International Journal of Applied Business and Management Sciences
Vol. 3, No. 2, 2022, pp. 239-265
https://DOI: 10.47509/IJABMS.2022.v03i02.06

ARF INDIA
Academic Open Access Publishing
www.arfjournals.com

IMPLEMENTATION OF MASS CUSTOMIZATION IN INDIA

Manoj Kumar

Professor, Management Department Management Education & Research Institute, Janakpuri Institutional Area, New Delhi, Delhi 110058, India. E-mail: manoj.kumar@meri.edu.in

Article History
Received : 13 October 2022; Revised : 06 November 2022; Accepted : 19 November 2022; Published : 29 December 2022

Abstract: Mass customization (MC) has been considered as an important competitive tool to increase the performances of manufacturers all over the world. More and more studies have been exploring the essence of MC and identifying the logic for effective implementation. Based on the theory of complementary assets, this study investigates relationships among MC practices (elicitation, process flexibility technology, and logistics) and their joint effects on financial performance. Simultaneous equation modeling and hierarchical regression analysis are applied to test the hypotheses using data collected from a large-scale survey in India. The results show that the MC practices positively affect each other, and that the interactions among the MC practices positively influence a firm's financial performance, indicating that the complementary adoption of MC practices is important. This study indicates that successful MC implementation requires the simultaneous deployment of elicitation, process flexibility technology, and logistics practices.

Keywords: Mass Customization, Complementary assets, Financial performance, India.

1. INTRODUCTION

The adoption of mass customization (MC) demands manufacturers to apply technologies and practices to develop an integrated manufacturing system that provides a high volume of products for a relatively large market without substantial tradeoffs in cost, delivery, and quality (Pine 2013; Tseng and Jiao 2021; Tu *et al.* 2014). One of the distinguishing features of MC is that it enables manufacturers to match their offerings with the rapidly changing environment, which is characterized by heterogeneity in customer demands,

To cite this paper:
Manoj Kumar (2022). Implementation of Mass Customization in India. *International Journal of Applied Business and Management Sciences*. 3(2), 239-265. *https://DOI: 10.47509/IJABMS.2022.v03i01.06*

accelerated new product development, and shortened product life cycles (Lai *et al.* 2021; Tu *et al.* 2017; Alfnes and Strandhagen 2020). Moreover, it also enables manufacturers to provide customized solutions in innovative ways, resulting in an increase in performance (van Hoek *et al*. 2018; Da Silveira *et al.* 2021; Liu *et al.* 2020; Zhang *et al.* 2021). The complexity and variety associated with MC demands manufacturers to develop an integrated system with unique operational capabilities for aligning manufacturing with customer needs (Salvador *et al.* 2019; Zipkin 2021). Hence, inefficient operations have been viewed as a significant hindrance factor for MC implementation (Salvador *et al* 2019; Rungtusanatham and Salvador 2018). Previous large-scale empirical MC studies have addressed what it is (Duray *et al.* 2020), its impact on performances (Zhang *et al.* 2013), and the effects of manufacturing practices (Kristal *et al.* 2020; Peng *et al.* 2021; Tu *et al.* 2014), organizational design (Huang *et al.* 2018), supply chain management (Huang *et al.* 2018; Lai *et al.* 2018; Liu and Deitz 2018), and environmental uncertainty (Liu *et al.* 2021; Liu *et al.* 2020) on MC capabilities. However, besides conceptual frameworks and case studies (e.g., Salvador *et al.* 2019; Zipkin 2021; Zhang and Chen 2016; Rungtusanatham and Salvador 2018), there is limited empirical evidence on the relationships among the MC practices.

Based on observations of successful mass customizers, Zipkin (2021) and Berman (2020) proposed that an MC system includes three key practices: elicitation of customer needs and wants, process flexibility technology, and integrated logistics. These practices cover the value chain of market analysis, product/process design, production, and delivery. Hence, this framework provides a holistic and systematic perspective to investigate MC implementation. The theory of complementary assets (TCA) indicates the complementarities among firms' practices play very important roles in developing operational capabilities (Milgrom and Roberts 2016; Teece *et al.* 2017). It argues that the effectiveness and efficiency of manufacturing practices are significantly influenced by the complementary assets in terms of other practices or infrastructure (Swink and Nair 2017; Teece 2016). Hence, designing operations systems using the complementary approach can fully realize the potentials of manufacturing practices. The objective of this study is to investigate the tactical issues of MC implementation by empirically investigating the relationships among MC practices and their joint effects on firm's financial performance.

The rest of the paper is organized as follows. We first review the literature related to TCA and MC practices and derive research hypotheses, followed by a description of the methodology and the results of empirical analyses.

Theoretical contributions and practical implications of the results are discussed in Section 5. Section 6 concludes the study with key findings, limitations, and future research directions.

2. THEORETICAL BACKGROUND AND RESEARCH HYPOTHESES

Theory of complementary assets

The concept of complementary assets is introduced by economic theorists to explain the underlying logic behind the adoption of various practices (Milgrom and Roberts 2016). Complementary assets refer to the resources required to capture the benefits associated with a strategy or a technology (Teece 2018). In particular, assets or practices are mutually complementary "if doing (more of) any one of them increases the returns to doing (more of) the others" (Milgrom and Roberts 2016, p. 181). TCA has been widely applied in the strategic management field to explain corporate strategy formation (Teece *et al.* 2017) and the principal beneficiaries of an innovation (Teece 2016). Empirically, researchers have found that complementary assets are essential for technology exploitation through firm formation (Shane 2021), firm growth (Lai *et al.* 2021), and alliance development (Colombo *et al.* 2016).

Teece (2016) further differentiated three types of complementary assets: generic assets are general-purpose assets that do not need to be customized; specialized assets have a unilateral dependence; and co-specialized assets have a bilateral dependence. Compared with generic and specific assets, the value of a co-specialized asset is a function of its use in conjunction with other particular assets (Teece 2018; 2017). Co-specialization gives rise to "synergy" among the complementary activities and joint use is value enhancing, with the total being more than the sum of the parts (Rothaermel and Hill 2015). Moreover, co-specialized assets can form an integrated system, which is idiosyncratic and cannot be easily sourced from market (Teece 2017). Empirically, researchers have found that co-specification plays a crucial role in realizing the business value of "best practices" and in explaining how manufacturing practices contribute to firm performances. For example, Christmann (2020) found that the capabilities for process innovation and implementation are complementary assets in moderating the effects of environmental management practices. Swink and Nair (2017) investigated the role of complementary assets in explaining how advanced manufacturing technology adoption contributes to manufacturing performance. Benner and Veloso (2018) discovered that firms with a very narrow or very broad technological focus have fewer opportunities for complementary interactions, thus benefitting less from ISO 9000 practices. Morgan *et al.* (2019) found that market orientation and marketing capabilities are complementary assets that contribute to a firm's superior performance. Hence, to gain the competitive potentials embedded in manufacturing practices, firms need to establish a prior position in certain complementary assets and resources required to capture the benefits (Teece 2018). Through systematic implementation and integration, complementary assets enable a firm to develop valuable, rare, inimitable, and non-substitutable resources, which result in sustainable competitive advantages (Barney 2021; Teece *et al.* 2017).

