe resource constraints, lack managerial expertise, and tend to pursue less aggressive customization options when offering products to customers. As a result, many SMEs may not have internal supply chain foundations upon which supplier integration strategies and processes can be based (Wagner, 2003). From this observation, the following hypothesis can be drawn.

H1: *LEs have a higher level of SCR-mass customization relationships than SMEs*

Since SME supply chains are much simpler, fewer and shorter, the process of collaborating and sharing information across the supply chain is much simpler than that of LEs. Unlike LEs, SMEs avoid using distribution centers or wholesalers. Instead, they usually deal with retailers, or, in many cases, directly with end-customers. The practice might help SMEs strengthen their relationships with customers (Morrissey and Pittaway, 2006); however, LEs tend to build stronger relationship with customers because they can offer better overall benefits to customers, which eventually will help them reduce overhead and improve operational effectiveness (Kalwani & Narayandas, 1995), increase sales volume, longer-term business agreements, and prompter payments (Giunipero & Brewer, 1993; Akacum & Dale, 1995).

LEs appear to develop stronger relationships with suppliers, enabling them to procure quality goods and services at lower cost. Shin et al. (2000) and Petersen et al. (2005) reported that improvements in supplier relations significantly improved delivery and quality of goods and services and financial performance. LEs usually prefer multi-tier suppliers in their supply chain and close integration is a key to their success. Compared to SMEs, LEs have capabilities to build long-term relationships with many critical suppliers in the industry due to the high volume and value of purchases. Having strong financial resources and IT capabilities also helps to strengthen this relationship. Wal-Mart has deployed the RetailLink System to integrate their internal system with all of their supplier systems in order to share all operating product development and inventory levels information. These discussions lead to the following hypotheses.

H2: *LEs have a higher level of customer integration (CI)-operational performance relationship than SMEs*

H3: *LEs have a higher level of supplier integration (SI)-operational performance relationship than SMEs*

3.2. Mass Customization in SMEs VS LEs

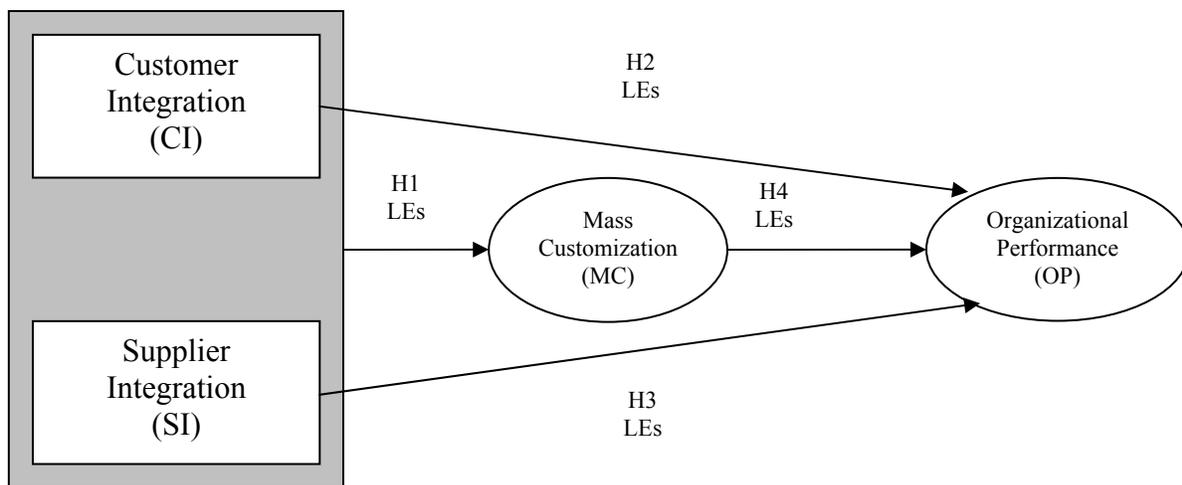
Morrissey & Pittaway (2006) revealed that the basic disadvantage for SMEs is their smaller size and lack of power when trying to offer MC to customers. Mudambi et al. (2004) confirmed that size asymmetry was a determining factor affecting the levels of negotiation between a purchasing firm and its suppliers. Ultimately LEs were found being able to dictate their preferred degree of closeness in their relationship with their smaller customers, and were also able to negotiate in the higher level of quality and detailed specifications from the suppliers thus benefiting more from the mass customization. Scully and Fawcett (1994) conducted a survey of 500 US firms to compare and contrast International Sourcing (IS) activities between SMEs and LEs and confirmed that SMEs were very limited in expanding their IS capabilities to support mass customization. Although some SMEs realized the benefits of such capabilities, they were reluctant to do so.

