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Overcoming the customization-responsiveness squeeze by using product configurators: Beyond anecdotal evidence

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ABSTRACT

Anecdotal evidence suggests that product configurators may be crucial in improving time performance when offering customized products so as to overcome what has been termed the customization-responsiveness squeeze. Large-scale hypothesis-testing studies that either corroborate this finding or discover unpredicted boundaries of validity are still lacking, however. Our paper contributes to fill this gap by testing the positive impact of product configurator use on time performance on a sample of 238 manufacturing plants from three industries and eight countries. The results support the hypothesized impact after the effects of widely acknowledged antecedents of accelerated time performance have been removed. Implications of our findings for both research and practice are finally discussed.

1. Introduction

Because of intensifying competition and increasingly sophisticated customers, more and more companies nowadays are being squeezed between the need to offer more customized products and the need to develop, produce and deliver such products with greater rapidity [1–3]. Several approaches have been proposed to increase compatibility between customization and responsiveness, including cellular manufacturing, set-up time reduction and product modularity, among others [1].

Anecdotal evidence formed through the examination of a few case studies points to the importance of using a product configurator in order to address the customization-responsiveness squeeze (e.g., [4–9]). Product configurators are a class of applications designed to help companies carry out the product configuration process [10,11], where the latter is defined as the set of activities aimed at translating each customer's idiosyncratc needs into correct and complete product information supporting order acquisition and fulfilment, such as the description of the product variant that better fits the customer's needs, its price, its bill of materials, its production sequence, etc. [12,2].

However, no large-scale empirical test of the suggested positive effect of product configurator use on time performance has been done as yet. Prior research on product configurators has focused on technical or application development issues, such as the logic structures that improve the modeling of product configuration knowledge (e.g., [13–17]) or the algorithms that make product configurators faster and more accurate (e.g., [18–22]). Fewer studies have treated the impact of product configurator use on company performance [6,2,23] and most of them are single-case studies whose findings may be legitimately questioned in terms of generalizability [24,25].

The present paper contributes to fill this gap by testing the positive impact of product configurator use on time performance on a sample of 238 mid- to large-sized manufacturing plants from three industries and eight countries representing North America, Asia and Europe. The analysis results support the hypothesized impact after the effects of time-based manufacturing practices, interfunctional integration and delivery priority on time performance have been removed. These results corroborate prior research findings on the time performance benefits of using a product configurator by providing empirical evidence with a higher degree of generalizability. These results also add to the wider debate surrounding information technology support to mass customization, where the latter is defined as the ability to fulfil each customer's idiosyncratic needs without substantial trade-offs in cost, time and quality performance [26–28].

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The remainder of this paper is organized as follows. In Section 2, we review the relevant literature and develop our research hypothesis. In Section 3, we describe our data and the operational measures used to develop the research constructs. Section 4 presents the results of the empirical analysis, while Section 5 concludes by discussing the theoretical and managerial implications of this study as well as its limitations and the associated directions for future research.

2. Literature review and hypothesis development

2.1. Product configurator: an application support to the product configuration process

Companies offering a wider variety of predefined and/or tailored product variants have higher information-processing needs during order acquisition and fulfilment [29]. During order acquisition, more information is to be exchanged between the company and the customer in order to communicate what the firm is able to offer, how these offerings meet specific customer needs, and on what price and delivery terms the transaction is possible. During order fulfilment, more information is to be processed within the company boundaries in order to translate the description of the product variant that the customer is willing to buy and the firm agrees to supply into the product data needed to build the end item (e.g., bill of materials, technical drawings, production sequence, etc.). As product variants proliferate, therefore, the product configuration process, which translates the individual customer's specific needs into correct and complete product information supporting order acquisition and fulfilment [12,2], is characterized by higher information-processing requirements.

