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# **A CLASSIFICATION OF BARRIERS TO PRODUCT VARIETY REDUCTION**

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## **ABSTRACT**

Many industrial companies face a demand for a steady increase in product variety in order to accommodate customers' requirements for more individual products. With this increasing product variety also come increasing costs, poor delivery performance and quality problems. Thus, many companies attempt to reduce their product variety; however, they often fail to do so. To understand the causes of this problem, this paper aims to identify and classify the most important barriers companies meet when trying to reduce their product variety. We present an overview of barriers identified from the literature and from a case study. The case study identified a type of barrier not identified in the existing literature, namely a barrier related to the culture and the personality of the people involved. The paper adds to the literature by providing a more extensive and well-organized perspective on barriers to product variety reduction. The overview of barriers to product variety reduction may help managers in focusing their attention and resources.

**Keywords:** Product Variety Reduction, SKU Rationalization, Barriers, Product Variety Management.

## 1. INTRODUCTION

Complexity management and product variety management (PVM) are fields of increasing interest for both researchers and practitioners. A 2010 survey conducted by IBM in over 1500 companies representing different sizes of organizations in 60 countries and 33 industries revealed that more than half of CEOs doubt their ability to manage complexity. Seventy-nine percent of CEOs anticipated even greater complexity ahead (IBM, 2010). Almost a decade later, in 2017, surveys have revealed that manufacturing companies are still struggling with increasing product variety, as they have realised that, on average, 75% of their revenue comes from 13% of their portfolio (Hirose *et al.*, 2017; Rigby, 2013). Offering greater product variety is supposed to create a competitive advantage (Da Silveira, 1998), but only to a certain extent, as the actual variety demanded from customers differs from the theoretical variety (i.e. the greatest variety possible to offer) (Stäblein *et al.*, 2011). In this context, a recent report by McKinsey & Company indicates that companies are struggling to distinguish between good and bad product variety, and reducing unneeded product variety is a subject of great interest (Adams *et al.*, 2016).

Practitioners are increasingly concerned about the cost of increasing product variety (Bannasch and Bouche, 2019; MacDuffie *et al.*, 1996). Specifically, increasing complexity is considered a major cause of the rising costs and deterioration of operational performance, leading to decreased quality, long delivery times, delayed deliveries and low process flexibility (Mariotti, 2008). The need to manage and control product variety is also apparent in the concept of Industry 4.0, the rapid progress of technology and the recently common practice of embedding software into products (Aljorephani *et al.*, 2016; Closs *et al.*, 2008). These factors highlight the need for manufacturers to manage and reduce the product variety of highly customised products in a more efficient manner (Bortolini *et al.*, 2018; ElMaraghy, 2005).

For the reasons discussed above, many CEOs would like to reduce their product variety (PV), but fail to implement programs to do so in their organization or meet difficulties in implementing the reduction of PV at the pace and to the degree they desire. Researchers define PV as the number of finished goods produced by a firm (Trattner *et al.*, 2019). High product variety implies important trade-offs. On the positive side, the image of the firm is improved, demand may be more stable, and there is the potential to expand markets and increase sales volume and revenue (ElMaraghy *et al.*, 2013; Ton and Raman, 2010; Ramdas, 2003). On the negative side, high product variety may cause problems with excessive setups and over-inventories, and it may increase the complexity of the supply chain processes. Moreover, customers might be confused by the differentiation among product variants and experience long lead times before making a choice (Ramdas, 2003; ElMaraghy *et al.*, 2013; Hu *et al.*, 2008). Product Variety Management is the process of making decisions related to the product offering of a firm. These decisions are made at different times and in different functions of the business (Ramdas, 2003). The main goal of PVM is to reduce variety-induced complexity and its associated costs. A variety of methods and strategies of analysing and managing existing product portfolios have been introduced. Examples of such methods and strategies are product ABC classification, pooling, modular product architectures, product family design and delayed differentiation (Bech *et al.*, 2019; Hvam *et al.*, 2019; ElMaraghy *et al.*, 2013; Alfaro and Corbett, 2003; Graman and Magazine, 2002).

