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The reduction of product and process complexity based on the quantification of product complexity costs

Complexity management is an increasing challenge for industrial companies. To address this issue, this paper develops a procedure to reduce the complexity of products and processes. This procedure includes five steps: (1) definition of the scope of the products and processes to be included in the analysis, (2) grouping of products into A,B, and C categories, (3) identification and quantification of the most important complexity cost factors, (4) identification of initiatives for the possible reduction of complexity costs and the quantification of possible cost savings, and (5) evaluation and prioritisation of initiatives. To test the usefulness of the suggested procedure, it was applied at a globally leading manufacturer of mechanical consumer products. The case study demonstrated the usefulness of the proposed procedure in (1) supporting the allocation of complexity costs in relation to individual product variants, (2) achieving a better understanding of the cost structure of product assortment and business processes, and (3) providing a basis for generating and evaluating initiatives aimed at reducing the complexity of products and processes. The case study also showed that the use of the procedure can produce considerable financial benefits.

Keywords: complexity management; complexity costs; quantification of complexity costs; complexity reduction; product architecture

1 Introduction

Complexity management involves identifying and reducing complexity within companies, which relates to products, business processes, and organisation, as well as the relationships between them (Wilson and Perumal 2009). Companies increasingly experience complexity due to a number of factors, including more diverse markets and groups of customers, product variants, subassemblies and components, production sites and sub-suppliers, distribution centres and customers, organisational levels, and shifts in responsibility within the organisation (Jacobs and Swink 2011).

This paper focuses on the complexity of products and processes only in order to limit the scope of the topic. Different definitions of product complexity can be found in the literature, and they relate to, among other areas, the number of functions offered by the product, the number of different core technologies incorporated into it, and the interfaces between its parts, functions, and technologies (Lakemund et al., 2013). In other words, product complexity increases the demand for resources and skills of the ones managing these. Process complexity has been defined as “the degree to which a process is difficult to understand or carry out” (Muketha et al. 2010), which is also the definition used in this paper.

Increasing complexity is considered a major cause of the rising costs and deterioration of operational performance, leading in particular to decreased quality, long delivery times, delayed deliveries, and low process flexibility (Mariotti 2008). Therefore, companies need to gain an awareness of their levels of complexity and determine how this affects their competitiveness. However, many companies find it difficult to identify and quantify the most important costs of complexity and to prioritise possible initiatives to reduce complexity. In this vein, this paper raises the following question: *How can industrial companies reduce product and process complexity?* To address this research question, this paper proposes a procedure that aims to reduce product and process complexity. This is achieved by identifying

product complexity costs, the basis on which product complexity can be reduced, as well as the processes used to handle this product complexity.

The costs of product and process variety can be reduced in various ways—for example, by increasing part commonality, postponing the point of product differentiation (Olhager, 2003; Forza et al. 2008; Trentin et al. 2011), and lowering setup and changeover costs (Closs et al. 2008; Jacobs and Swink 2011). However, as the actual complexity costs and the potential for reducing them vary from company to company, it can be difficult to provide general recommendations. Therefore, in this paper, cost is applied as the universal metric to relate complexity cost factors and initiatives to each other. The five-step approach presented in Hansen et al. (2012) is further developed in this article.

The remainder of this paper is structured as follows. Section 2 discusses the literature on complexity identification, quantification, and reduction. Based on this discussion, Section 3 defines a procedure for product and process complexity reduction. Section 4 describes the research method, and Section 5 presents the case study to which the procedure was applied. Section 6 discusses the lessons learned from the application of the suggested procedure, and Section 7 presents the conclusions.

2 Literature review

The purposes of this literature review are (1) to define the field towards which the paper's contributions are aimed and (2) to demonstrate that there is a relevant gap in the literature. Thus, this section focuses on the literature related to product and process complexity, the quantification of complexity costs, and the strategies used for complexity reduction.

2.1 *Product complexity*

Product architecture is widely recognised as a crucial determinant of product complexity (ElMaraghy et al. 2013), and product architecture management enables the efficient design of

new products that are targeted at individual market requirements. Furthermore, product architecture is considered a means of controlling the structure of the product assortment and the number of product variants, both of which affect the performance of sales, engineering, the production/supply chain, distribution, after-sales service, and so on (Meyer and Lehnerd 1997; Olivares Aguila and ElMaraghy 2018; Thumm and Goehlich 2015). Additionally, the literature on design for manufacturing discusses how to control product variety (e.g. Arashpour et al. 2016; Ulrich and Eppinger 2008).

A major cause of the increasing complexity in manufacturing environments is product variety (MacDuffie 2013; Schaffer and Schleich 2008). In this context, Wildemann (2001) performed an empirical study in the manufacturing industry to examine how the number of product variants affects unit costs. A comparison of a traditional manufacturing system with one that had flexible automated plants showed that with double the number of product variants in the production programme, the unit costs would increase by about 20%–35% for industries with traditional manufacturing systems, while in systems with segmented and flexible automated plants, the unit costs would increase by only 10%–15%.

A number of approaches and techniques have been proposed to control product architecture. For example, Meyer and Lehnerd (1997), Xie, Yang and Tu (2008), Lindemann, Maurer, and Braun (2010), Mortensen et al. (2010), Haug, Hvam and Mortensen (2013) and Zheng, Liu and Xiao (2018) have suggested approaches that deal with the implementation of product architecture and the reduction of complexity in the product range.

Several techniques for modelling product assortments have also been outlined (e.g. Ericsson and Erixon 1999; Hvam 2001; Lu, Petersen, and Storch 2007; Yang et al. 2008; Haug, 2010; Hvam, 2010; Chiu, Chu and Chen, 2017). In this context, Haug (2013) and Hvam et al. (2018) have investigated the effects of applying such modelling techniques. Such

product models help in managing the complexity induced by product variety and in many cases are implemented into product configurators (i.e., expert systems aimed at supporting sales or engineering activities) so that the knowledge they contain can be exploited in an automated way (Zhang, 2014; Kumar, 2018; Hvam et al., 2018).

2.2 *Process complexity*

ElMaraghy and Urbanic (2003) identified two factors that increase complexity: (1) the number and diversity of the features to be manufactured, assembled, and tested and (2) the number, type, and effort of the tasks required to produce the features. Samy and ElMaraghy (2012) defined complexity as ‘a measure of how product variety can complicate the production process’. Similarly, Sivadasan et al. (2002) described two types of complexity in the supply chain: structural complexity (which increases with the number of elements) and operational complexity (which increases with the uncertainty of information and element flows).

Complexity in business processes is closely related to the complexity of the product assortment. Therefore, product architecture decisions can be used to control not only the complexity in product assortment but also the cost and performance of business processes (Lindemann, Maurer, and Braun 2010). Jacobs and Swink (2011) reviewed the existing research, based on which they defined a three-dimensional model that describes the nature of product portfolio complexity. In addition, Kerstin et al. (2012) showed how to analyse a company’s optimal supply chain as a function of its product portfolio, and ElMaraghy et al. (2012) discussed the types of complexity involved in products, engineering, and manufacturing. Several researchers in the field of supply chain management have also suggested various methods of analysing and controlling complexity from a supply chain viewpoint (Bozarth et al. 2009; Choi and Krause 2006; Perona and Miragliotta 2004; Wu, Frizelle, and Efstathiou 2007). Also, the literature on lean manufacturing (e.g. Shah and Ward

2007) discusses how to apply it to improve production efficiency, but there is little focus on how product complexity would impact production.