Mass Customization Practices

With the aid of various technologies and manufacturing practices, MC aims at designing, producing, marketing, and delivering customized products and services at a reasonable price (Pine 2013). Researchers have empirically identified many best practices or enablers for MC implementation, such as customer learning (Huang *et al.* 2017), customer focus (Kristal *et al.* 2020; Liu and Deitz 2021), customer involvement (Duray *et al.* 2020; Lai *et al.* 2021), supplier involvement (Liu *et al.* 2020), postponement (Yeung *et al*. 2017; Liu *et al.* 2020), supplier lead-time reduction (Tu *et al.* 2014; Liu and Deitz 2018), and information technologies (IT) (Peng *et al.* 2021). By proposing that a MC system should have three building blocks (i.e., elicitation, process flexibility technology, and logistics), Zipkin (2021) and Berman (2020) provide a holistic framework for developing a seamless and integrated MC system that connects these practices.

Elicitation refers to "a mechanism for interacting with the customer and obtaining specific information" (Zipkin 2021, p. 82). Information sharing routines, processes and tools enhance the effectiveness and efficiency of communications and knowledge acquisition from customers, which enable manufacturers to fully understand market changes and customer demands (Zhang and Huo 2021; Lai *et al.* 2018). Close contacts with customers help manufacturers to determine what customers really want (Da Silveira *et al.* 2021). In addition, partnership and trust oriented relationships with customers reduce barriers of knowledge transfer and learning (Wang *et al.* 2011; Yeung *et al.* 2019). Elicitation enables knowledge to flow freely between customers and manufacturers because it can reduce the costs, risks, conflicts, and bureaucratic delays associated with information transfer (Yeung *et al.* 2019). Relying on acquired customer knowledge, manufacturers can speed up decision process, reduce lead-time, improve product design flexibility, implement cost-efficient production, and facilitate initiatives for process improvements (Huang *et al.* 2018).

Process flexibility technology refers to the "production technology that fabricates the product according to the information" (Zipkin 2021, p. 82). Berman (2020) explained that it involves flexibility in both the design and manufacturing processes. Flexibility in design, which includes postponement and supply chain co-design, has been identified by many researchers as key MC practices (Duray *et al.* 2020; Huang *et al.* 2017; Kristal *et al.* 2020; Lai *et al.* 2021; Liu and Deitz 2021; Liu *et al.* 2020). Collaborative product design with suppliers and customers enables manufacturers to combine expertise and integrate resources from partners, which reduce total costs and time-to-market (Zhang and Huo 2021). Customer and supplier co-design enable manufacturers to incorporate partners' opinions and voices into manufacturing and apply their technological knowhow directly, which minimize the possibilities of design errors and result in effective production (Huang *et al.* 2018; Lai *et al.* 2021). Moreover, involving customers in the design stage also results in higher degrees of customization (Duray *et al.* 2020). This is because customer co-design helps a manufacturer to tailor market offerings to fully satisfy customer needs and expectations (Kristal *et al.* 2020; Liu and Deitz 2018). Supplier capability influences a manufacturer's flexibility in responding to customized demands (Tu *et al.* 2014). Hence, supplier co-design ensures that suppliers are able to deliver the desired materials and components, thus avoiding supply disruptions during the production process (Liu *et al.* 2020). Postponement enables a manufacturer to solve the contradictions between mass production and craft customization by carrying standard components and moving customization downstream as close to end customers' demand as possible (van Hoek 2021; Yeung *et al* 2017). It enables manufacturers to use the same components to fulfill customized demands by reconfiguring standard modules, which reduces customization and inventory costs, shortens cycle time and improves flexibility and responsiveness (Tu *et al* 2014; van Hoek 2021). Flexibility in manufacturing is achieved through the application of advanced manufacturing technologies (AMTs) which are fundamental to MC (Da Silveira *et al.* 2021; Peng *et al.* 2021). IT tools like CAD (computer aided design) and CAE (computer aided engineering) provide information processing capabilities supporting product design (Peng *et al.* 2021). IT-enabled manufacturing technologies, such as CAM (computer-aided manufacturing), CIM (computer integrated manufacturing), and

FMS (flexible manufacturing system), enhance manufacturing precision and process flexibility and remove barriers to product variety increase, thus enabling manufacturers to benefit from both economy of scale and scope (Da Silveira *et al.* 2021). Moreover, ERP (enterprise resource planning) improves planning and control by translating customer choices into manufacturing instructions quickly and efficiently, which speeds up decision making. Workflow management and collaborations are improved, which decreases process variability and increases flexibility (Swink and Nair 2017). Hence, AMTs not only manage the data as they are generated in the field but also automate planning and production, which enable fast and efficient manufacturing operations.

Logistics refers to "subsequent processing stages and distribution that are able to maintain the identity of each item and to deliver the right one to the right customer" (Zipkin 2021, p. 82). According to Berman (2020), it includes two components: a just-in-time (JIT) supply chain, which accelerates physical flow, and an integrated logistics information system (ILIS), which facilitates information flow. A JIT supply chain controls the timeliness of production and product delivery and eliminates unnecessary elements in production, resulting in higher production agility, lower cost, and shorter response time (Da Silveira *et al.* 2021; Tu *et al.* 2014). It enables a manufacturer to reduce lead times and to provide rapid, direct-to-customer delivery to customers (Zhang *et al.* 2021). A well-designed and well-executed JIT supply chain is also widely considered as a means to reduce the levels of raw materials, work-in-process, and finished goods inventory, resulting in lower production costs and fewer defects (Berman 2020). Hence, manufacturers become more responsive to customer demands, and can provide customized products more cost effectively due to better inventory management (Zhang *et al.* 2021; Lai *et al.* 2021). ILIS has been viewed as an important MC enabler because it connects raw material management, production, shipping, and sales in real-time and integrate data and enterprise applications (Da Silveira *et al.* 2021; Pine 2013). It can process a large amount of information related to production and logistics efficiently and allow integrated access to manufacturing-related data, which reduces information processing and exchange costs and streamlines information flows (Peng *et al.* 2021). An ILIS improves information transparency across the supply chain and provides direct links between functional departments, removing the barriers to internal coordination and joint decision making, thereby reducing operating costs and improving flexibility and asset efficiency (Zhang and Huo 2013; Peng *et al.* 2021).

