Int. J. Production Economics 158 (2014) 145–155

Contents lists available at ScienceDirect

Int. J. Production Economics

journal homepage: www.elsevier.com/locate/ijpe

The effects of organizational flatness, coordination, and product modularity on mass customization capability

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ARTICLE INFO

Article history:
Received 8 October 2012
Accepted 31 July 2014
Available online 8 August 2014

Keywords:
Mass customization capability
Product modularity
Organizational flatness
Cross-functional coordination
Cross-plant coordination
Supply chain coordination

ABSTRACT

This study examines the effects of organizational flatness, coordination (cross-functional coordination, cross-plant coordination and supply chain coordination) and product modularity on mass customization capability (MCC) development. We develop a flatness-coordination-modularity-MCC model. Data from 317 firms located in ten countries across three industries are analyzed to test the research model using partial least squares. Our results show that product modularity, cross-functional coordination and supply chain coordination significantly contribute to MCC, whereas the influences of cross-plant coordination and organizational flatness are insignificant. Organizational flatness enhances coordination practices, and its effect on MCC is fully mediated by cross-functional and supply chain coordination. Moreover, both cross-functional and cross-plant coordination increase product modularity, whereas supply chain coordination does not. We also find that such empirical results are not significantly affected by industry type or plant size. This study contributes to the literature by providing empirical evidence of the links between the practices of flatness, coordination and modularity, and the ways in which they jointly improve MCC. Our findings also provide guidance for managers and executives regarding how to design organizational structures and coordinate with both internal and external stakeholders to improve product modularity and MCC. Limitations of the study related to the nature of the data and the plant level focus are noted.

1. Introduction

Given the expanding global competition and shortening product life cycle, there is an increasing need for the development and production of affordable goods and services that can be suitably customized (Da Silveira et al., 2001; Pine, 1993). Relying on a number of technologies, practices and systems, mass customization (MC) fundamentally changes the way businesses respond to the heterogeneity and unpredictability of customer demands by combining craft manufacturing and mass production (Duray et al., 2000; Huang et al., 2008; Kristal et al., 2010; Liu et al., 2006; Peng et al., 2011; Zhang et al., 2011). MC is a process of aligning an organization with its customer needs and requires unique operational capabilities (MacCarthy et al., 2003; Salvador et al., 2009).

Organizational flatness, coordination and product modularity have been advocated in the literature as important practices to achieve MC operationally (e.g., Brun and Zorzini, 2009; Huang et al., 2010; Lau Antonio et al., 2007; Liu et al., 2012; Tu et al., 2004). In a flat structure, communication between different levels becomes easier, which improves decision making and information sharing (Flynn and Flynn, 1999). Standardized modules or components can be combined into different functional forms and shared across various product families, which easily generates variety without significantly increasing costs (Peng et al., 2011; Tu et al., 2004). Such practices can enhance organizations' flexibility and responsiveness in coping with the increased complexity, dynamics and uncertainty associated with customization (Feitzinger and Lee, 1997; Fredriksson, 2006; Vickery et al., 1999). MC demands that manufacturers coordinate with both internal and external stakeholders to deploy their resources and capabilities (Lai et al., 2012; Liu and Deitz, 2011; Rungtusanatham and Salvador, 2008). Cross-functional coordination enables manufacturers to optimize internal operations, which leads to a connected and coordinated response to environmental changes and disruptions (Liu et al., 2012; Yeung et al., 2009). Moreover, cross-plant and supply chain

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http://dx.doi.org/10.1016/j.ijpe.2014.07.032
0925-5273/

coordination are also widely applied to achieve lower production and logistics costs, improve product quality, acquire deeper knowledge of customer needs and provide better customer services, all of which are important in MC (Feitzinger and Lee, 1997; Lai et al., 2012; Liu and Deitz, 2011; Zhang et al., 2011).

The success of modularity is dependent on how components are designed, assembled and configured, which require that manufacturers coordinate both internal and external activities (Baldwin and Clark, 1997; Fredriksson, 2006; Salvador, 2007). Such coordination also demands that manufacturers improve the quality, quantity and speed of information flows. This can be achieved by a flat structure that provides channels through which both internal and external stakeholders can interact (Flynn and Flynn, 1999). Hence, organizational flatness, coordination and product modularity should be aligned to improve MC capability (MCC). However, not much attention has been paid to the links among these practices or their synergies on MCC. The aim of this study is to analyze the joint effects of organizational flatness, coordination (cross-functional coordination, cross-plant coordination and supply chain coordination) and product modularity on MCC, and the relationships among these practices.

The remainder of this paper is organized as follows. We first review the literature on MCC, organizational flatness, coordination practices and product modularity, followed by research hypotheses development. We then describe the methodology and the results of our empirical analysis. Key findings and managerial implications are discussed in Section 5. Section 6 concludes the paper by summarizing the main results and highlighting its limitations and future research directions.