Blecker et al. (2004) described how to apply mass customisation to eliminate the process complexity caused by the increasing variation in the product architecture, inventory, and order-taking process, and they discussed the relationships between mass customisation and complexity. On the one hand, when applied as a pure customisation strategy, mass customisation increases product variety, which results in high planning and scheduling complexity; on the other hand, as the customer-order decoupling point moves towards the front end, mass customisation reduces product configuration and inventory complexity (Blecker et al. 2004). The degree of product customization impact complexity in several ways since it deeply impacts the organizational design for mass customization (Sandrin et al., 2014). However, a company in choosing its degree of product customization is influenced by several factors and in particular the demand dynamism (Sandrin, 2016).

2.3 The quantification of complexity costs

Activity-based costing (ABC) suggests the allocation of overhead costs to individual activities. Cooper and Kaplan (1988), among other researchers, proposed ABC as a method to avoid the deficiencies of the arbitrary allocation of overhead costs. ABC first allocates indirect costs to the activities performed using shared company resources and thereafter assigns these to individual orders, customers, or even products.

Anderson and Kaplan (2007) proposed an efficient cost-modelling principle called time-driven ABC (TD-ABC) that assigns resources (e.g. the costs of a customer service department) directly to cost objects (e.g. order handling) and connects these to the unit times for performing transactional activities in order to achieve a simple cost rate measure that is

based on time consumption. Park and Simpson (2008) described a method of applying ABC in the early stages of product development, which focuses on product families.

Lechner, Klingebiel, and Wagenitz (2011) proposed the use of variety-driven ABC (VD-ABC) to quantify the impact of adding or removing product variants in automotive logistics, based on the use of hypothetical zero-variant initiatives. This method is an expansion of the TD-ABC framework, which enables the calculation of incremental complexity costs associated with variants in different logistical operations. Jacobs (2013) discussed possible metrics for measuring complexity. Zhang and Thomson (2018) described how to apply knowledge-based measures of product complexity. Muketha et al. (2010) identified the metrics that are applied to measure process complexity.

The aforementioned methods of cost allocation distribute overhead costs to specific activities, but they do not focus solely on the most important costs; this means that a vast amount of data is needed and that undertaking the calculations requires considerable work. Rogozhin et al. (2010) thus suggested a method of adjusting the allocation of indirect costs in the automotive industry to obtain a more accurate estimate of the costs of adding new technology. Zhang and Tseng (2007) proposed a modelling approach to analyse the cost implications of product variety in mass customisation by bridging product variety and process variety; this was done by identifying cost drivers within the product design and including the manufacturing costs. Orfi, Terpenney, and Sahin-Sariisik (2011) proposed a set of product complexity dimensions (variety, functionality index, structural index, design index, and production index) and, along with these a set of associated indicators that consider the cost impact of the product complexity dimensions. Wan, Evers, and Dresner (2012) outlined the impact of product variety on operations and sales performance, using unit fill rate as the measure.

2.4 *Strategies for reducing complexity costs*

The calculation of complexity costs is an area that is of particular interest in this research because the aim is to rationalise a product programme with a view to allocating the true complexity costs to the product variants (Hansen et al. 2012). Several researchers that discuss the frameworks for assessing product profitability and cost behaviour have been identified in this field (ElMaraghy et al. 2013; Mariotti 2008; Sivadasan et al. 2002; Wan, Evers, and 2012; Wang et al. 2011; Wilson and Perumal 2009; Zhang and Tseng 2007). For example, Wilson and Perumal (2009) offered several top-down approaches to address interrelated product–process organisational complexity from a managerial perspective by dividing complexity costs into those that are value adding (good complexity) and those that are non-value adding (bad complexity), and Closs et al. (2008) and Jacobs and Swink (2011) provided a list of possible strategies for reducing complexity. Additionally, a number of product variant rationalisation approaches focus on different ‘tail-cutting’ methods (often called stock-keeping unit [SKU] rationalisation), some of which show that no relationship exists between the number of SKUs and the market share (Mahler and Bahlkar 2009). Table 1 summarises the literature.

Table 1. Summary of literature

	Contributions	Gaps
Product complexity	Product architecture as a means of controlling product variety Examples of impact of increased product variety on	How to identify the most critical drivers of complexity cost between product variety and process complexity

	production costs	
Process complexity	Examples of how product variety impacts the costs of production processes and of how, e.g., mass customisation strategies can improve the ability to handle increased product variety in these processes	Methods of identifying the most important product variety factors that impact process complexity
Quantification of complexity costs	Examples of allocating overhead costs to products and production processes	Focus on only the most important complexity cost drivers in order to reduce the amount of data and number of resources needed for the analysis
Strategies for reducing complexity	Approaches to the top-down management of product-process and organisational complexity; bottom-up approaches to reducing product variety	Identify potential areas for improvement based on the quantification of the most important complexity costs

From the literature review, it emerges that a number of approaches have been proposed for modelling and controlling complexity in product architecture and for analysing complexity in

business processes. In relation to the quantification of complexity costs, ABC provides methods of allocating overhead costs to specific activities, and several approaches are used to assess the cost of product complexity. However, to the authors' knowledge, the existing literature fails to provide simple and operational methods of identifying the most significant complexity costs of products and processes and of quantifying this complexity using limited data and resources. Furthermore, the literature that discusses possible strategies for complexity reduction does not link this discussion to specific and simple methods of identifying and quantifying complexity costs or identifying the most relevant initiatives for reducing complexity costs in products and operations.

3 A procedure for reducing product and process complexity

The following five steps for reducing product and process complexity were developed based on the literature review:

1. Define the scope of the products and processes to be included in the analysis.
2. Conduct ABCC (A, B and C categorization) analysis of products.
3. Identify and quantify the most significant complexity cost factors.
4. Identify and quantify possible initiatives for the reduction of complexity costs.
5. Evaluate and prioritise initiatives to establish a complexity cost reduction programme.

These five steps are described in the following subsections.

3.1 Step 1: Defining the scope of products and processes to be included in the analysis

The first step involves delimiting the analysis by determining which products to include in it and establishing whether it should focus on the finished-goods level only or should also include module levels in the product assortment (George and Wilson 2004). Furthermore, the

scope is defined in terms of which parts of the process flow to include in the analysis—for example, sales, production, sub-suppliers, sales distribution, and after-sales service. When the scope is determined, the products are described using posters that show the features that are relevant to understanding the differences between the product variants—for example, capacity, power supply, dimensions, and colours (Hvam, Mortensen, and Riis 2008; Yang et al. 2008).

To restrict the amount of data and time necessary for the analysis, it is advisable to select a limited number of product families for inclusion, and they should be produced at a limited number of production sites and perhaps sold in a limited number of regions worldwide. It is possible to include product families from high- and low-end market tiers, providing there is adequate similarity in the ways in which the products are manufactured and handled internally to enable them to be analysed concurrently.