Research hypotheses

Grounded on the TCA, the present study analyzes the complementary implementation of MC practices based on the framework proposed by Zipkin (2021) and Berman (2020). We argue that elicitation, process flexibility technology, and logistics are co-specialized assets. The implementation of MC practices will be positively influenced by each other and applying MC practices in a bundle will result in higher financial performance. By interacting and integrating with one another, the MC practices will form an integrated system that is generally valuable and difficult to imitate and can therefore be a source of competitive advantage (Milgrom and Roberts 2016; Teece 2017).

Manufacturers learn customer knowledge through elicitation. The process flexibility technology enables the manufacturers to translate customer choices gained from elicitation into product design features and manufacturing instructions (Huang *et al.* 2018; Zhang and Chen 2016). ILIS enables the manufacturers to process information more effectively and efficiently, which improves their abilities in learning from customers (Lai *et al.* 2021). JIT supply chain is an interface between manufacturers and customers. Good logistics practices can improve the image of a manufacturer in customers' mind, which reduces the costs and barriers in elicitation. In addition, logistics also increases the effectiveness of elicitation as it builds an infrastructure to improve the responsiveness of customer interactions (Berman 2020). Hence, the process flexibility technology and logistics build a foundation for acquiring customer knowledge (Lai *et al.* 2021). Therefore, we propose the following hypotheses:

H1a: Process flexibility technology positively affects elicitation.

H1b: Logistics positively affects elicitation.

The effectiveness of process flexibility technology depends on manufacturers' capabilities to capture rapidly changing customer demands and market trends quickly and accurately (Piller 2014). Elicitation enables the manufacturers to regularly access customer desires and adjust their operations accordingly, providing information inputs to the process flexibility technology (Liu and Deitz 2021). Accurate and reliable information about customers enhances the manufacturers' capabilities in designing products and processes, implementing changes in the manufacturing process to meet market demand quickly, and reducing the mismatch between customer requirements and production (Kristal *et al.* 2020). ILIS enables the manufacturers to process more information to execute these tasks precisely and timely (Peng *et al.* 2021). Through reducing waste and variance, JIT techniques improve the speed of material flows (Tu *et* *al.* 2017). Production processes can therefore receive parts and information whenever and wherever they are demanded. In this way, uncertainty is reduced and smoothness and flexibility of the production process is improved (Liu *et al.* 2020). Therefore, we propose the following hypotheses:

H1c: Elicitation positively affects process flexibility technology.

H1d: Logistics positively affects process flexibility technology.

To provide JIT delivery, logistics requires the information gained through elicitation to improve the flows of material and information along a supply chain (Berman 2020). Elicitation also enhances the quality and quantity of acquired information, which improves the efficiency and effectiveness of ILIS (Lai *et al.* 2021). Logistics requires flexible production processes to respond to demand changes quickly. If not, the JIT supply chain will cause great troubles to the whole operations as it keeps a very low level of inventory buffer (Da Silveira *et al.* 2021). Process flexibility technology enables automation and optimization of the designing, planning and manufacturing processes, which reduces the complexity and uncertainty in the manufacturing processes and improves the responsiveness of the whole supply chain (Liu *et al.* 2020). Moreover, elicitation and process flexibility technology also help manufacturers turn to "pull" based processes, which reduce finished goods inventory, total lead time and changeover costs (Zhang and Chen 2016). Therefore, we propose the following hypotheses:

H1e: Elicitation positively affects logistics.

H1f: Process flexibility technology positively affects logistics.

In a MC system, elicitation helps manufacturers to understand customer demands and acquire updated customer requirements (Zipkin 2021). Logistics establishes an efficient communication and transportation infrastructure for a supply chain (Berman, 2020). These two practices, combined with flexibility in design and manufacturing, can increase performances as the manufacturers can obtain knowledge of personalized needs in advance, respond to market demands quickly, and shorten delivery times (Duray *et al.* 2020; Huang *et al.* 2018; Kristal *et al.* 2020). Specifically, elicitation requires a good relationship between the manufacturer and customers to make the latter feel that they are treated well, which relies on high-level delivery services. The value of elicitation is realized by the logistics, which manages physical and information flows from suppliers to the customers. In addition, process flexibility technology enables the manufacturers to incorporate customers' information into the process and product design and manufacturing, which realize the value of customer knowledge (Kristal *et al.* 2020; Liu and Deitz 2021).

Process flexibility technology is internally focused, which means that customers may not be able to feel it directly. Thus, it requires logistics as an intermediary and hence its value is affected by the speed and efficiency of the delivery (Piller 2014). Particularly, JIT techniques reduce wastes, and ILIS processes and distributes the required information across the manufacturing process (Berman, 2020). By managing information and materials efficiently and effectively, both customers and internal employees can obtain their required information and products through one interface in real time. Therefore, the logistics practices provide infrastructural support for manufacturers' elicitation and process flexibility technology practices. Hence, these three practices form a connected manufacturing system, which gives the manufacturers competitive advantage by improving responsiveness, shortening lead times, increasing forecasting accuracy, and reducing obsolete inventory and stock outs, which leads to better financial performance (Zhang *et al.* 2021; Zipkin 2021). Thus, the implementation of all three MC practices can enhance the group effects, and the interactions of any two of the three practices are positively related to financial performance. As a performance-enhancing resource bundle, the manufacturer needs to match up relevant complementary practices within the MC system. Therefore, we propose the following hypotheses:

H2a: The interaction between elicitation and process flexibility technology positively influences a firm's financial performance.

H2b: The interaction between elicitation and logistics positively influences a firm's financial performance.

H2c: The interaction between process flexibility technology and logistics positively influences a firm's financial performance.

3. RESEARCH METHODOLOGY

Questionnaire design

The current study used large-scale mail survey as the research method. The items used to measure MC practices were based on Zhang *et al.* (2021). Elicitation was operationalized as relationship building, improvement in inter-organizational processes, and information sharing with customers. Process flexibility technology was operationalized as the application of flexibility in design (postponement and supply chain partner co-design), and AMTs (CAD/

CAE, CAM/CIM/FMS, and ERP) throughout the manufacturing process. Logistics was operationalized as the use of JIT practices throughout the supply chain and integrative management of logistics information. Financial performance was measured using three indicators: return on investment, return on sales, and market share (Vickery *et al.* 2013).

