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Product configuration, ambidexterity and firm performance in the context of industrial equipment manufacturing

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ABSTRACT

The practice of configuring products to individual customer orders has found application in a variety of industry contexts, but little is known about the specific capabilities that firms develop to successfully compete when offering configurable products. Our research begins to fill this gap in the context of industrial equipment manufacturing. Drawing from the ambidexterity literature, we argue that firms have to balance dual goals of reducing variation and promoting variation in their product configuration activities by fostering two distinct firm-level capabilities: product configuration effectiveness (PCE) and product configuration intelligence (PCI). Specifically, we hypothesize that the simultaneous presence of PCE and PCI—that is, product configuration ambidexterity (PCA)—drives superior firm responsiveness and, indirectly firm sales and operating margin. However, we also contend that responsiveness gains through PCA can diminish with product complexity and can increase operating cost. We test these hypotheses by collecting both primary and secondary data from a sample of 108 European industrial equipment manufacturing firms. Results from our analyses indicate that PCA has an indirect effect through responsiveness on sales and operating cost but not on operating margin, with this effect diminishing with product complexity. Taken together, our results suggest that investment in developing PCA may represent a conundrum for industrial equipment manufacturing firms, because it translates into market but not financial advantages, and it is intertwined with product design decisions. We conclude this study with a discussion of the findings for theory and practice.

1. Introduction

How do firms that allow each customer to configure his or her own products succeed? Companies such as Dell, Build-A-Bear, Mini Cooper, Adidas and John Deere have shown that configuring products to order is a viable approach to offer customized product categories as diverse as computers, toys, cars, apparel and industrial products (Davenport and Harris, 2007; Eng, 2012; Magretta, 1998; Salvador et al., 2009). By offering configurable products, these companies on the one hand give customers unprecedented possibilities in choosing product features. On the other hand, they constrain such product features to a pre-defined set of solutions (Hvam et al., 2010) in order to reduce uncertainty and variability associated to the generation of customized product variants (Tenhiälä and Ketokivi, 2011).

To date studies on the performance effects of product configuration are very limited, often anecdotal, and surprisingly yield mixed results. For example, Peng et al., 2011 in a sample of 266 manufacturing plants found that plants with a sophisticated product configuration technology did not have a greater mass customization capability. Conversely, a study by Trentin et al., 2011 on a sample of 238 manufacturing plants found that plants with a more sophisticated product configuration technology enjoyed superior time performance, measured as a composite of on-time delivery, delivery speed, and speed of new product introductions. Even in-depth case studies report mixed findings on the performance effects of IT (Information Technology) and expert systems supporting product configuration activities. For example, despite Digital Equipment Corporation's technical success in reducing configuration errors through an innovative expert system (Barker and O'Connor, 1989) serious implementation issues arose due to

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resistance and dissatisfaction within large groups of sales people (Leonard-Barton, 1987).

The inconsistency in the performance benefits reported in the business press and the academic research calls for a closer examination of the mechanisms through which configure-to-order businesses achieve superior performance. We start from two basic premises in addressing this problem. First, we argue that the current focus in the extant literature on IT solutions such as product configurators and expert systems (Aldanondo et al., 2000; Haug et al., 2011; Trentin et al., 2012; Pitiot et al., 2013) has to be broadened to consider firm-level capabilities that support configure-to-order businesses. IT solutions, by themselves, cannot ensure that firms control variation in selling and delivering custom-specified products because the effectiveness of these systems depends on several other factors such as adoption and use by the firm personnel (Venkatesh et al., 2003; Amoako-Gyampah and Salam, 2004; Bendoly and Cotteleer, 2008) as well as the fit between these systems and organizational workflow processes (Van Stijn and Wensley, 2001; Bendoly and Jacobs, 2004).

Second, we argue that configure-to-order business models should not only rely on controlling variation in the generation of customized products—an unquestionably important requirement that has been the focus of past research (Gunasekaran and Ngai, 2005)—but should also promote variation and adaptation of configurable products and associated production processes to the evolving needs of the customer. This line of reasoning draws support from organizational learning theories that link firm performance to the simultaneous pursuit of activities that control variation (i.e., exploitation) and activities that foster variation (i.e., exploration) (Benner and Tushman, 2003; Tushman and O'Reilly, 1996; Chandrasekaran et al. 2012a). The synergies from simultaneously pursuing exploitation and exploration, or *ambidexterity*, in the context of configurable products is exemplified by Capital One, which outperformed its competitors for a decade by complementing their ability to (1) rapidly and reliably configure financial products from an existing set of solutions for each individual customer with their ability to (2) regularly analyze customers' transaction data to identify new product and process innovation opportunities (Paige et al., 2000).