Regarding the purchasing power, Axelsson & Larsson (2002) asserted that, irrespective of the source, power can result in compliance and can drive the adoption of new practices. LEs can force suppliers to expand their envelope to adopt new systems which enhance the mass customization process. In this position dominant buyers are able to make demands, not only for the deliveries and quality of the product, but for sake of mass customization (Holmlund and Kock, 1996; Sauders, 1997). The confirmation from these studies leads to the following hypothesis:

H4: *LEs have a higher level of mass customization-organization performance relationship than SMEs*

Figure 2 shows the updated framework in the hypothesized format.

FIGURE 2: Supply Chain Relationships and Mass Customization in SMEs VS LEs Framework



4. RESEARCH METHODOLOGY

Instrument development for customer integration, supplier integration, mass customization, and organizational performance constructs was carried out in three phases: (1) item generation, (2) pilot study, and (3) large-scale data analysis. An extensive literature review was conducted to identify the domain of the major constructs. Based on theory development and a literature review, construct definitions and initial items were generated. Next, a pilot study was conducted three times using the Q-sort method. Analysis of inter-rater agreement helped to identify weaknesses in construct definitions as well as bad items. Third, a large-scale data set was collected and analyzed to validate the instruments and test the model.

4.1. Item Generation and Pilot study

A list of initial items for each construct was generated based on theory development and a comprehensive literature review. The number of items used in each category was 6 customer integration, 6 supplier integration, 9 MC, and 5 organizational performance. Scales for the items were five-point Likert-type scales where 1 = “Strongly Disagree”, 2 = “Disagree”, 3 = “Neutral”, 4 = “Agree”, 5 = “Strongly Agree”, and NA = “Not Applicable, or Do Not Know”. Items for the various constructs were reviewed by five academicians and re-evaluated through structured interviews with two practitioners to check the relevance of each construct’s definition and clarify wordings. Based on the feedback from the academicians and practitioners, redundant and ambiguous items were either modified or eliminated. New items were added when necessary. A pilot study was conducted three times using the Q-sort method; however, the results are not shown here because of limited space. Interested readers may seek the pilot results directly from the authors. A confirmatory factor analysis (CFA) using structural equation modeling method - AMOS version 16 was conducted to refine the measurement models. Tables 2, 3, and 4 list the items shown in the final measurement models. The asterisk * marks the items that were used in the large scale data analysis.

TABLE 2: Items for Customer Integration and Supplier Integration Constructs

Customer Integration (CI)	
CI1	The willingness of customers to share their market demands *
CI2	The participation level of customers in product development processes *
CI3	The participation level of customers in finished goods distribution processes *
CI4	The level of customer involvement in preparing business plans *
CI5	The extent of follow-up with customers for feedbacks *
CI6	The participation level of customers in manufacturing processes *
Supplier Integration (SI)	
SI1	The participation level of suppliers in manufacturing processes *
SI2	The participation level of suppliers in production planning processes *
SI3	The participation level of suppliers in product development processes *
SI4	The participation level of suppliers in logistics processes *
SI5	The level of cross-over of activities between our firm and our suppliers *

SI6	The level of supplier involvement in preparing our business plans *
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TABLE 3: Items for Mass Customization Construct

