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Impact of product configuration systems on product profitability and costing accuracy

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ABSTRACT

This article aims at analyzing the impact of implementing a product configuration system (PCS) on the increased accuracy of the cost calculations and the increased profitability of the products. Companies that have implemented PCSs have achieved substantial benefits in terms of being more in control of their product assortment, making the right decisions in the sales phase and increasing sales of optimal products. These benefits should have an impact on the company's ability to make more accurate cost estimations in the sales phase, which can positively affect the products' profitability. However, previous studies have not addressed this relationship to a great extent. For that reason, a configure-to-order (CTO) manufacturing company was analyzed. A longitudinal field study was performed in which the accuracy of the cost calculations and the products' profitability were analyzed before and after a PCS was implemented. The comparison in the case study revealed that increased accuracy of the cost calculations in the sales phase and consequently increased profitability can be achieved by implementing a PCS.

1. Introduction

In today's business environment, companies are forced to offer customized solutions without compromising delivery time, quality and cost [1]. To respond to these challenges, mass customization strategies have received increasing attention over the years, from practitioners and researchers. Mass customization refers to the ability to make customized products and services that fit every customer through flexibility and integrations at cost similar to mass-produced products [2]. Utilizing product configuration systems (PCSs) is one of the key success factors in achieving the benefits of the mass customization approach [2,3].

PCSs are used to support design activities throughout the customization process, where a set of components and their connections are pre-defined and where constraints are used to prevent infeasible configurations [4]. Companies that have implemented PCSs have achieved numerous benefits such as shorter lead times, more on-time deliveries, improved quality, less rework and increased customer satisfaction [1,5–7]. In addition, the supportive function of the PCS enables improved decision making in the early phases of engineering and sales processes [8]. Furthermore, the system can be used as a tool that allows the salesperson to offer custom-tailored products within the boundaries of standard product architectures, thus giving companies the opportunity to be more in control of their product assortment [1]. It can be assumed that these benefits will have an impact on the company's ability to increase the accuracy of the cost calculations in the sales phase, which can positively affect the products' profitability. However, the link between the implementation of a PCS and the effects on the company's ability to increase the accuracy of the cost calculations in the sales phase and consequently increase the products' profitability has not received much attention from researchers [9]. Thus, the focus of this study is assessing the impact of implementing a PCS on a company's ability to make accurate cost calculations in the sales phase and products' profitability. Aiming to investigate these effects, the following propositions were developed:

Proposition 1. *The accuracy of the cost calculations in the sales phase is increased by utilizing a PCS.*

Proposition 2. *Product profitability is increased by utilizing a PCS.*

To test the propositions, a longitudinal field study was performed in a configure-to-order (CTO) company. In 2009, an analysis of product profitability and the accuracy of the cost calculations in the quotations generated in the sales phase was conducted. The results indicated that the performance of the sales processes could be significantly improved by implementing a PCS.

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That recommendation was adopted by the company; thus, a PCS was developed and implemented in 2011. Although the company has used the PCS since 2011, some salespersons still have not accepted the system and therefore generate quotations outside the PCS. This behavior provides an opportunity to compare quotations generated with the PCS and without the PCS over a 4-year period after the implementation. The results indicate that the quotations generated in the PCS have more accurate cost calculations, and consequently, the profitability of the products sold via the PCS is higher.

2. Literature review of the benefits of utilizing PCSs

In this section, the theoretical background of the present research is reported. To find relevant articles, a literature review was performed in the research area of PCSs. The focus of the literature review was identifying the main benefits and challenges of implementing and utilizing PCSs. Several research groups have conducted extensive studies in this field.

2.1. Benefits

First, the benefits identified by utilizing a PCS are discussed. As the focus of this study was to assess the impact of implementing a PCS, quantitative data were required. The results from the literature study are presented in Table 1. The benefits discussed in the literature are listed, and the articles discussing the benefits are listed in the second column. The last column specifies whether the impact of the utilization of a PCS was measured and shows quantitative data from the benefits identified.

Summarizing the findings from the literature review, the implementation of a PCS provides various benefits to companies, in terms of resource reduction, decreased lead time, better communication with customers and improved product quality (Table 1).

There is a lack of empirical evidence that measured the impact of implementing PCSs on improved profitability and more accurate cost estimates. The present work contributes to the literature by providing a longitudinal field study that compared the economic performance of the products and the accuracy of the cost calculations before and 4 years after a PCS was implemented in an industrial manufacturing company.

2.2. Challenges of implementing a PCS

In this section, the literature focuses on the challenges and practical implications of implementing PCSs. The challenges refer not only to the scope of the PCS but also to the implementation and utilization of the system by employees and its acceptance as part of their daily work routine. The following table summarizes the main challenges identified in the literature (Table 2).

The implementation of PCSs is not free of challenges during the process. This is explained in the difficulties faced by the users and the developers of PCSs related to supporting customers' needs in the configuration process, product modeling and data acquisition, errors in the configuration process, documentation and maintenance and challenges regarding change management and acceptance of the system as part of the work procedures.

3. Research method

This research was conducted as a longitudinal field study, where the impact of implementing PCSs was analyzed, focusing on the accuracy of the cost calculations and profitability. The research was conducted as a collaboration between the Technical University of Denmark (DTU) and the case company over the 2009–2014 period and included multiple observations of the change process. The research team monitored the implementation and the impact of the PCS from the beginning until the PCS was fully integrated into the company's business processes. The company was selected as it is highly representative of medium-sized CTO companies that provide highly customized products and operate globally.

A longitudinal field study was selected as the research method for this work as this design allows the team to make real-time and in-depth observations of the change process and development in organizations [29,30] and specifically in this case, the process of implementing and utilizing a PCS over a 4-year period. Longitudinal field studies are a special type of case study in which the phenomenon is studied in its natural setting over time using

Table 1
Benefits obtained from implementing PCSs.

Benefit	Authors	Measurement
Reduction in lead time for making specifications	[1,5,7,10–16]	From 5–6 days to 1 day [10] The real working time for preparing offers and production instructions is near zero [11] 75–99.9 % reduction in the quotation lead time [7] 15–25 days to 1–2 days [12]
Reduction in lead time for delivering the product	[11,14–18]	Delivery time reduced from 11 to 41 days to 1 day [11]
Saved work-hours	[1,10,12,15–19]	The engineering hours for creating quotations were reduced from 5 work-weeks to 1 to 2 work-days [12] Throughput cycle was reduced from 6 days to 1 day [19]
Increased quality of product information/ specifications	[1,6,10,12–16,18–23]	Reduction to almost zero of errors in configurations released by the sales office [1] Increased level of correctness of product information to almost 100% [10] Specifications quality improved from 60% to 100% manufacturable [19]
Improved product quality	[21,24]	N/A
Improved on-time delivery	[1,10,25]	N/A
Increased employee productivity	[1,14,22]	N/A
Lower production costs	[11,21]	Fixed production costs were reduced by 50% and variable costs by 30% [11] Reduction from 30% to less than 2% in the number of assembly errors [11]
Improved efficiency in aftersales	[11]	Time for replacement was reduced from 5 to 6 h to 20–30 min [11]
Improved knowledge management	[1,6,11,22,26]	N/A
Improved control of product variants	[1,10,20,25]	N/A
Reduced product lifecycle cost	[27]	PCS supporting the complete configuration process may reduce the configuration cost up to 60% over the product lifecycle [27]
Increased customer satisfaction	[21]	N/A
Improved customer relationships/ communications	[1,10,13,20,22,26]	N/A