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## Complexity Management in Mass Customization SMEs

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### Abstract

As mass customization is being widely adopted, manufacturing companies are faced with an increasing challenge of establishing and maintaining manufacturing systems with sufficient flexibility to meet customers' diverse needs and yet be efficient enough to be competitive. This is also the case in Small and Medium Sized Enterprises (SMEs), which are also experiencing a demand for increased product variety. However, increased variety in the product portfolio often implies increased complexity in manufacturing costs, which combined with low manufacturing volumes in SMEs often implies that parts of the product portfolio may prove unprofitable. This is often found to be a product management issue, where complexity increases over time, as new variety is introduced in the product portfolio, not following an explicit procedure for assessing impact of increased product variety and complexity. This paper investigates the impact of excess product variety and complexity in four different SMEs, and describes experiences with using a structured approach to assessing variety and consolidating the product portfolio. The issues found in the cases are SME specific, as the volume-variety relationship as well as the organizational resources available to perform product management in relation to new product development and adaption of the product portfolio to accommodate requirements for specific customer orders.

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### 1. Introduction

Mass Customization is a business strategy, for which the goal is to sell and manufacture goods, which are individually customized to fit individual customers' needs, while doing so at a cost level close to similar mass-produced products. Mass Customization, introduced by Davis [1] and later operationalized and popularized by Pine [2] in the early 1990's, has since its introduction been receiving increased attention and adoption within an increasing number of different industries. Academically, Mass Customization can be defined as "producing individually customized products at a cost near mass production" [2]. Mass Customization has also grown to become a well-researched topic [3, 4], and several sub-disciplines can be identified when reviewing literature, ranging from logistics, through strategy, IT-systems and planning to organizational issues. A recent study however suggested that

the capabilities, which are uniquely critical for mass customizing companies are three fundamental capabilities [5]:

- Solution space development "the ability to identify the product attributes along which customer needs diverge" [5]
- Robust process design "the ability to reuse or recombine existing organizational and value-chain resources [5]
- the ability to help customers identify or build solutions to their own needs [5]

As stated above, much research has focused on different aspects of mass customization, and a query on "mass customization" on Elsevier's research database Scopus returned over 3,000 results. However, the research on mass customization in small and medium sized enterprises has a very limited extent. A recent literature review on mass customization in SMEs identified less than 40 publications

available through Scopus and Thomson Reuters Web of Science [6]. According to Eurostat, in the European Union 22.3 million SMEs were operating in the non-financial business. These SMEs contributed with 57.5% of the value added in this sector in EU, and employed 67% of the workforce. Furthermore, it is commonly acknowledged, that the challenges in operating an SME are significantly different from those experienced in large enterprises. As Welsh expressed it already in 1981: “A small business is not a little big business” [7]. Given that SMEs are vital to the European economy, and the fact that very little research has invested in mass customization research, it seems there is a research gap that needs to be addressed. One challenge, which can be found in both SMEs and large enterprises, is the challenge of increasing product variety .

Various research has concluded that excess complexity in a company's product portfolio has a negative influence on Operative performance. An empirical study by Adani et al. reported that best practice companies in reducing complexity in terms of component standardization and number of suppliers were able to perform significantly better on several operative performance parameter such as running capital cost, obsolescence cost, transportation cost and administrative cost, compared to the average of that particular industry [8].

When companies engage in mass customization, it is inevitable that product variety increases, and there is hence a risk of a reduction in operational performance. On the other hand, the competitive environment in Europe, especially parts of Europe with high wages, such as Denmark, pursuing a mass customization strategy is often a necessary business strategy, since the production of standard products is often performed in low wage countries in the Far East. Hence, these companies must find a way to balance product variety with standardization and efficiency. It has long been acknowledged that modularization and product platforms are effective ways of addressing the tradeoff between variety and commonality [9, 10], however, many SMEs still find challenges in operationalizing these principles.

Complexity management is a term, which refers to how companies can handle increased product variety, and thereby complexity in product portfolios, and complexity in business processes and manufacturing. The focus of this paper is centered on the combination of complexity management and SME. The research question of this paper is:

*What are the major challenges SMEs experience in relation to complexity management and how can these challenges be addressed?*

In this paper we delimit the study to the part of complexity management which related to controlling and reducing product variety, since reductions in product variety will usually lead to reductions in other types of complexity, such as process complexity, supply chain complexity etc.

## 2. Methods

Since very literature exists on complexity management in SMEs we have chosen to address the research question using a multi case study as this allows us to explore a wide range of different companies in different businesses and with different

challenges. Five different companies are included in this study. The included companies are all SMEs which are manufacturing customized durable goods. The companies were studied during the course of a research and knowledge dissemination project focusing on mass customizing SMEs. The aim of the project was to disseminate state of the art knowledge on mass customization and related methods to Danish SMEs manufacturing customized products. The five SMEs are described briefly below and referred to as case A through E:

**Case A** is a company manufacturing customized and high-end luxury building components. This company has in the range of 20-49 employees. Products are manufactured in various wooden materials with smaller metal components. Product variety is on materials, dimensions and combinations of different additional components.

**Case B** is also manufactures customized building components, however mid-range high quality products. This case has in the range 50-99 employees. Products are manufactured in various wooden materials with smaller metal components. Product variety is on materials, dimensions and combinations of different additional components.

**Case C** manufactures heavy contractor equipment and employs around 200 people. Products are assembled from a high number of primarily metal components which are a combination of own production components and components from sub-suppliers.

**Case D** Also manufactures contractor equipment but employs only in the range of 20-49 people. Products are assembled from a high number of primarily metal components, which are sourced from sub-suppliers.

**Case E** manufactures small components for process equipment and employs in the range of 20-49 people. Products contain a few components and are assembled mainly from metal components of own production and a small number of purchased standard components.

Throughout the project, a number of workshops were conducted where companies were asked to map their product variety and asses this product variety in relation to customer demand for variety. This was done using the method described by Mortensen et al. [11] called product variant master, where three views; customer, engineering and production view are modelled using two mechanisms; the “part of” and the “kind of” mechanisms. The “part of” mechanism corresponds to BOM like product breakdown, and “kind of” corresponds to branching, where different modules can be used in the “part of” structure.

Together with each company, areas were selected for further analysis and transfer of knowledge on methods to improve the company. In the results section below, the challenges experienced by each company will be described, as well as potential solutions identified through the project as well as an analysis of why these challenges are considered SME related.

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