3.2 *Step 2: Conducting an ABCC analysis of products*

The second step, ABCC analysis of products, split the products into A, B, and C categories. The purpose of applying this type of analysis is to identify (and, later, possibly eliminate) product variants that contribute only minimally to revenue but imply significant additional complexity. As a rule of thumb, the Pareto distribution can be used to separate the product variants into the three categories (Koch 2008). In practice, the statistical analysis of the revenue data could give rise to more advantageous distributions. However, if it is assumed that the Pareto distribution makes sense in a particular setting (if not, then the percentages should be adjusted), the products in category A are the variants that contribute to 80% of the contribution margin (i.e., product price minus all associated variable costs), the B products are the variants contributing the next 15% of the contribution margin, and the C products are those accounting for the remaining 5%. The contribution margins are calculated as ‘contribution margin 1’, which is defined as sales price minus direct production costs. When

undertaking the double Pareto analysis, some products fall outside the three categories. These products are listed separately and are put into one of the three groups, based on an assessment of where they would have the strongest clustering.

A similar analysis can be undertaken for the customers of the product range to determine which ones are the most profitable. Therefore, for each customer (or group of customers), the contribution margin and the revenues are plotted in a diagram in the same way as described for products (George and Wilson 2004; Wilson and Perumal 2009).

The revenues of the included product variants are determined by collecting the realised revenues of all the variants from all the sales of the companies within a given period (e.g. 6, 12, or 18 months). For this, the revenues reported might have to be adjusted for deviations arising from customs, currencies, and discounts. The direct production costs (including those related to materials and wages) should be reported directly from the factories. Based on this, a contribution margin (named contribution margin 1) for each product variant is calculated by subtracting the cost per item from the revenue per item. The revenue, cost, and contribution margin 1 are added to the poster described in step 1, and the contribution margin 1 and revenue for each product variant are plotted in a diagram with revenue on the horizontal axis and the contribution margin on the vertical axis (Wilson and Perumal 2009). Both axes use a logarithmic scale.

3.3 Step 3: Identifying and quantifying the most significant complexity cost factors

The purpose of step 3 is to identify and quantify the most significant complexity cost factors (i.e. fixed costs in the cost distributions, each of which accounts for more than, for example, 1% of the total cost) with an uneven distribution of costs between the product variants (Park and Simpson 2008; Wilson and Perumal 2009). This step is important because it directs focus towards the analysis, avoids wasting resources on analysing superfluous data, and identifies

the most significant complexity drivers that should be addressed when identifying initiatives for reducing complexity.

The starting point is to brainstorm on possible complexity cost areas that have uneven cost distributions. Examples of cost areas with asymmetric cost distributions are inventories (C items may be in stock longer than A items), setup costs (C items may be produced in smaller batches than A items, leading to relatively higher setup costs for C items than for A items), or administrative costs for sales order handling (C items may be sold in smaller batches than A items, leading to relatively higher costs for the sales order handling of C items than A items).

Identifying the most significant complexity cost factors

The most significant cost factors can be identified through the cost distributions for the product families and the lists of possible complexity cost factors in the analysis. In this context, a list of possible cost factors to be used as the basis for a brainstorming process can be found in the literature (e.g., Closs et al. 2008; Jacobs and Swink 2011; Myrodia and Hvam 2015). The list includes the cost factors incurred in sales, the production/supply chain, product development, and distribution. Examples of these cost factors are costs of sales order administration, warranty costs, costs of setting up production, costs of inventories, and handling costs in distribution centres.

Carrying out analysis, quantification, and allocation

Having identified possible significant complexity cost factors, the next step involves analysing the complexity cost factors and finding quantification objects that allow for approximations of the indirect costs to allocate them directly to product variants, where applicable. By dividing all costs by the net revenue recorded for each variant, all costs are comparable as percentages. It is often necessary to settle for incomplete data extracts and be

creative in applying unconventional quantification objects to develop reliable approximations (inspiration can be found in Anderson and Kaplan [2007] and Lechner, Klingebiel, and Wagenitz [2011]).

If it is possible to find data to support the quantification of the identified complexity cost factors and if the analysis shows an unambiguous uneven distribution of the costs, the complexity cost factors are used to adjust the contribution margins and contribution ratios for each product variant. The costs allocated from the analysis and quantification of the complexity cost factors can be accumulated to provide an overview of the complexity-adjusted contribution ratios (%) (as well as the complexity-adjusted contribution margins [EUR]).

3.4 Step 4: Identifying and quantifying possible initiatives for reducing complexity costs

Based on the insights from steps 2 to 3 and on Jacobs and Swink (2011) and Mortensen et al. (2010), it is possible to generate different initiatives for reducing complexity costs by changing the product range (e.g. reducing the number of product variants, adjusting prices, adjusting the product variants offered to each market, redesigning modules, and changing the product architecture) or by making changes in the business processes (e.g. reducing setup times, changing the order-decoupling point and points of stock, and changing delivery times).

The suggested initiatives are grouped into short-term, mid-term, and long-term initiatives (Wilson and Perumal 2009). Short-term initiatives include adjusting the product assortment using the contribution ratios, as described in step 3. Often, a thorough analysis reveals several low-hanging gains and increased earnings before interest and tax (EBIT). In this context, it is important not to assume 0% substitutability of discontinued variants (rare cases only) but to apply a more realistic number to estimate the true incremental revenue loss. Other examples of short-term initiatives include minor process adjustments (e.g. reducing

setup times and adjusting settings in the ERP system for planning and stock management). Examples of mid-term and long-term initiatives are redesigning products to improve variant creation or making changes to production flow or stock points. For each initiative, the quantification of possible savings is carried out based on the identified complexity cost factors and an estimate of the project costs for implementing the suggested initiative.

3.5 *Step 5: Evaluating and prioritising initiatives for reducing complexity costs*

Step 5 involves evaluating the initiatives and making a plan for their implementation. The initiatives selected for implementation are divided into short-term, mid-term, and long-term initiatives. The insights obtained from the complexity analysis are reflected upon, and consideration is given to how they may be used, for example, in product planning, product development, and the ongoing development of business processes.

Therefore, step 5 aims to implement the findings from steps 2 to 4 in a complexity reduction programme. The central aspect is identifying the drivers of the complexity cost factors to create complexity costs. The aim is to work with these drivers to reduce their negative impact on complexity. An example might be the country-specific customisation of product variants that could be solved differently. The cost transparency achieved in step 3 can serve to justify the cost of changing the country-specific feature or solution.

The complexity reduction programme contains the initiatives aimed at diminishing the negative effects of the complexity cost factors (e.g. by postponing the point of product differentiation) and initiatives for working actively with the complexity cost drivers to eliminate them or reduce their negative effects.