MC1	Our capability of customizing products at low cost is *
MC2	Our capability of customizing products on a large scale is *
MC3	Our capability of translating customer requirements into technical designs quickly is *
MC4	Our capability of adding product variety without increasing cost is *
MC5	Our capability of customizing products while maintaining a large volume is *
MC6	Our capability of setting up for a different product a low cost is *
MC7	Our capability of responding to customization requirements quickly is
MC8	Our capability of adding product variety without sacrificing overall production volume is
MC9	Our capability of changeover to a different product quickly is

TABLE 4: Items for Organizational Performance Construct

OP1	Customer retention rate. *
OP2	Sales growth. *
OP3	Return on investment. *
OP4	Production throughput times. *
OP5	Overall competitive position. *

4.2. Survey Methods, Data Collection, and Sample Characteristics

A cross-sectional self-administered mail survey was conducted. The sampling frame was obtained from the Society of Manufacturing Engineers (SME). Of 4,000 mailed questionnaires, 579 did not reach the targeted respondents because of bad addresses. A large number of respondents (235) wrote a refusal on their returned survey and 3,171 questionnaires did not return surveys. In addition, 14 questionnaires were returned empty. Therefore, the number of complete and usable responses was 220, representing a response rate of 6.94% (calculated as 220/3,171).

5. LARGE SCALE INSTRUMENT ASSESSMENT METHODOLOGY

Reliability and validity assessments were based on 220 responses. Table 5 shows the results for unidimensionality, reliability, and convergent validity for customer integration, supplier integration, mass customization, and organizational performance. Cronbach’s alpha was used to assess the reliability. Values of 0.80 and higher are considered acceptable for basic research (Cronbach, 1951; Nunnally, 1978).

TABLE 5: Model Fit Indices and Reliabilities for CI, SI, MC, AND OP

Constructs	Sub-Constructs	No. of items	GFI	AGFI	RMSEA	Cronbach Alpha
Supply Chain Relationships	Customer integration (CI)	6	0.99	0.98	0.00	0.83
	Supplier integration (SI)	6	0.97	0.93	0.09	0.93

MC	Mass customization (MC)	6	0.96	0.92	0.09	0.88
OP	Organizational Performance (OP)	5	0.99	0.96	0.05	0.84

6. HYPOTHESES TESTING

To test hypotheses, linear regression analysis is applied. The following show the regression models tested for each hypothesis.

$$MC = \beta_0 + \beta_1 SCR * S + r \quad (H1)$$

$$OP = \beta_0 + \beta_1 CI * S + r \quad (H2)$$

$$OP = \beta_0 + \beta_1 SI * S + r \quad (H3)$$

$$OP = \beta_0 + \beta_1 MC * S + r \quad (H4)$$

Where:

- MC = mass customization
- OP = operation performance
- SCR = supply chain relationships
- SI = supplier integration
- CI = customer integration
- S = the size of companies
- r = the residual
- β_0 and β_1 = intercept and slopes

The size of companies (S) is a categorical item representing the number of employees in the company. This variable was originally categorized into six stratifications, namely: 1-50 employees; 51-100 employees; 101-250 employees; 251-500 employees; 501-1000 employees; and over 1000 employees. It is then coded into nominal scale variables with 1 value representing SMEs (the number of employees less than or equal to 500 employees) and 0 value representing LEs (the number of employees more than 500 employees).

7. RESULTS

All hypotheses were tested using linear regression methodology. Table 6 shows the results of the hypothesis tests.

TABLE 6: Hypotheses Testing Results

Interaction effects of S and SCR on MC (H1)					
<i>Variables</i>	<i>Coefficient</i>	<i>Std</i>	<i>t-value</i>	<i>Sig</i>	<i>Supported</i>
β_0	2.800	0.126	22.301	0.0001	H1 is supported.
SCR*S	0.194	0.044	4.365	0.0001	
Interaction effects of S and CI on OP (H2)					
<i>Variables</i>	<i>Coefficient</i>	<i>Std</i>	<i>t-value</i>		<i>Supported</i>
β_0	3.482	0.109	32.081	0.0001	H2 is supported.
CI*S	0.087	0.034	2.602	.01	