2. Literature review and research hypotheses

2.1. Mass customization capability

MCC refers to the ability to reliably offer a high volume of different product options in a relatively large market that demands customization without substantial trade-offs in cost, delivery and quality (Liu et al., 2006; Tu et al., 2001). Aiming at producing customized goods for a mass market, MCC has four components: high volume customization, customization cost efficiency, customization responsiveness and customization quality (Huang et al., 2008; MacCarthy et al., 2003; Tu et al., 2001). High-volume customization refers to the ability to aggregate individual customers' demands into large-batch common parts production (Pine, 1993). Customization cost efficiency refers to the ability to provide customized products at a price similar to mass production. Although customers will pay a premium for personalization, customization that comes with a dramatically increased production cost will not bring competitive advantage to a firm. Customization responsiveness refers to the ability to reduce total lead time for customized product delivery (Da Silveira et al., 2001). Customization quality refers to the ability to manage and guarantee the quality level of every customized product (Liu et al., 2006). MC significantly increases production variety and complexity, and hence ensuring quality conformance becomes a critical challenge. In this study, we define MC from an operations management viewpoint as an organizational capability within a manufacturing plant (MacCarthy et al., 2003; Tu et al., 2001). It is conceptualized as a cumulative competence of achieving multiple operational priorities simultaneously and hence both assemblers and component/material suppliers can benefit from a high level of MCC (Liu et al., 2006, 2012; Pine, 1993; Squire et al., 2006). Although some manufacturing plants may not be full mass customizers, they all face the challenge of improving performance on multiple dimensions at the same time, which can be captured by their responses to the MCC scale (Huang et al., 2008).

Empirically, researchers have explored the effects of various practices on MCC development using large scale surveys. For example, Duray et al. (2000) developed a configurational model for classifying mass customizers based on customer involvement in design and product modularity, and found that the companies using modularity in the later stages of production exhibit higher performance. Tu et al. (2004) discovered statistically significant and positive relationships between modularity-based manufacturing practices, which include product modularity, process modularity and dynamic teaming, and MCC. Using a knowledge-based view, Huang et al. (2008) provided empirical evidence that both internal and external learning significantly affect MCC, and the effects are fully mediated by effective process implementation. Huang et al. (2010) found that a flat, decentralized organizational structure with a wide use of multifunctional employees plays a significant role in MCC development and the positive influence is statistically significant only for full mass customizers. Kristal et al. (2010) discovered a positive link between quality management practices and MCC. Using organizational information processing theory, Liu et al. (2010) found that both demand and supply uncertainty management practices positively affect a company's MCC and Peng et al. (2011) revealed that new product development information technology (IT) and supplier collaboration IT are related to MCC, either directly or indirectly through modular product design. Relying on service-dominant logic, Liu and Deitz (2011) argued that both customer-focused product design and reduced supplier lead-time positively contribute to MCC and they are driven by supply chain planning. Liu et al. (2012) found that functional integration has a significant positive impact on MCC and operational performance, and MCC partially mediates functional integration's impact on operational performance. Using an extended resource-based view, Lai et al. (2012) found that both internal and customer integration directly improve MCC, and that internal integration also has a positive indirect effect on MCC through customer integration, which is amplified when demand is uncertain and competition is intense. Empirical studies have discovered significant direct effects of product modularity (Duray et al., 2000; Liu et al., 2010; Peng et al., 2011; Tu et al., 2004), organizational flatness (Huang et al., 2010) and coordination (Huang et al., 2008; Kristal et al., 2010; Lai et al., 2012; Liu and Deitz, 2011; Liu et al., 2012) on MCC. Moreover, MC demands manufacturers to jointly design their technical and social subsystems (Da Silveira et al., 2001; Liu et al., 2006). However, how flatness, coordination and modularity jointly influence MCC, and the connections and relationships among them have not been sufficiently acknowledged or investigated. This calls for further in-depth empirical analyses.

2.2. Organizational flatness

Organizational flatness can be defined as a state in which there are few levels in the organizational hierarchy or chart, and small number of management levels in the chain of command (Huang et al., 2010; Nahm et al., 2003). Reducing layers can improve an organization's flexibility (Vickery et al., 1999). Flatness influences how authorities and responsibilities are allocated and how employees interact with others within an organization (Huang et al., 2010). Since there are few tiers in the chain of command, hierarchical load is reduced and decision making moves to where information exists (Flynn and Flynn, 1999; Nahm et al., 2003). Otherwise, an increase in the number of management layers can hinder an organization's ability to compete as decisions must be pushed through excessive layers and are often made by people who do not have first-hand information (Vickery et al., 1999).