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Return on investment from the use of product configuration systems – A case study

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ABSTRACT

Product configuration systems (PCS) are increasingly being used in industrial companies to enable the efficient design of customized products. The literature describes substantial benefits that companies have achieved from the use of PCS, such as reduced resource consumption, reduced lead-time, improved quality, and increased sales, which should lead to a significant return on investment (ROI). However, there is little detailed quantification of the benefits, costs, and ROI from using PCS in the literature. Thus, the true value of PCS remains unknown. Hence, this study quantifies (1) the benefits in terms of reduced man-hours, improved quality of specifications, reduced lead-time, and increased sales and (2) the costs of development, implementation, and maintenance of PCS. Based on this, the ROI is calculated. The analyses presented in this study are based on a world-leading company in pump manufacturing. This study verifies the benefits of PCS that are described in the literature. Further, it contributes to the field by introducing a method to quantify the related benefits, costs, and ROI. Finally, the article illustrates how PCS can be used in companies having product portfolios consisting of a standard to engineered products.

1. Introduction

In today's business environment, customers are increasingly demanding customized products that can be delivered within a quick turnaround time and at competitive prices [1]. In response to the emerging challenges, mass customization strategies have received increased attention from both industrial practitioners and researchers in recent decades. Mass customization refers to the ability to provide customized products and services with flexibility and at a cost similar to that of mass-produced products [2]. To enable the successful implementation of mass customization, companies need to develop a solution space that can enable robust process design and navigational choice over the existing systems [3]. One way of achieving mass customization is by designing more modular products for which a product configuration system (PCS) is used in the customization process [2]. A PCS is used to support design activities throughout the customization process, during which a set of components and their connections are pre-defined and constraints are developed to prevent infeasible configurations [4].

The literature describes numerous benefits of implementing a PCS to support specification processes. A specification process can be defined as a process that is concerned with generating different product specifications (e.g., quotes, sales prices, bill of materials, CAD models), which normally involves employees from different departments [1,5]. Companies utilizing a PCS demonstrate better capability in terms of offering a variety of products, improving product quality, simplifying the customer-ordering process, and reducing the complexity of both processes and products, in addition to increased product profitability [6–10]. Further, a PCS facilitates knowledge sharing, uses fewer resources, optimizes product designs, performs less routine work, ensures timely delivery, reduces the time required to train new employees, and augments the product related and experience related benefits perceived by customers [1,11–20].

The literature confirms that companies can achieve a positive return on investment (ROI) from using PCS [21–24]. However, while the literature explains both the benefits and the ROI from using a PCS, further research is needed to understand the process leading to this value creation and to perform a comparison of the benefits (e.g., reduced

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man-hours and lead-time, improved quality, or increased sales) and the cost (e.g., the development, implementation, and maintenance) of the PCS. ROI is used to measure the ratio of cost to benefit, and it is a performance measure that is employed to evaluate the efficiency of a number of different investments [25].

The aim of this article is, therefore, to provide more understanding of the value creation from implementing and utilizing a PCS and to provide an operational method to evaluate this value creation. More specifically, the objective of the article is to analyze the benefits and costs so that ROI can be calculated. Additionally, the process changes and the product coverage of the PCS are elaborated based on a case company, which is a global manufacturing firm with a product portfolio consisting of a standard to engineered products. To address these issues, the following research questions are developed:

RQ 1: How to quantify the costs, benefits and ROI from developing, implementing and utilizing PCS?

RQ 2: What are the costs, benefits, and ROI from developing, implementing and utilizing a PCS?

To answer the research question, this article first determines whether prior research quantifies the benefits, costs and ROI of developing, implementing and utilizing a PCS. Additionally, the literature is reviewed to identify the different production strategies in companies making both standard and engineered products and how a PCS support these activities. Next, a case study was conducted at Grundfos, which is a global company producing industrial pumps that utilize a PCS to support its sales and specification processes.

The remainder of this paper is organized as follows. Section 2 presents a literature review, and Section 3 describes the research method. Section 4 contains the main results of the case study analysis. Finally, Section 5 discusses these results, generates the conclusions, and provides a direction for future research.

2. Literature review

In this section, the literature background for the study is presented, first, in terms of the PCS and different manufacturing strategies. Second, the benefits, costs, and ROI are elaborated. Finally, based on the relevant literature, we establish our research focus.

2.1. PCS and product structure

The configuration task can be described in terms of a pre-defined set of components, which are described by a set of properties (attributes) and their values, connections of the components (parts), and constraints to prevent infeasible configurations [4,26]. A PCS can be implemented both to support the end-user of the product and/or as an internal tool to increase efficiency by improving the dialogue with the customer and automating the generation of product specifications [1,5,15,17,27,28].

In line with the configuration task, companies need to define parts/modules and constraints that ensure that only allowed combinations can be selected. Product architecture can be defined as (1) the arrangement of functional elements; (2) the mapping from functional elements to physical components; or (3) the specification of the interfaces among interacting physical components. [29]. The highest degree of modularity occurs when each functional requirement can be directly connected to one module and where there are few interactions between the modules, making it possible to change specific modules without affecting other parts of the design [30].

The customer-order-decoupling point (CODP), distinguishes between the work carried out before and after the customer places the order and is commonly defined to classify companies' order fulfilment strategies [1]. Thus, the CODP can also be defined in terms of the separation of decisions made under uncertainty from decisions are made based on customers' demand, where the position of the CODP determines the optimal balance between productivity and flexibility in companies [31]. The literature discusses configure-to-order (CTO) versus engineer-to-order (ETO) strategies, where CTO strategies are based on combinations of modules/components according to the rules defined in the PCS, whereas ETO denotes orders for which it is necessary to go beyond the modules/components and rules defined in the PCS when designing customized products [1,6,32]. Many companies however operate in a span between CTO and ETO strategies where it can be a challenging task to find the appropriate degree of standardization and automation [33–36]. Wikner and Rudberg [35] elaborate on the CODP, which focuses on the production dimension, by adding the engineering dimension. Different archetypes of ETO companies (i.e., complex ETO, basic ETO, repeatable ETO and non-competitive ETO) can be defined based on engineering complexity (man-hours used for engineering of a product) and volume (units of products sold on yearly base) [34]. Another classification of ETO companies is presented by Gosling et al. [36] based on customer penetration concepts where nine potential subclasses are proposed.

2.2. Economic value creation from implementing and utilizing a PCS

The PCS literature describes numbers of benefits from using these systems. In particular, three benefits are widely discussed and considered to be directly linked to cost savings: (1) a reduction in resource consumption (man-hours) and lead-time, (2) improved quality of product specifications, and (3) increased sales. Second, previous works that have addressed the cost in relation to a PCS, which is defined based on the cost of developing, implementing, and maintaining the systems, is reviewed. Third, the literature that has addressed the ROI related to a PCS is elaborated.

2.2.1. Cost savings related to the benefits of implementing a PCS

Previous works have shown that the use of a PCS results in *reduced man-hours and lead-time when generating product specifications* [6,17,21,23,24,37–50]. Even though this benefit is the most commonly mentioned and quantified in previous studies, the literature does not explain the extent to which reduced man-hours and lead-time result in direct cost savings. Table 1 summarizes the studies that quantify the reduction in man-hours and lead-time due to the utilization of a PCS.