We also included four control variables in our analysis: city, industry type, firm size, and competitive strategy. As India is a very large country, the behaviors of companies in different areas may be affected by the regional economic and social environments (Zhao *et al.* 2016). We included Delhi- NCR region, that is, Delhi, Faridabad, and Gurgaon, in the analysis to counter this effect. The literature also reveals MC implementation is influenced by industry characteristics (Lai *et al.* 2021; Huang *et al.* 2018). Hence, we included five industries (i.e., food, textiles, machinery, plastics, and electronics) in the analysis to control this effect. In addition, large companies may have higher levels of MC practices because they are more likely to have additional resources (Huang *et al.* 2018; Liu *et al.* 2020). Thus, we controlled firm size effects using the number of employees as an indicator. Competitive strategy guides the decisions of manufacturers on processes, technologies, and manufacturing practices (Ward *et al.* 2016). Mass customizers aim at providing differentiated products/services at low cost (Pine 2013). Hence, they focus on multiple competitive priorities and both cost leadership and differentiation strategies will influence the adoption of MC practices. The items used to measure the two competitive strategies, cost leadership and differentiation, were extracted from Nayyar (2013) and Dess and Davis (2014). All measurement items were assessed using seven-point Likert scales, which are listed in Appendix I.

The original questionnaire was developed in English. The questionnaire was pilot-tested among more than 40 manufacturing managers from India to ensure its comprehensibility to the target Indian respondents.

Data collection

To test the proposed hypotheses, manufacturing firms were randomly from Delhi – NCR region: Delhi, Gurgaon, and Faridabad. To improve the response rate, we followed the approach of Frohlich (2019). A total of 3,187 companies were selected from the database of The Federation of Indian Chambers of Commerce & Industry (FICCI). Among them, 463 could not be contacted because the listed telephone number was incorrect or the company had moved or closed down. Among the remaining 2,724 companies, 614 agreed to participate and completed the questionnaire, which yielded a response rate of approximately 23%. Ten cases were excluded because of missing values. Table 1 shows the profile of the respondent companies.

Table 1 Sample profile

Annual Sales (in million Rs/-)		*Number of Employees*	
Below 5	14.4%	100 to 199	42.7%
5 to 10	18.2%	200 to 499	41.6%
10 to 30	34.8%	500 to 999	9.6%
30 to 50	11.1%	1000 to 4999	5.5%
50 to 100	9.9%	5000 or more	0.7%
100 to 250	4.8%	Total: 100%	
250 to 500	3.8%		
500 to 1000	1.3%		
Above 1000	1.7%		
Total: 100%			

We conducted our survey in India for two reasons. First, India represents an institutional context characterized by the lack of well-established legal frameworks to define intellectual property rights (Zhou and Poppo 2010). Although India's growing body of law is already sizable, the legal systems are still weak, and patent protection is either absent or ineffective (Pattison and Herron 2014). The lack of intellectual property protection in India has enabled widespread copyright infringement, making the protection of patents and trade secrets difficult (Luo 2017; Wang *et al.* 2011). Hence, Indian manufacturers tend to adopt established manufacturing programs and practices rather than invest on ground-breaking technologies. Second, although Indian manufacturers have become global manufacturing powerhouse, their competitive advantage lies in low-cost manufacturing and not in their technological capabilities (Jiang *et al.* 2017; Zhao *et al.* 2016). Many Indian manufacturers are transiting from mass production to MC because of the pressures from the changing business environments, including increasing material and labor costs, and decreasing foreign market demand caused by the recent financial crisis. Without knowledge and skill accumulation, they have to invest a lot if they want to have a technological edge, which is costly. Hence, they choose another development path by customizing and localizing imported technologies and achieving low-cost through operational and supply chain capabilities. Their customization mainly takes the form of application engineering and market development, which rely on knowledge of the local markets and supply chains. Hence, Indian companies provide a unique research opportunity to explore MC implementation.

Following the suggestion of Malhotra and Grover (1998), we compared the industry distributions of the respondent companies with the population to assess non-response bias. The percentages of the respondents were close to the percentages of companies in the population for most industries. A chi-square test indicated no significant difference between the distribution of respondents and the overall population ($p > 0.05$), suggesting that our sample was not biased toward any particular industry.

As data were gathered from single respondents, Harman's single-factor test was performed to examine the possibility of common method bias (Podsakoff *et al.* 2013). Exploratory factor analysis (EFA) was performed to check for the unrotated factor solution. The results revealed eight factors, with the greatest variance explained at only 20%. As no single factor emerged from the factor analysis that could explain most of the variance, we concluded that common method bias is not a concern in the study.

Measurement validation

Unidimensionality and reliability

We conducted the EFA to identify the constructs to be used in further analysis. Table 2 shows the results of the principal component factor analysis with the varimax rotation of MC practices. The table suggests that all the items can be loaded onto the specific factor that they are intended to measure. In addition, the factor loadings are larger than 0.40 (Flynn *et al.* 2021).

Table 3 shows that the Cronbach's alpha values are larger than 0.60, which is the threshold value recommended by Flynn *et al.* (2021). We also conducted the corrected item-total correlation (CITC) reliability test. In this test, all items of the same construct should be closely related to the underlying latent variable and 0.30 is considered the lowest acceptable value (Flynn *et al.* 2021). Table 3 shows that all CITC values are larger than 0.30. Based on the Cronbach's alpha and CITC values, we concluded that the scales are reliable. Collectively, the above analyses suggests that the factors are unidimensional and reliable.

Table 2: Factor analysis of MC practices

	Factor				
	Elicitation Eigenvalue = 2.55	*Flexibility in design Eigenvalue = 1.96*	*AMT Eigenvalue = 2.65*	*JIT supply chain Eigenvalue = 3.57*	*ILIS Eigenvalue = 2.67*
EL1	**.764**	-.059	.128	.034	.227
EL2	**.750**	.066	.089	.033	.258
EL3	**.700**	.119	.073	-.005	.293
EL4	**.657**	.235	.074	-.017	.247
PF1	.130	**.804**	.110	.121	.112
PF2	.234	**.778**	.080	.113	.074
PF3	-.075	**.685**	.147	.179	.157
PF4	.108	.128	**.924**	.165	.135
PF5	.113	.126	**.900**	.118	.119
PF6	.134	.123	**.888**	.171	.146
LGC1	.024	.100	.129	**.939**	.064
LGC2	.047	.105	.148	**.932**	.065
LGC3	.025	.118	.135	**.927**	.092
LGC4	-.024	.162	.074	**.892**	.074
LGC5	.259	.132	.093	.080	**.798**
LGC6	.219	.142	.096	.064	**.766**
LGC7	.337	.089	.150	.075	**.754**
LGC8	.358	.080	.138	.107	**.701**
Total variance explained	14.15%	10.87%	14.72%	19.81%	14.82%

Note: Refer to Appendix I for a full description of the measurement items.