Interaction effects of S and SI on OP (H3)					
<i>Variables</i>	<i>Coefficient</i>	<i>Std</i>	<i>t-value</i>		<i>Supported</i>
β_0	3.485	0.100	34.754	0.0001	H3 is supported.
SI*S	0.108	0.038	2.838	0.005	
Interaction effects of S and MC on OP (H4)					
<i>Variables</i>	<i>Coefficient</i>	<i>Std</i>	<i>t-value</i>		<i>Supported</i>
β_0	3.419	0.105	32.488	0.0001	H4 is supported.
MC*S	0.111	0.033	3.362	0.001	

Regarding MC as a dependent variable, the results (Table 6) suggest that the level of MC differs significantly between SMEs and LEs and LEs are likely to have higher MC than SMEs ($t = 4.365$). The obtained results support hypothesis 1 that states LEs have a higher level of SCR-MC relationship than SMEs.

With OP as a dependent variable, the regression results support hypothesis 2 that states that LEs have a higher level of CI than SMEs ($t = 2.602$). The results imply that LEs can form a better relationship with customers than SMEs can. The results also show that LEs are likely to have better SI than SMEs ($t = 2.838$); therefore, the results support hypothesis 3, which states that LEs have a higher level of SI than SMEs.

With regard to the relationship between MC and OP, the results support hypothesis 4 ($t = 3.362$), which states that LEs have a higher level of MC than SMEs.

8. DISCUSSION AND CONCLUSIONS

This research contributes to the literature in supply chain management and SME research. It suggests that three main issues are important: (1) supply chain integration, (2) the size of companies (SMEs vs. LEs), and (3) the level of mass customization (MC). The results in this study reinforce important roles of SCI previously reported in the literature (Ragatz et al., 1997; Simchi-Levi et al., 2003; Narasimhan and Kim, 2002; Vickery et al., 2003). Efficient SCI leads to the intensification of key practical resources and subsequently drive much more significant performance improvement by enabling the sharing of special resources and technological knowledge for particular supply chain capabilities from supply chain partners. However, the previous studies have focused on SCI in general and discarded issues regarding the differences between SMEs and LEs. This study emphasizes the importance of SMEs in helping LEs to reach potential performances. From the results, the following managerial implications can be drawn.

The contributions of this research arise from combining the three research directions ‘SCR’, ‘SMEs vs. LEs’, and ‘Mass Customization’. This study emphasizes the differences between SMEs and LEs in contributing to organizational performance (OP), overall supply chain relationship (SCR), upstream integration (SI), downstream integration (CI) in a supply chain, and the extent to which the organization adopts mass customization (MC). The results prove that LEs perform better than SMEs in all dimensions (e.g., OP, SCR, SI, CI, MC). The level of SCR tends

to increase with the size of organizations. Two implications could be drawn from this finding. First, larger organizations view supply chain integration as a strategically important tool to compete successfully in the market place. Firms such as Wal-Mart and GM spent billions of dollars implementing enterprise resource planning system (SAP) to guarantee transparent communication. By doing so, they can achieve accurate transactions, highly efficient processes, high production throughput time, and high customer retention rate. Second, LEs also have much needed resources and high bargaining power to implement supply chain systems. Conversely, SMEs are less likely to view SCR as an important part of their businesses. This is not surprising because SCR is a capital intensive approach. As a result, SMEs have little or no power to influence supply chain systems and lack resources to implement supply chain integration projects. This hurts not only SMEs, but also LEs because most LEs need SMEs to supply their products. Therefore, LEs might take a larger role to help SMEs to achieve full participation in supply chain systems. After all, supply chain integration is motivated by the recognition of interdependency between suppliers and customers.

LEs also show better supplier integration and customer integration than SMEs. According to Zipkin (1991), LEs are likely to initiate the relationship with suppliers based on arms' length relationships (the buying power LEs have over their suppliers). By building long-term relationships with suppliers, LEs are moving from arms' length relationships toward strategic supplier relationships or 'the supply base' (Jayaram, Kannan, and Tan, 2004). Examples include Intel, Proctor and Gamble, Hewlett Packard, and Wal-Mart. Wal-Mart, for example, provides a good illustration of a firm that has built structural mechanisms that help add key supply chain members such as Proctor and Gamble to its supply base located close to Wal-Mart's headquarters in Bentonville, Arkansas. In an empirical study of purchasing managers in North American manufacturing firms, Handfield and Bechtel (2002) found that efforts by the buying firm to build trust resulted in more responsive behavior by suppliers even when buyers had no power over suppliers.