3.6 *Application of the procedure*

The proposed steps of the procedure could be adapted to a specific company with regard to the level of product analysis (at the finished-goods level only or including modules and

component levels in the product assortment), the product life cycle processes of the products to be included in the analysis (e.g. product development, sales, production, assembly, and distribution), the level of detail of the ABCC analysis (i.e. single products or groups of products), the inclusion of customers in the ABCC analysis, and the use of metrics other than costs to quantify the impact of complexity (e.g. flow in production, on-time delivery, lead time, and quality of products). Finally, given the need for affordable support, the proposed procedure has to employ data that are reasonably accessible and executable within a limited period and with limited use of resources.

4 Research method

To investigate the usefulness of the proposed procedure, a case study of a company using it was carried out. The study aimed to establish whether the procedure helps to identify significant areas of complexity, whether the data required for the detailed analysis and quantification are accessible, whether the analysis can be executed with a limited number of resources, and whether the results of the analysis provide an empirical basis for the generation of complexity-reduction initiatives.

The single case study can be described as having a holistic, representative design with a single unit of analysis (the case company) (Yin 2009). The case is representative because the company is typical of many major manufacturers that have had problems managing product and process complexity, which is also the main sampling criterion. As this type of case study methodology pertains to a single case, it is possible to generate only an analytical generalisation, as opposed to a statistical one (Yin 2009).

A project team was formed in an industrial company involving a controller and a product developer from the company (who spent 50% of their time working on the project), as

well as two consultants. Managers from all relevant departments also participated in three workshops during the course of the project, which lasted for four months. The role of the consultants was to provide the methods for analysing and quantifying complexity costs, arrange workshops, extract and analyse data, and contribute to discussions of future initiatives to reduce complexity costs.

The entire project was followed by one researcher. The research method consisted of document studies, observations, and semi-structured interviews. These methodological steps were carried out throughout the study, as opposed to in different stages. The interviews were conducted with the managers of four departments and the participants from the product team. This method was chosen because the investigated data are relatively unstructured and their analysis involves explicit interpretation (Silverman 2002). Using semi-structured interview protocols gave the interviewer the flexibility to focus on what the company believed were the most important problems. Notes about events were taken over the course of the entire project, and the obtained information was cross-checked with the participants in the project. To minimise bias as the greatest extent possible, triangulation, in the form of a combination of interviews, direct observation, documentation, and participant observation, was carried out (Yin 2009).

5 Case study

The procedure was applied at a leading global manufacturer of mechanical consumer products with 5,200 employees worldwide and an annual turnover of approximately EUR 900 million. The products are manufactured to stock and distributed via regional distribution centres. The scope and data used in the study are further described in the following sections.

At the time of the study, the company was undergoing an increase in the number of product variants. The management considered this increase to have a negative effect on

company performance and, thus, focused its attention on reducing the number of product variants. However, the company did not know the specific costs of having the increased number of product variants, and it lacked a means for identifying the products that should be removed from the product assortment to reduce the complexity costs of its operations.

The company's large scale combined with the lack of systems to assess the cost implications of the complexity induced by the product variety made it a particularly interesting setting for testing the procedure. On the one hand, the managers were extremely interested in using the procedure, as the potential contribution was exactly what they were looking for. On the other hand, the scale of the company would make it difficult to find information that had not previously been stored in a structured form, such as the cost of the complexity.

5.1 Step 1: Defining the scope of the analysis

The analysis focused on one of the product groups covering consumer goods sold in more than 40 countries worldwide. The group of products was chosen because it had a low total profitability and a long tail of low-selling products. To adjust for seasonal variations, the analysis was based on the sales data for the latest 12-month period. Furthermore, products with no sales and those that had been released but not sold in the period were excluded from the analysis. The final scope included approximately 350 item numbers with an annual turnover of around EUR 40 million.

The scope was decided in cooperation with the product managers, who provided insight into the product's technical features and the market/customer base. The products in the scope were manufactured in two different factories and distributed via three regional distribution centres. To distinguish between the 350 product variants, a list of descriptive characteristics (i.e. name, product family, and part number) and a list of product

characteristics (i.e. capacity, type of nozzle, type of filter, cable, and voltage) were added to each item number. These characteristics were added by the R&D department and assessed by the product managers. Furthermore, data on the release date, the factory in which the item was produced, and the region in which it was sold were added to the list.

5.2 Step 2: Conducting the ABCC analysis of product profitability

To calculate the contribution margin of the product variants, the realised revenues of all 350 product variants from sales companies within the 12-month period were collected. The analysis included sales numbers from the top 30 sales companies, which cover approximately 98% of the sales; the remaining 12 sales companies account for less than 2% of the sales in this product group and were not included in the analysis. The sales revenues from the individual sales companies were adjusted for local bonuses, customs, and deviations in currencies. The direct production costs (including materials, wages, and other factory costs) for each of the 350 item numbers were subtracted from the sales revenue, resulting in a measure of the contribution margin. Based on this, an ABCC analysis was undertaken, as shown in Figure 1. The net revenue for each product variant is plotted on the horizontal axis and the contribution margins on the vertical axis, as explained in Section 4.

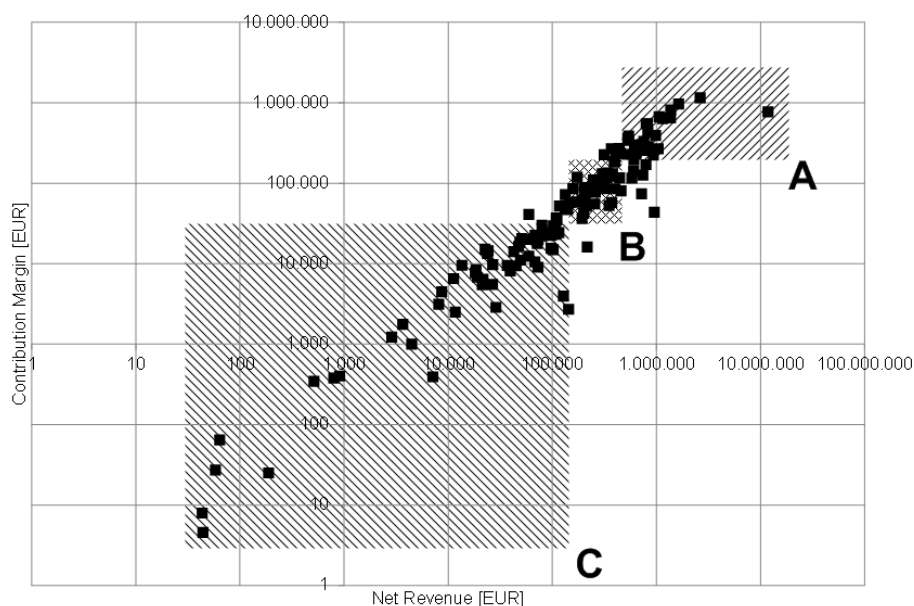


Figure 1. ABCC analysis of product profitability

The ABCC analysis showed that 120 variants (34%) were C products, 110 were B products (31%), and 120 were A products (34%). Products that fell outside of the three categories were listed and attached to the B and C groups of products. In the analysis, the products were divided into four main categories, and each group was marked with different patterns in the diagram (see Figure 1). The ABCC analysis showed that some of the product groups had significantly lower contribution margins than the others (Figure 1). Figure 2 shows the contribution ratios (contribution margin relative to sales revenue) for the 350 items.