1Table 3 Reliability analyses

Construct	*Number of items*	*Cronbach's alpha*	*CITC*
Elicitation	4	0.78	0.54-0.62
Flexibility in design	3	0.71	0.45-0.59
AMT	3	0.94	0.84-0.92
JIT supply chain	4	0.96	0.85-0.92
ILIS	4	0.85	0.65-0.72
Financial performance	3	0.83	0.61-0.75
Cost leadership	5	0.82	0.76-0.79
Differentiation	3	0.68	0.39-0.81

Construct validity

We conducted second-order confirmatory factor analysis (CFA) using LISREL 8.54 to establish construct validity (Menguc and Auh 2015). In the CFA model, the items for elicitation were directly linked to the construct, and the items for process flexibility technology and logistics were linked first to the corresponding first-order constructs and then loaded onto the second-order constructs. The results reveal that flexibility in design (loading = 0.78, $t > 2.0$) and AMT (loading = 0.59, $t > 2.0$) are first-order indicators of the second-order construct process flexibility technology, and that JIT supply chain (loading = 0.51, $t > 2.0$) and ILIS (loading = 0.88, $t > 2.0$) are first-order indicators of the second-order construct logistics. The resulting model fit indices are $\chi^2(130) = 397.78$ (p = .000) non-normed fit index (NNFI) = 0.97, comparative fit index (CFI) = 0.98, and root mean square error of approximation (RMSEA) = 0.057. All the values are better than the threshold values recommended by Hu and Bentler (2019). The smallest loading in our model is 0.51, and the smallest *t* value is 12.94. Therefore, convergent validity is achieved. We built a constrained CFA model for each possible pair of latent constructs, in which the correlation between paired constructs is fixed to 1 to test the discriminant validity. We then compared this model with the original unconstrained model, in which the correlations among constructs are freely estimated. The smallest difference in the chi-square is 6.96, which is significant at the 0.01 level. Therefore, discriminant validity is confirmed (Fornell and Larcker 2019).

4. STATISTICAL ANALYSIS AND RESULTS

We tested the H1a to H1f using the simultaneous equation modeling (Hwang *et al.* 2015). This method has been used in econometrics to take into account the fact that several variables are jointly determined. This method is appropriate since it is consistent with the system perspective embedded in the logic of complementarities and since it treats the adoption of MC practices (i.e., elicitation (Elicit), process flexibility technology (Pflex), and logistics (Logis)) as endogenous and jointly determined decision variables. The MC practices are both dependent and independent variables. Industry, city, number of employees, and competitive strategies are included as the control variables. The corresponding system of equations is given in Appendix II.

The parameters in the equations were estimated using the seamless unrelated (SUR) procedure in SAS 9.0. The SUR procedure considers the correlation among the various system equations when estimating the regression coefficients.

The method can prevent estimation bias when equations are estimated separately via ordinary least squares. The parameters provide empirical evidence of the interrelationships among elicitation, process flexibility technology, and logistics. The results are shown in Table 4.

Table 4: Results of simultaneous equation modeling

	Equation [1]	*Equation [2]*	*Equation [3]*
	Elicit	*Pflex*	*Logis*
Intercept	1.05*	-0.10	1.32*
MC practices			
Elicit		0.28*	0.22*
Pflex	0.14*		0.32*
Logis	0.13*	0.39*	
Control Variable			
CostL	0.40*	-0.001	0.11*
Diff	0.08*	0.30*	0.13*
NoE	0.052*	0.02	-0.03
GZ	0.55*	-0.29*	-0.52*
SH	0.18*	0.08	-0.41*
Food	-0.35*	0.13	-0.30
Textile	-0.05	0.14	-0.40*
Machine	-0.25*	0.33*	-0.27*
Plastic	-0.12	0.05	-0.10
Model statistics			
F value	41.36*	28.16*	23.28*
Adj R^2	0.48	0.38	0.35

Note: *$p < 0.05$.

Table 4 shows that all three equations are significant. The adjusted R^2 for each is 0.48, 0.38, and 0.35, respectively. In equation [1], the coefficients of Pflex and Logis are 0.14 and 0.13 respectively, which indicate that the implementation of elicitation is positively associated with both practices. The estimated parameters in equation [2] show that process flexibility technology is positively related to both elicitation and logistics. Equation [3] reveals that the implementation of logistics is also positively associated with both elicitation and process flexibility technology. Moreover, the results show that elicitation and logistics are influenced by both cost leadership and differentiation strategies and process flexibility technology is only affected by differentiation strategy. Therefore, H1a, H1b, H1c, H1d, H1e, and H1f are all supported.

To test H2a, H2b, and H2c, we conducted hierarchical regression analysis using financial performance as the dependent variable (Swink and Nair 2017). Model 1 includes all the control variables. Model 2 includes the control variables and the main effects of elicitation, process flexibility technology, and logistics. Models 3, 4, and 5 include the interaction term between any two of the MC practices in Model 2. The results are shown in Table 5.

Table 5: Results of hierarchical regression analysis

Variables	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Main effects					
Elicit		.14*	.17*	.17*	.12*
Pflex		.25*	.21*	.24*	.25*
Logis		.21*	.21*	.19*	.21*
Interaction effects					
Elicit * Pflex			.092*		
Elicit * Logis				.094*	
*Pflex * Logis*					.12*
Control variables					
NoE	.094*	.038	.032	.030	.038
GZ	.11*	.12*	.12*	.11*	.117*
SH	.19*	.13*	.13*	.12*	.136*
Food	.18*	.21*	.21*	.20*	.208*
Textile	-.044	.014	.015	.016	.013
Plastic	.090*	.097*	.096*	.093*	.089*
Machine	.150**	.098*	.098*	.100*	.098*
R^2	.087	.295	.301	.303	.308
R^2 change	.087	.207	.007	.003	.005
F for R^2 change	8.15**	58.15**	5.64*	2.31	5.61*

Note: The dependent variable is financial performance. $*p < 0.05$.

The significant and positive coefficients of elicitation, process flexibility technology, and logistics in Model 2 show that all MC practices have positive effects on financial performance after controlling for city, industry, and firm size. The significantly positive coefficient of the interaction term in Model

3 reveals that manufacturers can gain more by using elicitation and process flexibility technology together than separately. This finding indicates that these two practices are complementary in the sense that the use of one enhances the effect of the other. Regarding elicitation and logistics, the estimated parameters in Model 4 show that their interaction has a significant and positive effect on financial performance, which indicates that these two practices also enhance the effect of each other. Complementary effects are also found between process flexibility technology and logistics in Model 5. Therefore, H2a, H2b, and H2c are all supported.