Information technology has been used to cope with this problem since the 1980s, as documented in [30,4,31]. In those years, manufacturers of very complex products, such as Digital's minicomputers, developed specific applications designed to support the product configuration process: namely, product configurators. More recently, such applications have become a standard package of all major ERP suites (e.g., SAP, Baan, J.D. Edwards) and many other software vendors offer numerous solutions for small companies [2].

The fundamental functions of a product configurator [6,32,8] can be summarized as follows: communicating the company's product offerings to the customer; checking the completeness and validity of the description of the product variant that the customer is willing to buy and the company agrees to supply; providing real-time information on price, cost, delivery terms, technical characteristics, etc. of a product variant; making quotations; generating the product data necessary to build the product variant requested by the customer. To implement these functions, product configurators rely on logic structures that model product configuration knowledge [15]: namely, the sales configuration model and the technical configuration model [29]. The former is a formal representation of the company's product offerings, or product space [12], and of the procedures according to which a product variant can be generated or selected within that space. The sales configuration model includes sequences of questions, possibly supported by images and/or films, which guide the customer in progressively defining all product characteristics and prevent inconsistent or unfeasible characteristics from being defined. In turn, the technical configuration model is a formal representation of the links between the product characteristics codified into the sales configuration model and the data describing each product variant from a manufacturing standpoint (product code, bill of materials, production sequence, etc.). Therefore, the technical configuration model includes all the information and rules necessary to generate those data for each possible product variant within the company's product space.

2.2. Time performance

Along with cost, quality and flexibility, time is one of the basic performance dimensions of operations (e.g., [33–35]). Various terms have been used in the operations/manufacturing strategy literature to refer to this performance dimension, including delivery, dependability, and speed (e.g., [33,36,34]).

Besides terminological differences, the lack of precise and shared definitions is another problem that have plagued the literature on operational performance dimensions [37,38]. As regards time performance, a distinction can be made between external and internal time performance, depending on whether performance outcomes are directly perceived by customers or not [35]. Internal time performance comprises the four elements that typically make up production lead-times: namely, run time, set-up time, move time, and queue time [39]. These lead-time elements are perceived exclusively within the firm [35], although they may be a major determinant of the delivery lead-time experienced by customers. External time performance obviously includes delivery speed and reliability. Speed of delivery is defined as the elapsed time between customers requesting products or services and their receiving them, while delivery reliability is defined as delivering products or services when they were promised to the customer [40]. Another aspect of time performance that is directly seen from the outside of the company is the purchasing, production and distribution stacked lead-time [35]. This is because the purchasing, production and distribution cumulative lead-time influences the positioning of the customer order decoupling point [41] and, therefore, the way a firm responds to customer requests (e.g., according to a make-to-stock, rather than make-to-order mode of operation). Finally, external time performance comprises time-to-market, defined as the time required to develop a new product or service [35]. This is because engineering activities may be routinely performed prior to purchasing, production and distribution in the operational value chain [42] and, consequently, may influence the way a firm responds to customer requests [35].

2.3. Relating product configurator use to time performance

Three fundamental mechanisms explain the impact of product configurator use on time performance. A first mechanism is reduced reliance on ad hoc solutions to fulfil idiosyncratic customer needs. Product configurators enable automated generation of product data (bill of materials, production sequence, etc.) that univocally correspond to the set of product characteristics requested by the customer. Automated generation of product data allows the company to systematically reuse the same solution whenever the set of customer specifications is the same [43,23]. Conversely, without the support of a product configurator, an ad hoc solution could be designed even when an adequate product variant already exists, just because it is too laborious to search for the related product data [5,44]. Product configurators also enable the company to provide real-time information on product price, cost and, sometimes, delivery terms to the customer. Such information may be used to drive the customer toward a pre-defined solution that costs less than an ad hoc solution and equally fulfils his/her specific needs [6]. The reuse of validated solutions shortens manufacturing lead-times through faster learning [45] and by reducing complexity of production systems [46]. Additionally, delivery may be accelerated also because increased requirements of pre-defined components and subassemblies may justify the build-up of speculative inventory of these parts [47]. Finally,