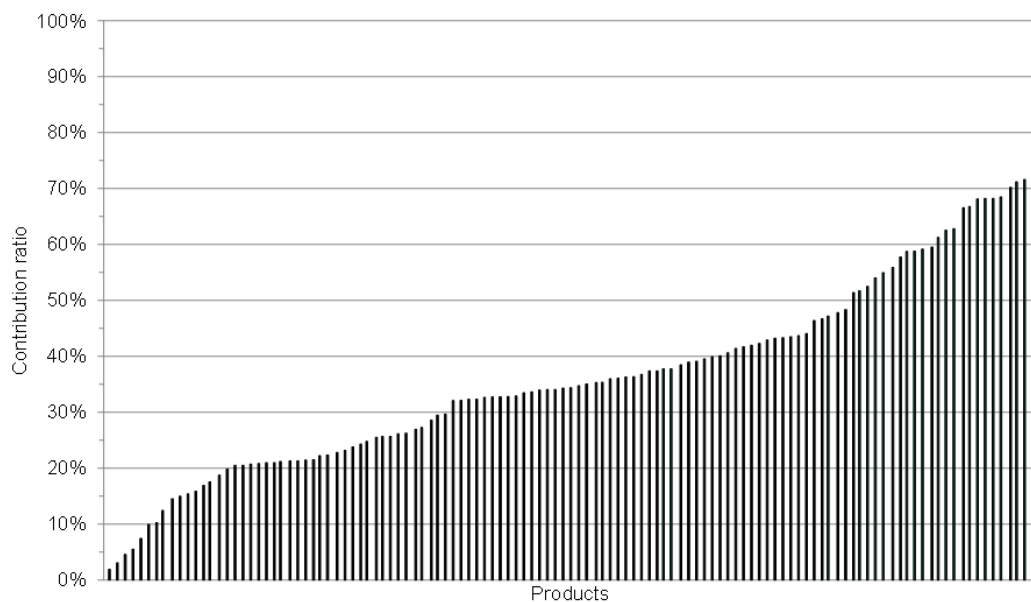


Figure 2. Contribution ratios for the products included in the analysis

As can be seen in Figure 2, the contribution ratios for the 350 products in the study vary from close to 0% to more than 80% for the different items, which indicates significant potential to improve the contribution margin of the product portfolio.

5.3 *Step 3: Identifying and quantifying the most significant complexity cost factors*

Based on the early indication of the product variants making the least contribution in step 2, the aim of step 3 was to identify and quantify the most significant complexity cost factors

throughout the product life cycle and adjust the contribution margins for each item. The analysis started with a cost breakdown (top down) and a brainstorm (bottom up) of possible factors with asymmetric costs for the different product groups. The complexity cost factors were identified in cooperation with the product managers, as well as the sales, production, and distribution managers. The following possible complexity-related cost factors were identified:

- White-collar costs in factories
- Setup costs in factories
- Stocks of materials in factories
- Warranty costs
- Order-handling and administrative costs in distribution centres
- Handling in distribution centres
- Inventory costs – finished goods
- Freight costs (inbound and outbound to distribution centres)
- Administrative costs in sales
- Advertising costs

To quantify these possible complexity-related cost factors, the necessary data were requested (e.g. the setup time and order quantities in production for different item numbers to calculate the setup costs for each item). The analysis showed a significantly asymmetric cost distribution for the following factors: ‘inventory of materials in factories’, ‘handling in distribution centres’, ‘order-handling and administrative costs in distribution centres’, ‘finished goods inventories’, ‘inbound freight to distribution centres (from the factories)’,

‘outbound freight from distribution centres (to the customers)’, and ‘administrative costs in sales’. The other factors listed proved to be either insignificant (less than 0.5% of the turnover) or to have no asymmetric distributions of costs. Regarding quality costs, it was not possible to obtain complete data to analyse the costs of quality for each item number; however, the data available from three sales companies indicate an asymmetric distribution in the quality costs, which account for approximately 2% of the turnover. Based on this analysis, the company decided to implement more detailed reporting of quality costs from the sales companies.

Figure 3 shows an example of the adjustment needed because of the freight costs for the 350 products in the study. The freight costs were calculated based on an estimate of 5.2% (1.6% inbound, 3.6% outbound) of the product’s sale price revenue for all 350 products handled in the distribution centres. The freight cost per item was calculated based on unit sales and actual figures for shipping quantities per container and pallet per item.

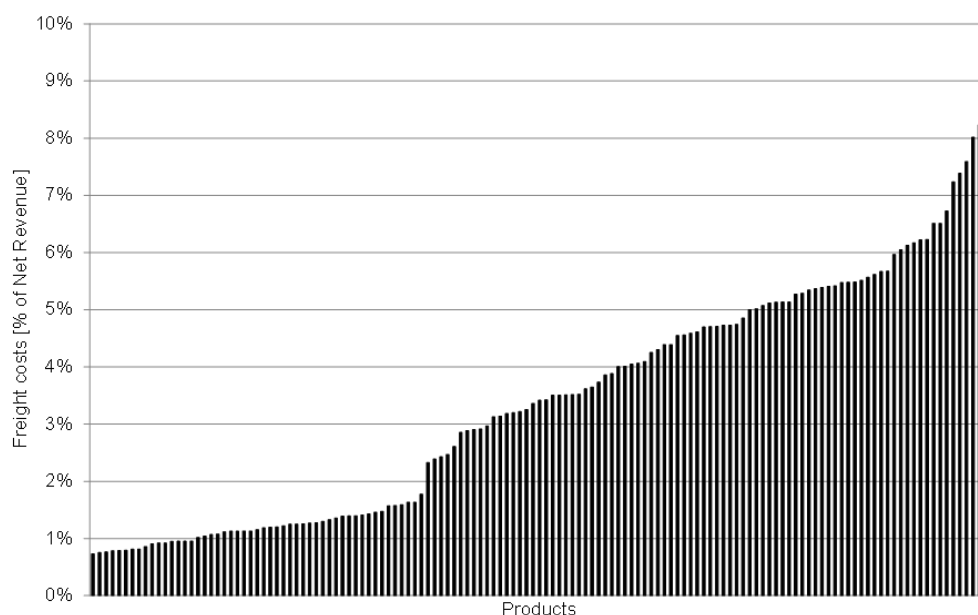


Figure 3. Contribution of freight costs

As seen in Figure 3, the freight costs vary between 1% and 9% for each item number. This variation is a result of the different filling of the pallets and containers, which is due, in part, to the volume of the boxes and partly to the order size shipped; large orders are shipped on full pallets and containers, and small orders are shipped on partly filled containers and pallets. C items tend to have higher freight costs than A items.

Another example is sales order handling, for which a time study showed that the average cost per order line is EUR 3.5. Based on this, the costs of sales order handling per product is calculated as follows:

Sales order handling cost per product

$$= \text{No. of orders per product variant} * \text{Sales order handling cost per order line}$$

The data needed for the quantification of sales order-handling costs are as follows: number of orders per product variant and average sales order-handling costs per order line.