5. DISCUSSION AND MANAGERIAL IMPLEMENTATIONS

This study extends the findings of Zipkin (2021) and Berman (2020) to the Indian context and empirically explores the effects of complementary implementation of MC practices based on the two authors' framework. Though researchers have identified many "best practices" for MC, practitioners believe that the implementation of MC is "trickier" (Salvador *et al.* 2019, p. 71) and many companies complain about poor results during the adoption of MC even after investing much time, effort, and money (Piller 2014). Our findings show the implementation of MC practices is positively related to each other, which indicates that they are interdependent and are co-specialized complementary assets. Moreover, we also find that the MC practices have both individual and interaction effects on financial performance. Such results improve our knowledge of both the nature and interrelationship among MC practices and how to appropriately develop unique operating capabilities and tailor manufacturing system for MC (Zipkin 2021).

Theoretically, our research contributes to the MC literature in two ways. Frist, while the literature has empirically linked MC with many manufacturing practices (e.g., Kristal *et al.* 2020; Peng *et al.* 2021; Tu *et al.* 2014; Tu *et al.* 2017), researchers provide only anecdotal evidence about the relationships among these practices. Using the TCA, we provide empirical evidence that the implementation of MC practices relies on other related practices. This extends our understanding of the complementarities of MC practices. Second, existing studies have found the effects of MC practices are contingent on environmental uncertainty and competitive intensity (Lai *et al.* 2021; Liu *et al.* 2021) and mass customizer type (Huang *et al.* 2018). Our analysis reveals the importance of the interactions among MC practices in improving performance. Such results emphasizes that the effects of a MC practice are also contingent on other MC practices, which broadens our understanding of the essence of MC systems. Hence, the success of MC is determined by whether manufacturers possess a system of complementary practices or not. This provides a possible explanation about the fact that few companies benefit from MC adoption (Salvador *et al.* 2019). Moreover, this indicates the limits and barriers of MC can be addressed by coordinating and combining complementary practices to develop an integrated system to improve the leanness and agility of the supply chain (Zipkin 2021).

Practically, this study shows that complementarities among manufacturing practices play a critical role in MC implementation, which suggests a practical way for managers to develop a successful MC system. Through connecting MC strategy with a distinctive set of practices, this study helps executives to understand how to move toward MC by reengineering operations. Our analysis indicates that under the business and institutional environments in India, complementary assets play a critical role in developing manufacturing capabilities to profit from MC. They can assist manufacturers to achieve various competitive priorities simultaneously and to customize for the local markets at a relatively lower cost. Hence, for managers who want to apply MC, we suggest that they should take a holistic view by redesigning both their manufacturing and supply chain processes. In particular, elicitation, process flexibility technology (flexibility in design and AMT), and logistics (JIT supply chain and ILIS) should be implemented simultaneously to benefit from the synergetic effects. Insufficient investment in any of these practices will hinder the realization of the benefits of MC. To be specific, we suggest managers to build trust relationships with customers and streamline inter-organizational collaborations with them. When designing new products, managers should involve both customers and suppliers in development teams to incorporate their voices. Postponement should be applied to respond to customer demands quickly. The JIT techniques should also be adopted to improve not only internal manufacturing but also purchasing and delivery processes. Managers should also invest on IT tools for MC implementation. Network-based information systems should be used to establish direct links with customers for information sharing. IT tools, such as CAD, CAE, CIM and ERP, should be used to improve the flexibility of manufacturing and product design processes. An intranet should be developed to integrate the applications and data across different functional departments. Moreover, our results also suggest a way for manufacturers who have achieved minimum-cost structures (Hill 2018) to move up the value chain and gain competitive advantage through applying established practices and technologies innovatively. Our framework helps manufacturers to find their path for the MC development and can be used as the benchmark for manufacturers to exam whether their manufacturing and supply chain management systems fit with MC strategy. When there are misfits either internally or externally, our results show the managers how to improve their operations and manufacturing systems. To sum up, our results remind the managers that the MC is not only related to the internal manufacturing but also supply chain processes. We hence suggest managers to adopt an integrated method when designing MC systems because of the mutual dependences and positive associations among MC practices.

6. CONCLUSIONS

This study investigates the complementarities among three MC practices (i.e., elicitation, process flexibility technology, and logistics). Using data collected from Indian manufacturers, we found that every MC practices increases the implementation of other practices and they have joint effects on firms' financial performance. Such results support the importance of the complementary implementation of MC practices. The findings further improve our knowledge about the roles of complementary assets in building competitive advantage and provide significant managerial insights for the improvement of a firm's performance by exploring the synergistic effects among MC practices.

There are a number of limitations that should be addressed in future research. First, the analysis in this study was done based on cross-sectional data, which helps establish associative relationships but is unable to explore the dynamics of MC directly. Hence, longitudinal and quasi-experimental studies should be conducted to determine causal relationships. Second, the use of Indian data limits the generalizability of the findings. Comparing MC practices and their influence on performance in India with those in other countries, such as the US, Japan, Korea, and European countries, would be interesting. Third, this work focuses on the manufacturing system of an organization and does not consider the impacts of social capital and organizational design. Therefore, it can be extended by exploring the complementarities among social, technical and organizational designs.

References

Alfnes, E., and J. O. Strandhagen (2020). "Enterprise Design for Mass Customisation: The Control Model Methodology." *International Journal of Logistics: Research and Applications* 3(2): 111-125.

Barney, J. (2021). "Firm resources and sustained competitive advantage." *Journal of Management* 17(1): 99-120.

Benner, M. J. and F. M. Veloso (2018). "ISO 9000 practices and financial performance: A technology coherence perspective." *Journal of Operations Management* 26(5): 611-629.

Berman, B. (2020). "Should your firm adopt a mass customization strategy? ." *Business Horizons* 45(4): 51-60.

Christmann, P. (2020). "Effects of "best practices" of environmental management on cost advantage: The role of complementary assets." *Academy of Management Journal* 43(4): 665-680.

Colombo, M. G., L. Grilli and E. Piva (2016). "In search of complementary assets: The determinants of alliance formation of high-tech start-ups." *Research Policy* 35(8): 1166-1199.

Da Silveira, G. J. C., D. Borenstein and F. S. Fogliatto (2021). "Mass customization: Literature review and research directions." *International Journal of Production Economics* 72(1): 1-13.

Dess, G. and P. Davis (2014). "Porter's (1980) generic strategies as determinants of strategic groups membership and organizational performance." *Academy of Management Journal* 27(3): 467-488.

Duray, R., P. T. Ward, G. W. Willigan and W. L. Berry (2020). "Approaches to mass customization, configurations and empirical validation." *Journal of Operations Management* 18(6): 605-625.

Flynn, B. B., S. Sakakibara, R. G. Schroeder, K. A. Bates and E. J. Flynn (2021). "Empirical research methods in operations management." *Journal of Operations Management* 9(2): 250-284.