In addition, the results also show that LEs are likely to be more successful in building relationships with their customers. Recent studies showed that LEs are more likely to form tight relationships with their customers because they are able to invest in high-end technologies that help them understand and better serve their customers (Sophie Lee et al., 2000; Sinclair et al., 1996). With high-end technologies, large firms such as Levi's, Nike, and Dell are able to enhance manufacturing processes to match the customer needs. The applications of technologies can enhance efficiency and precision of manufacturing equipment or facilitate the application of advanced manufacturing technology (AMT) and flexible manufacturing (Ho, 1996).

The next issue addressed in this study regards the level of mass customization. The results show definite advantages of the larger firms in offering mass customization to customers. This is consistent with previous studies (Choi and Krause, 2006; Malhotra and Grover, 2003; Gibbons, 2005). According to the resource based theory, LEs have strong financial resources and IT capabilities to enforce the stability of the supply chain. Since SCI is capital intensive, it is likely that larger size firms are likely to have better infrastructures that support the integration initiatives. It has been reported in the literature that LEs can expand their large size supply chains without losing power by enforcing the adoption of information technologies. Lee, Padmanabhan, and Whang (1997a, 1997b, 2004) suggest that large firms can achieve higher level of integration

because they can afford technology implementations such as VMI (vendor managed inventory), CMI (co-managed inventory), JMI (jointly-managed inventory), CPFR (collaborative planning, forecasting, and replenishment), collaborative commerce, and CTM (collaborative transport management). With the help of communication technologies, a virtual supply chain is able to control all aspects of supply, production, and distribution through contracts and franchise arrangements (Schroeder, 2007) and bring both higher quality and lower costs to the customer (Larson and Kulchitsky, 1998). IT makes it virtually possible for buying firms to manage the large number of intermediaries in a supply chain virtually everywhere. Prahalad and Hamel (1994) and Hammer (2001) suggest that LEs such as GM, Ford, and Wal-Mart can achieve effective vertical integration when each participant concentrates on processes it performs best, leaving the rest to others. The ideal situation is that the entire process across the supply chain is designed, managed, and coordinated as a unit.

Limitations of the study

While the current research made significant contributions from both a theoretical and practical point of view, it also has limitations. First, because of the limited number of observations (220), the revalidation of constructs was not carried out in this research. This needs to be addressed in future research. New mailing lists and research methods may be applied to improve the response rate.

Second, Table 3 shows that only 14 percent of the respondents represent top management positions in the form of director or president. This group consists of the most knowledgeable people who can answer questions regarding strategic integration issues. Because of the small number in this group, the extent of supply chain integration found in this study might be skewed downward. This leads to an interesting research question. To what extent does each group of respondents contribute to the total extent of supply chain integration? However, this is beyond the scope of the current study.

Additionally, in this research, individual respondents (manufacturing managers and top management) in an organization were asked to respond to the integration issue dealing with all the participants across the organizations. However, no person in an organization is in charge of all processes across the organization. For example, manufacturing managers are mainly responsible for procuring raw materials and parts and managing production and, therefore, may not be in an appropriate position to answer the supplier/customer-related questions. The main area of manufacturing managers is production and they may not have thorough knowledge of their suppliers, customers, and firm performance. Therefore, the use of single respondent responses may generate some measurement inaccuracy. Future research should seek to utilize multiple respondents from each participating organization as an effort to enhance reliability of research findings. In addition, the study can be expanded to include customers as well as suppliers.

Furthermore, the response rate of 7 percent, even though comparable to similar studies, is considered low. The length of the survey instrument most likely contributed to the low response rate. Because of the time constraints, top management, manufacturing managers and executives are unlikely to participate in the survey. This issue can be addressed in future research by

reducing the number of items in the questionnaire and focusing on areas requiring further clarification.

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