Another example is the order-handling costs in the warehouse. In this case, a study analysed the time used relative to the frequency of handling the product variant in the warehouse, as shown in Table 2.

Table 2. Example of order-handling costs

Order frequency	[min]	Unit sale per year
High	5	>5,000 units
Medium	7	1,500–5,000 units
Low	12	<1,500 units

The time per order is calculated as follows:

$$Time\ per\ product = \sum_{1}^n (time\ per\ order + (order\ size - 1) * 10\ seconds)$$

In the calculation above, n is the number of orders in a year, and order size is the number of pallets in the order.

The data needed for calculating the time used per product in the distribution centre is the following: list of order lines in a one-year period, number of pallets per order and time used per order for the first pallet, and time used for the subsequent pallets (in this case, 10 seconds per pallet).

Based on the analysis of the complexity cost factors, the contribution margins and ratios calculated were adjusted using the exact cost of each complexity cost factor, which gives a more accurate value for the costs and contribution margins for each item number. Figure 4 shows the contribution margins and contribution ratios adjusted using the calculated complexity cost factors. Each line in Figure 4 represents a product variant. The first seven columns contain information on volume sold, revenue, production costs, and contribution margin and contribution ratio for each product. The next eight columns show the allocated complexity costs for each complexity cost factor, the sum of the complexity costs, and the allocated complexity costs relative to the revenue for each product. The last two columns show the adjusted contribution margin and the adjusted contribution ratio for each product after the allocation of the complexity costs.

Contribution margin and ration before complexity cost adjustment [EUR]							Complexity cost factors and total complexity cost adjustment [EUR]								Complexity adjusted contribution margin and ratio [EUR]	
Total Cost per unit	Avg. Unit Price	Unit Sales	Total Cost	Net Revenue	Contribution Margin	Contribution Ratio	Component inventory	Freight	EDC PO handling	EDC WH order handling	L6 Inventory	Sales order handling	Total complexity cost adjustment	Complexity cost adjustment relativ to revenue	Adj. Contribution Margin	Adj. Contribution Ratio
53	127	16.988	893.100	2.165.957	1.272.857	59%	6.288	192.823	2.997	93.902	107.883	31.867	435.760	20%	843.385	39%
69	170	10.669	740.821	1.813.329	1.072.508	59%	4.785	121.099	2.412	72.430	124.077	22.872	347.675	19%	729.618	40%
39	87	17.377	683.905	1.518.498	834.594	55%	623	65.745	1.681	26.379	16.489	8.992	119.909	8%	715.307	47%
32	85	16.434	522.066	1.404.192	882.126	63%	668	62.177	73	70.913	156.015	22.419	312.266	22%	570.529	41%
34	64	28.284	952.935	1.803.970	851.035	47%	823	107.011	1.316	89.191	89.775	30.317	318.432	18%	533.427	30%
52	164	6.436	335.813	1.054.305	718.492	68%	1.551	36.523	512	57.399	52.247	19.315	167.547	16%	552.496	52%
106	318	3.400	359.775	1.082.756	722.981	67%	4.605	51.449	1.462	44.202	70.170	12.754	184.642	17%	542.945	50%
32	112	6.412	206.750	717.181	510.431	71%	122	24.258	1.389	56.999	18.195	19.243	120.206	17%	390.347	54%
111	234	4.662	519.078	1.093.063	573.985	53%	4.691	70.553	1.023	61.484	132.528	17.490	287.770	26%	290.907	27%
126	397	1.765	222.730	701.205	478.475	68%	1.416	26.714	950	47.344	40.999	13.245	130.668	19%	349.223	50%
93	249	2.873	267.895	715.304	447.408	63%	4.943	43.476	3.582	4.024	27.260	980	84.264	12%	368.088	51%
32	83	6.982	224.697	580.231	355.534	61%	233	21.459	2.339	6.742	65.355	1.435	97.563	17%	258.204	45%
38	134	3.102	118.182	416.029	297.846	72%	690	11.736	2.632	3.360	48.943	517	67.879	16%	230.658	55%
95	231	2.342	223.144	541.753	318.608	59%	2.688	35.449	2.778	52.476	37.733	17.575	148.699	27%	172.597	32%
31	65	9.232	288.189	597.160	308.971	52%	211	28.374	2.705	68.722	29.144	23.089	152.245	25%	156.937	26%
69	216	1.063	72.935	229.514	156.579	68%	-1.964	6.034	219	29.852	9.748	7.977	51.866	23%	102.749	45%
183	398	526	96.253	209.214	112.961	54%	-1.558	7.954	744	11.417	46.741	3.944	69.242	33%	42.161	20%
184	586	134	24.786	78.705	53.919	69%	-4.347	2.034	177	6.605	14.045	1.008	19.522	25%	30.050	38%
69	122	28.586	1.965.884	3.478.146	1.512.262	43%	11.881	230.545	2.360	26.206	187.191	43.696	501.879	14%	1.022.263	29%
52	87	15.018	786.191	1.300.352	514.160	40%	2.599	60.559	1.899	39.345	70.715	49.853	224.970	17%	291.789	22%
182	352	2.304	419.045	811.166	392.120	48%	7.894	26.057	1.324	24.357	37.913	11.707	109.252	13%	290.763	36%
120	427	1.146	137.509	489.089	351.580	72%	2.004	12.323	58	1.041	40.541	593	56.560	12%	297.024	61%
41	71	13.709	566.334	966.845	400.511	41%	321	44.482	1.036	23.385	43.152	43.490	155.867	16%	244.966	25%
111	196	5.124	569.037	1.003.423	434.386	43%	3.942	55.099	403	14.983	151.556	13.912	239.896	24%	198.433	20%
177	298	3.030	536.497	903.613	367.116	41%	13.282	34.268	1.151	24.251	57.483	19.759	150.195	17%	230.203	25%
38	51	26.638	1.019.898	1.371.706	351.807	26%	777	57.622	1.094	3.547	28.457	4.816	96.312	7%	256.272	19%
117	185	5.311	621.885	983.218	361.334	37%	3.773	57.112	806	23.593	27.337	33.350	145.971	15%	219.135	22%
117	179	6.113	716.276	1.091.377	375.100	34%	9.830	65.732	748	18.198	62.522	17.215	174.245	16%	210.685	19%
38	59	14.128	537.910	839.813	301.904	36%	113	30.561	2.820	15.712	83.415	21.854	154.475	18%	147.541	18%
68	103	9.623	653.982	991.456	337.474	34%	1.283	77.606	1.842	17.340	62.841	24.641	185.553	19%	153.204	15%
104	184	3.737	386.830	686.749	299.919	44%	1.295	40.182	2.072	29.087	57.373	15.326	145.336	21%	155.878	23%
33	52	16.183	530.889	847.661	316.773	37%	2.044	43.505	2.187	49.339	39.372	48.445	184.892	22%	133.924	16%
100	188	2.818	283.097	530.869	247.772	47%	2.547	30.298	2.130	24.858	18.467	11.973	90.273	17%	160.046	30%
56	83	9.660	544.848	802.130	257.281	32%	491	47.017	173	5.100	53.379	7.360	113.520	14%	144.252	18%

Figure 4. Contribution margins and ratios adjusted using complexity cost factors

As Figure 4 shows, the complexity cost factors change the contribution margins and cost ratios significantly, thus providing a more accurate calculation of the contribution margins and ratios for each item in the analysis. A further analysis of the true costs and margins of different product groups was undertaken.