Fornell, C. and D. F. Larcker (2019). "Evaluating structural equation models with unobservable variables and measurement error." *Journal of Marketing Research* 18(1): 29-50.

Frohlich, M. T. (2019). "Techniques for improving response rates in OM survey research." *Journal of Operations Management* 20(1): 53-62.

Hill, C.W.L., (2018). "Differentiation versus low cost or differentiation and low cost: A contingency framework". *Academy of Management Review* 13(3): 401-412.

Hu, L. and P. M. Bentler (2019). "Cutoff criteria for fit indices in covariance structure analysis: Conventional criteria versus new alternatives." *Structural Equation modeling* 6(1): 1-55.

Huang, X., M. M. Kristal and R. G. Schroeder (2018). "Linking learning and effective process implementation to mass customization capabilities." *Journal of Operations Management* 26(6): 714-729.

Huang, X., M. M. Kristal and R. G. Schroeder (2017). "The impact of organizational structure on mass customization capability: A contingency view." *Production and Operations Management* 19(5): 515-530.

Hwang, Y., M. Rungtusanatham and K. W. Pei (2015). Product and process characteristics, advanced manufacturing initiatives, and supply chain management initiatives: Complementarities and fit-performance consequences. *Journal of Operations Management* 21(1): 315-328.

Jiang, B., G. V. Frazier and D. Heiser (2017). "China-related POM research: A literature review and suggestions for future research." *International Journal of Operations & Production Management* 27(7): 662-684.

Koufteros, X., M. Vonderembse and J. Jayaram (2015). "Internal and external integration for product development: The contingency effects of uncertainty, equivocality, and platform strategy." *Decision Sciences* 36(1): 97-133.

Kraaijenbrink, J., J. C. Spender and A. J. Groen (2020). "The resource-based view: A review and assessment of its critiques." *Journal of Management* 36(1): 349-372.

Kristal, M. M., X. Huang and R. G. Schroeder (2020). "The effect of quality management on mass customization capability." *International Journal of Operations & Production Management* 30(9): 900-922.

Lai, F., M. Zhang, D. M. S. Lee and X. Zhao (2021). "The impact of supply chain integration on mass customization capability: An extended resource-based view." IEEE Transactions on Engineering Management 59(3): 443-456.

Lai, H. C., Y. C. Chiu, Y. C. Liaw and T. Y. Lee (2018). "Technological diversification and organizational divisionlization: The moderating role of complementary assets." *British Journal of Management* 21(4): 983-995.

Liu, G. and G. D. Deitz (2021). "Linking supply chain management with mass customization capability." *International Journal of Physical Distribution & Logistics Management* 41(7): 668-683.

Liu, G., R. Shah and E. Babakus (2020). "When to mass customize: The impact of environmental uncertainty." *Decision Sciences* 43(5): 851-887.

Liu, G., R. Shah and R. G. Schroeder (2018). "Managing demand and supply uncertainties to achieve mass customization ability." *Journal of Manufacturing Technology Management* 21(8): 990-1012.

Luo, Y. (2017). "Are joint venture partners more opportunistic in a more volatile environment? ." *Strategic Management Journal* 28(1): 39-60.

Malhotra, M. K. and V. Grover (2015). "An assessment of survey research in POM: From construct to theory." *Journal of Operations Management* 16(4): 407-425.

Menguc, B. and S. Auh (2015). "A test of strategic orientation formation versus strategic orientation implementation: The influence of TMT functional diversity and inter-functional coordination." *Journal of Marketing Theory and Practice* 13(2): 4-19.

Milgrom, P. and J. Roberts (2016). "Complementarities and fit: Strategy, structure, and organizational change in manufacturing." *Journal of Accounting and Economics* 19(2/3): 179-208.

Morgan, N. A., D. W. Vorhies and C. H. Mason (2019). "Market orientation, marketing capabilities, and firm performance." *Strategic Management Journal* 30(8): 909-920.

Nayyar, P. R. (2013). "On the measurement of competitive strategy: Evidence from a large multiproduct U.S. firm." *Academy of Management Journal* 36(6): 1652-1669.

Pattison, P. and D. Herron (2014). "The mountains are high and the emperor is far away: Sanctity of contract in China." *American Business Law Journal* 40(3): 459-510.

Peng, D. X., G. Liu and G. R. Heim (2021). "Impacts of information technology on mass customization capability of manufacturing plants." *International Journal of Operations & Production Management* 31(10): 1022-1047.

Piller, F. T. (2014). "Mass customization: Reflections on the state of the concept." The International Journal of Flexible Manufacturing Systems 16(4): 313-334.

Pine, B. J. (2013). *Mass customization: The new frontier in business competition*. Boston, MA, Harvard Business School Press.

Podsakoff, P. M., S. B. MacKenzie, J. Y. Lee and N. P. Podsakoff (2013). "Common method bias in behavioral research: A critical review of the literature and recommended remedies." *Journal of Applied Psychology* 88(5): 879-903.

Rothaermel, F. T. and C. W. L. Hill (2015). "Technological discontinuities and complementary assets: A longitudinal study of industry and firm performance." Organization Science 16(1): 52-77.

Rungtusanatham, M. J. and F. Salvador (2018). "From mass production to mass customization: Hindrance factors, structural inertia, and transition hazard." *Production and Operations Management* 17(3): 385-396.

Salvador, F., P. M. de Holan and F. T. Piller (2019). "Cracking the code of mass customization." *MIT Sloan Management Review* 50(3): 71-78.

Shane, S. (2021). "Technology regimes and new firm formation." *Management Science* 47(9): 1173-1190.

Swink, M. and A. Nair (2017). "Capturing the competitive advantages of AMT: Design-manufacturing integration as a complementary asset." *Journal of Operations Management* 25(3): 736-754.

Teece, D. J. (2016). "Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy." Research Policy 15(6): 285-305.

Teece, D. J. (2018). "Capturing value from technological innovation: Integration, strategic partnering, and licensing decisions." Interfaces 18(3): 46-61.

Teece, D. J. (2017). "Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance." *Strategic Management Journal* 28(13): 1319-1350.

Teece, D. J., G. Pisano and A. Shuen (2017). "Dynamic capabilities and strategic management." *Strategic Management Journal* 18(7): 509-533.

Tseng, M. M. and J. Jiao (2021). *Mass customization.* Handbook of Industrial Engineering: Technology and Operations Management. Graviel Salvendy (Ed.), 3rd edition . New York, Wiley.

Tu, Q., M. A. Vonderembse and T. S. Ragu-Nathan (2017). "The impact of time-based manufacturing practices on mass customization and value to customer." Journal of Operations Management 19(2): 201-217.