Following these two premises, we propose that configure-to-order firms benefit from developing two distinct organizational capabilities, namely *product configuration effectiveness* (*PCE*) and *product configuration intelligence* (*PCI*). We refer to PCE as the *ability of a firm's sales personnel to autonomously and reliably configure existing products and processes in response to customer requirements*. PCE controls variation in products and processes by avoiding errors and delays from poorly informed product configuration decisions during order acquisition activities (Forza and Salvador, 2002; Tenhiälä and Ketokivi, 2011). We refer to PCI as the *ability of a firm's personnel to identify opportunities for product and process innovation by systematically analyzing information on past product configurations*. PCI promotes variation in the firms' products and processes by generating insights during the early stages of NPD activities wherein firm personnel from both sales and technical areas (e.g., R&D, production and purchasing) interact to define new product and process specifications (Davenport and Harris, 2007; Kruschwitz, 2011). Consistent with the ambidexterity literature we define *product configuration ambidexterity* (*PCA*) as the simultaneous presence of these two capabilities within the firm.

The purpose of this research is to understand *how PCA, or the simultaneous development of PCE and PCI, impact firm performance* in the context of industrial equipment manufacturing. Building on the concept of ambidexterity developed from individuals (Lubatkin et al., 2006; Gibson and Birkinshaw, 2004), we argue that PCA benefits firm performance by creating synergies between sales personnel's efforts to configure existing products and sales and technical personnel's efforts to specify future configurable products and processes. We further contend that these synergies diminish with increase in the complexity of products offered by the firm. Finally, we argue that the relationship between PCA and firm performance is indirect and mediated through responsiveness, defined as *the speed and reliability with which the firm serves its customers*'. That is, PCA drives firm performance by improving responsiveness.

Industrial equipment manufacturing context is chosen because of two main reasons. First, unlike apparel, cars and toys industries, a vast majority of industrial equipment manufacturers compete primarily through configure-to-order products (Mazzoleni, 1999). Hence, sampling from this industry is more likely to include firms for which developing both PCE and PCI (i.e., PCA) is a meaningful concern. Second, industrial equipment manufacturing firms are predominantly small-and-medium enterprises (NCMM, 2012) for which developing both PCE and PCI (i.e., PCA) is a non-trivial effort due to resource constraints (Zahra et al., 2000). Moreover it is common for sales and technical personnel to encounter learning and information processing difficulties when selling and developing configurable industrial products (Salvador and Forza, 2004). Therefore, PCA can differentiate firms in this context and may have a stronger association with firm performance.

We test our hypotheses on a sample of European industrial equipment manufacturers by combining two different data sources: (1) primary survey data on *PCE*, *PCI* and other variables from 108 industrial equipment manufacturers and (2) financial performance data collected from secondary data sources. Results from our analyses suggest three main contributions. First, we broaden the variation-reduction focus (i.e., PCE) in the product customization literature (e.g., see Liechty et al., 2001; Zipkin, 2001) by empirically demonstrating the synergies derived from developing capabilities that also promote variance in product configuration (i.e., PCI). We also show that such synergies are hindered by product complexity, shedding new light on the interaction of product and process design decisions in the context of configure-to-order businesses. Second, our study empirically examines on a large sample the effect of product configuration capabilities on objective firm performance, addressing Fogliatto et al., 2012 call for more research on this topic. Specifically, we provide novel insights relative to the conundrum of competing via configurable products, showing that firm responsiveness gains obtained through PCA are reflected in higher sales but not in higher margins, due to linear growth in manufacturers' operating cost. Third and last, this study contributes to Raisch's et al. (2009) call for more fine-grained research on the ambidexterity-performance link. That is, we show that decisions to pursue ambidexterity in the context of industrial equipment manufacturers should be taken with due caution because PCA unevenly impacts different dimensions of firm performance, and such impact is indirect and subject to contingencies.

2. Theoretical background

We provide a brief overview of the industrial equipment manufacturing setting and discuss how these firms develop PCE and PCI capabilities as well as their connections to the dual goals of controlling and promoting variation within the manufacturer's products and processes. We also review findings from the ambidexterity literature that are relevant to understand how PCA impacts firm performance for industrial equipment manufacturers.

2.1. Product configuration in industrial equipment manufacturing

Industrial equipment manufacturers offer durable goods that are highly customized to fit customers' production processes. Customization in these firms entails a trade-off with responsiveness