Based on the adjusted contribution ratios, the profitability of the 16 product families was analysed. The analysis showed that an old product family, which the company had wanted to withdraw from the market for years, had a turnover of approximately EUR 5 million and an adjusted contribution ratio of 60%. Another newly launched product family,

for which the company had high expectations, had a turnover of EUR 500,000 and an adjusted contribution ratio of only 8%. Based on this new information, the company considered relaunching the old product family and redesigning the newly launched product family.

5.4 Step 4: Identifying and quantifying initiatives for complexity reduction

Based on the analysis of complexity cost factors, in this step, initiatives for reducing the complexity of the products and processes were developed, and the potential savings were quantified. The following are possible initiatives for reducing complexity:

- Adjust the product line based on an analysis of product variants, price points, and contribution margins per country.
- Optimise variance creation (products and accessories are packed in distribution centres rather than in factories).
- Reduce the number of components kept in stock in factories.
- Introduce direct shipments from the factory to the customers for low-selling products.
- Adjust bonus agreements per country/customer/product group.

The following ideas were also identified for further analysis:

- Conduct complexity analysis of spare parts and accessories across product categories.
- Analyse the cost of certificates and the possible relationships to product platforms and OEM customers.
- Conduct OEM analysis (improving profitability for OEM customers).
- Investigate optimising the R&D process to include freight costs to a greater extent.

- Implement a phasing-out strategy – alignment of product management, product development, and production when phasing out products to avoid producing obsolete components and products.
- Analyse the trade-off between lower stock cost vs. high purchase order-handling cost and changeover cost.

The potential savings from each initiative were calculated based on the quantified complexity cost factors. An example of this is the first initiative in which the product line is adjusted based on an analysis of the variants, price points, and contribution margins per country. For this, eight initiatives for each brand in the product group were evaluated, which cover high or low levels of product pruning, full or no product substitution, and high or low levels of positive price adjustment. Recognising the different challenges faced by each brand, decisions were made for each brand separately with regard to the following issues: which items to exclude, which ones could be substituted with others, and the extent to which the prices were to be adjusted. The initiatives yielded new overall net revenues, contribution ratios, and contribution margins for each brand. The quantified scenarios indicate an increase of between 2% and 4% in portfolio profitability (increased contribution margin), corresponding to an increased EBIT of between EUR 800,000 and EUR 1.6 million. Where applicable, the costs that were dependent on the number of variants were subtracted in the scenarios (e.g. freight costs, component inventory in factories, and finished goods inventory in the distribution centres). The cost of undertaking the analysis and implementing the revised product assortment was estimated to be EUR 100,000. Similar quantifications of possible savings and project costs were made for each initiative.

5.5 Step 5: Evaluating the initiatives and the insights gained from the procedure

In step 5, the suggested initiatives were evaluated and prioritised based on the quantification derived from the complexity analysis. This included an assessment of the strategic impact of

the suggested initiatives. Based on the complexity analysis, the company decided to implement the following three projects to reduce complexity:

- Adjust the product line, as described in the previous section
- Reduce complexity costs in the factory/supply chain
- Change the order-decoupling point by shipping accessories to the distribution centres and undertaking the final configuration of products and accessories in the distribution centres rather than at the factory.

The third project led to a significant reduction in finished goods inventories in the distribution centres. A number of minor changes, such as adjusting settings in the ERP systems to manage inventory levels and procedures for handling orders in the distribution centres, were also made.

The application of the procedure had implications for several functions and directors of functions. More specifically, the analyses were utilised in the following areas:

- For the product managers, the project provided detailed insight into the profitability of each finished goods item. This insight was used to trim the product portfolio in the first implementation project mentioned and is currently used in negotiations between the product manager and the sales representatives in each country to decide which variants to promote in the portfolio for each country and price setting.
- For R&D, the project provided new and more detailed insight into the cost structure of product variants and the costs of sales, production, and distribution. This insight is of significant value when R&D department develops new products and makes decisions about which product variants to include in the new product portfolio and which modules to include in the product architecture.

- For the managers of sales, production, and distribution, the complexity analysis provided insights into how costs are allocated for different groups of processes in business areas. This information has led to an increased focus on complexity costs and to the initiation of projects, leading to lower costs of handling complexity in sales, production, and distribution.

Furthermore, to ensure that the findings would be implemented in the daily business, the company decided that the ABCC analysis should be conducted every six months and submitted to the product manager. The ABCC analysis should be adjusted using the complexity cost factors found in the first analysis.

5.6 *Use of the procedure after the test period*

The project was implemented within four months, using approximately 700 man-hours, excluding consultant time. Since the completion of the project, the company has initiated and completed three other projects on complexity analysis, using the procedure on other groups of products. These projects have been carried out by internal employees using the competences they gained from the first project, but with some supervision from the researchers. Based on the experiences gained from these projects, the employees can undertake the data extraction and the calculations, but they still need support to identify the complexity cost factors, interpret the data and findings, and determine possible initiatives for reducing complexity. The employees also need support when checking and validating the data and findings—that is, when asking critical questions regarding the accuracy of data, calculations, and findings, as well as double-checking all data and findings.

6 Discussion

The aim of the proposed procedure was to identify the most significant complexity costs in the system of products and processes, quantify these costs, and allocate them to individual

products and process steps. On this basis, it is possible to conclude whether the potential for complexity reduction lies in the product domain or in the supply/production/process/delivery domain or whether a coordinated redesign of the two domains is needed.

Table 3 lists the major difficulties that the case company encountered and its requests for assistance during the project, as well as solutions that were found to work and can, thus, be recommended for future application of the procedure.

Table 3. Major difficulties/requests and recommended solutions

Difficulties encountered and specific requests	Solutions
The accuracy of the data and findings were questioned by employees at all levels of the company.	It is crucial to have trustworthy data and findings. Thus, experienced employees should be involved in undertaking a critical assessment of data and calculations. Furthermore, it should be ensured that data and calculations are transparent and easy to understand; and all data and calculations for possible errors should be checked (possibly double-checked) and validated.
Obtaining data to quantify complexity cost factors was a challenge with regard to certain factors.	Project managers should identify sources of data with production, distribution, and sales managers. If a complexity cost factor cannot be quantified due to a lack of data, begin temporary registration of these data, and if the results are interesting, implement permanent registration of these data.
Finding potential initiatives to reduce complexity was crucial to ensuring business impact from the analysis.	Workshops generate fruitful discussions and numerous ideas from area managers and others. It is important to use experiences from other companies to enable the consideration of as many possible solutions as possible.
The company requested to use the findings in ongoing projects and in its daily business.	There was significant interest in the findings from managers at all levels. The analysis needs to be updated constantly to include findings from the current product-planning process. The company has decided to update the ABCC analysis every six months for the product

	managers and for use in R&D and ongoing process improvement projects.
The company demanded that it should be able to apply the procedure after the project period.	The researchers supervised the working team during the procedure. The team members were then able to undertake data extraction and calculations. Future projects will benefit from having a person on the team who has been trained in the procedure and has experience with similar projects in other companies.
The company required that the analysis be completed within the scheduled four-month period and without exceeding the resources that were assigned for the project.	These requirements were met. It is crucial to have a realistic scope for the analysis and to constantly limit data gathering and calculations to ensure that only what is needed is included. Experienced employees should be involved in discussing the scope and focus of the analysis.