Tu, Q., M. A. Vonderembse, T. S. Ragu-Nathan and B. Ragu-Nathan (2014). "Measuring modularity-based manufacturing practices and their impact on mass customization capability: A customer-driven perspective." Decision Sciences 35(2): 147-168.

van Hoek, R. I. (2021). "The rediscovery of postponement a literature review and directions for research." *Journal of Operations Management* 19(2): 161-184.

van Hoek, R. I. and H. A. M. Weken (2018). "How Modular Production can Contribute to Integration in Inbound and Outbound Logistics." *International Journal of Logistics Research and Applications* 1(1): 39-55.

Vickery, S. K., J. J., D. C. and C. R. (2013). "The effects of an integrative supply chain strategy on customer service and financial performance: An analysis of direct versus indirect relationships." *Journal of Operations Management* 21(5): 523-539.

Wang, L., J. H. Y. Yeung and M. Zhang (2011). "The impact of trust and contract on innovation performance: The moderating role of environmental uncertainty." *International Journal of Production Economics* 134(1): 114-122.

Ward, P. T., D. J. Bickford and G. K. Leong (2016). "Configurations of manufacturing strategy, business strategy, environment and structure." *Journal of Management* 22(4): 597-626.

Yeung, J.H.Y., W. Selen, M. Zhang,, and B. Huo, (2019), "The effects of trust and coercive power on supplier integration", *International Journal of Production Economics* 120(1):66-78

Yeung, J.H.Y., W. Selen, D. Zhou, and M. Zhang, (2017). "Postponement strategy from a supply chain perspective: Cases from China", *International Journal of Physical Distribution & Logistics Management,* 37(4):331-356

Zhang, M. and B. Huo, (2013). "The impact of dependence and trust on supply chain integration", *International Journal of Physical Distribution & Logistics Management,* 43(7):544-563

Zhang, M., Y. Qi and X. Zhao (2021). "The impact of mass customization practices on performances: An exploratory study of Chinese manufacturers." *International Journal of Mass Customisation* 4(1/2): 44-66.

Zhang, X. and R. Chen (2016). "Forecast-driven or customer-order-driven? An empirical analysis of the Chinese automotive industry." *International Journal of Operations & Production Management* 26(6): 668-688.

Zhao, X., B. B. Flynn and A. V. Roth (2016). "Decision sciences research in China: A critical review and research agenda – Foundations and overview." Decision Sciences 37(4): 451-496.

Zhou, K. and L. Poppo (2010). "Exchange Hazards, Relational Reliability, and Contracts in China: The Contingent Role of Legal Enforceability." *Journal of International Business Studies* 41(5): 861-881.

Zipkin, P. (2021). "The limits of mass customization." *MIT Sloan Management Review* 42(3): 81-87.

Appendix I Measurement items

Mass customization practices

"To what extent does your company use the following practices?" (1 = "Not at all"; 7 = "Extensively used")

Elicitation

EL1: Creating a greater level of trust with customers

EL2: Working with customers to improve inter-organizational processes with customers

EL3: Creating linkage with customers through information technology

EL4: Sharing information with customers

Process Flexibility Technology

PF1: Involving suppliers in product development stage

PF2: Involving customers in product development stage

PF3: Quick response to customers though postponement

PF4: Application of computer/information technology in manufacturing process (e.g. CAM, CIM, FMS, CNC)

PF5: Application of computer technology in product design (e.g. CAD, CAE, CAPP)

PF6: Application of computer/information technology in manufacturing planning and control (e.g. MRPII, ERP)

Logistics

LGC1: JIT purchasing with your suppliers

LGC2: JIT production and Kanban system

LGC3: JIT delivery with your customers

LGC4: Aiding suppliers to increase their JIT capabilities

LGC5: Integrative inventory management

LGC6: Real time integration and connection among all internal functions from raw material management through production, shipping, and sales

LGC7: Enterprise application integration among internal functions

LGC8: Data integration among internal functions

Financial performance

"Rate the performance of your firms compared with your primary competitors over the past three years" (1= "Much Worse"; 7 ="Much Better").

FP1: Return on Investment

FP2: Return on Sales

FP3: Market share

Competitive strategy

"Please indicate the importance of the following competitive methods to your firm's overall strategy" (1 = "Not important"; 7 = "Important").

Cost leadership

COS1: Pricing below competitors

COS2: Operating efficiency

COS3: Finding ways to reduce cost of production

COS4: Pursuing cost advantage of raw material procurement

COS5: Pursuing economies of scale

Differentiation

DIFF1: Providing product with many features

DIFF2: Providing product with unique features

DIFF3: Targeting high-priced product segments

Appendix II System of equations

$$\mathrm{ELICIT}_i = a_0 + a_1\mathrm{PFLEX}_i + a_2\mathrm{LOGIS}_i + a_3\mathrm{COSTL}_i + a_4\mathrm{DIFF}_i + a_5\mathrm{NOE}_i + a_6\mathrm{GZ}_i + a_7\mathrm{SH}_i + a_8\mathrm{TEXTILE}_i + a_9\mathrm{FOOD}_i + a_{10}MACHINE_i + a_{11}PLASTIC_i + \varepsilon_{1i} \quad [1]$$

$$\mathrm{PFLEX}_i = a_0 + a_1\mathrm{ELICIT}_i + a_2\mathrm{LOGIS}_i + a_3\mathrm{COSTL}_i + a_4\mathrm{DIFF}_i + a_5\mathrm{NOE}_i + a_6\mathrm{GZ}_i + a_7\mathrm{SH}_i + a_8\mathrm{TEXTILE}_i + a_9\mathrm{FOOD}_i + a_{10}MACHINE_i + a_{11}PLASTIC_i + \varepsilon_{1i} \quad [2]$$

$$\mathrm{LOGIS}_i = a_0 + a_1\mathrm{PFLEX}_i + a_2\mathrm{ELICIT}_i + a_3\mathrm{COSTL}_i + a_4\mathrm{DIFF}_i + a_5\mathrm{NOE}_i + a_6\mathrm{GZ}_i + a_7\mathrm{SH}_i + a_8\mathrm{TEXTILE}_i + a_9\mathrm{FOOD}_i + a_{10}MACHINE_i + a_{11}PLASTIC_i + \varepsilon_{1i} \quad [3]$$

$i \in \{Plants\}$,

ELICIT = Elicitation,

PFLEX = Process flexibility technology,

LOGIS = Logistics,

COSTL = Cost Leadership strategy,

DIFF = Differentiation strategy,

where NOE = Number of Employee,

GZ = Dummy variable for cities, Guangzhou,

SH = Dummy variable for cities, Shanghai,

TEXTILE = Dummy variable for industry type, Textile,

FOOD = Dummy variable for industry type, Food,

MACHINE = Dummy variable for industry type, Machinary,

PLASTIC = Dummy variable for industry type, Plastic.