The case study revealed a series of difficulties and further requirements related to the suggested procedure, which led to a list of recommendations for applying the procedure to future projects (Table 3). Further applications will lead to additional insights that may give rise to improvements in the procedure and may generate a more detailed description of how to adapt it to individual company settings. An important aspect of learning from the project is that it is crucial to use significant resources to check and validate all data and calculations, thereby ensuring that the data are correct and unquestionable. Furthermore, it is essential for the interpretation of the results to be focused on the analysis of the most significant areas and for the findings to be presented and discussed with the managers of the company.

The results of the complexity analysis were presented and discussed with the group of production, distribution, R&D, and sales managers. During the first three phases of the project, the project team identified possible initiatives for reducing complexity when interviewing and discussing the findings with individuals in the organisation. These initiatives were discussed and further elaborated with the managers during workshops in which the

complexity analysis and the findings were discussed. The knowledge and experience of the company's managers and employees were used to focus the analysis of complexity costs on the most significant cost elements and on the identification of initiatives to reduce complexity. This approach enabled the delimitation of not only the data but also the resources needed for the data analysis and calculation.

A vital aspect of the procedure is the identification and quantification of the company's most significant complexity cost factors. In that respect this procedure contributes to the Suzic et al. (2018a; 2018b) call for as-is analysis tools to help practitioners to implement mass customization. Such insights contribute to the literature on process complexity (ElMaraghy et al. 2012; Jacobs and Swink 2011) by providing empirical evidence (albeit limited to one case) identifying the product and process correlations that contribute to the most significant complexity cost factors. The use of these complexity cost factors enriches the literature in that it delimits the data and resources needed to calculate these costs.

Determining initiatives based on the identified complexity cost factors contributes to the literature on strategies for reducing complexity (Closs et al. 2008; Jacobs and Swink 2011), in that these factors help focus on the most significant complexity cost drivers. Thus, the paper provides a basis for identifying initiatives that have significant potential to reduce complexity in the company. Furthermore, involving experienced managers and employees in determining the project scope, as well as in the analysis and synthesis, makes it possible to use the company's internal knowledge and experience in the analysis and identification of the most relevant initiatives, thus contributing to defining strategies for reducing complexity in individual companies (Closs et al. 2008; Jacobs and Swink 2011).

7 Conclusion

Based on a literature review, this paper proposed a five-step procedure that provides a structured method of identifying and quantifying the most significant complexity cost factors to then enable the identification and quantification of possible initiatives to reduce these complexity costs. The five steps are as follows: (1) define the scope of the products and processes to be included in the analysis, (2) conduct ABCC analysis of the products, (3) identify and quantify the most significant complexity cost factors, (4) identify and quantify possible initiatives for the reduction of complexity costs, and (5) evaluate and prioritise initiatives to establish a complexity cost reduction programme. To test the usefulness and efficiency of the procedure, a case study was carried out.

The case study showed that the procedure is applicable to projects of a relatively short duration, and that it demands relative limited resources to apply. The study also showed that the use of the procedure in a project made it possible to obtain the necessary data, identify and quantify significant complexity cost factors, and identify and quantify initiatives to reduce the complexity. Furthermore, the analysis provided the case company with new and more detailed insight into the costs of complexity for each variant in the product portfolio.

Because the study pertains to a single case, it is possible to make only analytical generalisations concerning justification based on similarities to other cases. In this context, it should be considered that the challenges in the investigated company, as well as the ways in which the products and processes were managed, are largely typical in manufacturing companies. Thus, it seems that the procedure would also be applicable to many other companies. More specifically, the suggested procedure should be applicable to other companies that manufacture consumer products, where the number of finished items could be considered for reduction, the costs of having numerous variants in the product portfolio could be investigated, and possibilities for reducing complexity costs in the business processes

could be examined. However, detailed cost registration is required for the application of the procedure. If the cost information is too limited, the procedure could encounter too many difficulties, thereby preventing its application. In such cases, a more qualitative approach is advisable. Finally, it should be mentioned that subsequent applications of the proposed procedure have been made by the case company. The experiences from these subsequent projects have demonstrated that while company employees are capable of carrying out the data analysis and calculations, they need support in regard to checking and validating the data and findings, identifying potential complexity cost factors and initiatives, and interpreting the results. In other words, it has been shown that the procedure can be applied without facilitation by consultants and researchers—that is, support for the validity of the findings.

The proposed procedure contributes to the literature on product complexity (ElMaraghy et al. 2013; Yang et al. 2008) by suggesting an operational method of grouping products into A, B, and C categories and characterising them using features that are identified by the company's R&D employees. Furthermore, the adjusted contribution margin for each product variant contributes to the literature on product architecture (Meyer and Lehnerd 1997) by suggesting the use of adjusted contribution margins based on the quantified complexity cost factors. The proposed procedure also supplements the literature on process complexity (ElMaraghy et al. 2012; Sivadasan et al. 2002) by suggesting complexity cost factors as a means of analysing the most significant correlated complexity between product variants and processes and by using experienced practitioners in the company to identify the most significant complexity cost factors. The proposed procedure contributes to the literature on the quantification of complexity costs (Orfi, Terpenney, and Sahin-Sariisik 2011; Zang and Tseng 2007) by describing the most significant complexity cost factors based on an analysis of the cost distribution of the products identified and providing a list of possible complexity cost factors. The use of these insights reduces the data and calculations needed to quantify the

complexity costs and to calculate the expected impact of the initiatives identified to reduce complexity. Finally, this procedure contributes to the theory on strategies for reducing complexity (Jacobs and Swink 2011; Wilson and Perumal 2009) by making use of the company employees' knowledge and experience to identify the most relevant initiatives for reducing complexity and by using the complexity cost factors to quantify the expected benefits from each initiative.

Scheiter, Scheel, and Klink (2007) claimed that reducing complexity could improve EBIT by 3%–5%; however, according to Wilson and Perumal (2009), Mariotti (2008), and Jacobs and Swink (2011), many companies are unaware of this potential and lack operational and easy-to-use procedures for analysing and reducing complexity. The proposed procedure assists with the analysis and quantification of the most significant complexity cost factors in companies with limited resources and data. This is important to enable awareness and insight into the potential gains from reducing complexity in products and operations. Furthermore, the proposed procedure suggests how to develop initiatives to reduce complexity based on the analysis. Ultimately, as shown by the first applications, the use of the procedure may lead to a significant reduction in complexity costs and improved EBIT for the company.

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