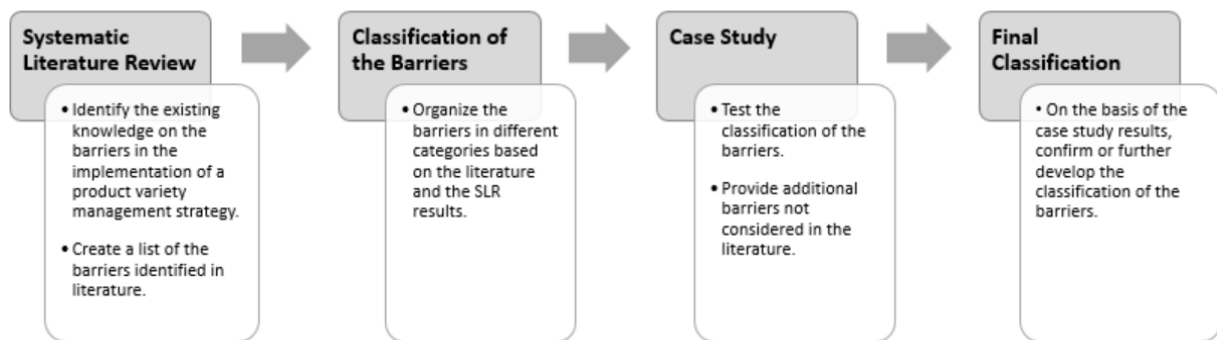
As indicated by ElMaraghy *et al.* (2013), PVM literature inadequately explains and predicts the cost and value of PVM. Moreover, the literature regarding the difficulties and challenges met during the application of a PVM strategy is very limited. This is problematic from both a research and practice perspective. Specifically, in order to further develop PVM approaches or study the causes of problems in such projects, there is a need to understand which issues companies encounter. Without a complete account of these PVM barriers, this is not possible. With regard to practice, an overview of possible barriers may help companies avoid potential issues through a pro-active approach. To avoid having too overall a focus, the

focus of the paper is delimited to a central part of PVM, namely product variety reduction (PVR) (EIMaraghy *et al.*, 2013).

Based on the discussion above, the research question addressed in this paper may be formulated as follows:

*Which barriers do companies encounter in product variety reduction projects?*

To address the research question, we first conduct a systematic literature review (SLR) to identify existing knowledge on the barriers to implementing a PVR strategy. In order to make the research clearer and more complete, we reported, when possible, the reasons why a company decided to initiate a PVR program, the methods applied and the business context. As the literature resulting from the SLR was limited, we decided to enrich the research by analysing other publications related to variety management. At this point, a case study research methodology was adopted to understand the challenges of applying a portfolio rationalization in a real case company. The purpose of the case study was to verify if the case company had met the same challenges in implementing a PVR program previously discovered in the SLR, to enrich the list of barriers with new challenges and to test the completeness and the accuracy of the classification. Figure 1 shows the steps taken by the researchers in conducting the study. The remainder of the paper is structured according to these four steps, followed by a discussion and conclusion section.



**Figure 1.** Research approach.

## 2. SYSTEMATIC LITERATURE REVIEW

### 2.1 Review process

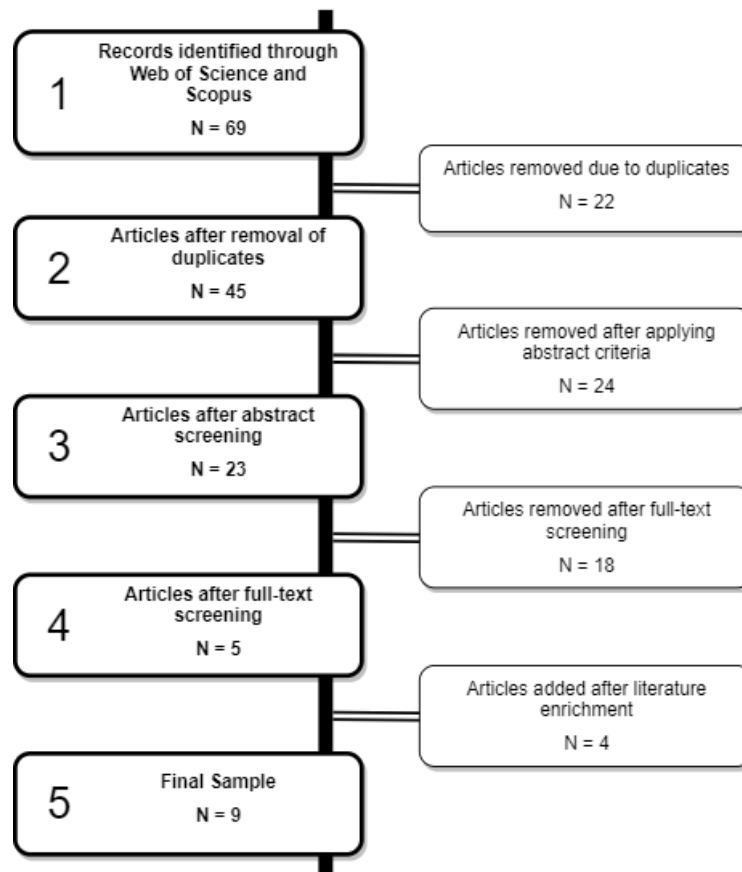
The purpose of the review was to identify barriers to PVR described in the literature. To do so, a systematic literature review was carried out. Following the approach proposed by [Tranfield et al. \(2003\)](#), we divided the SLR into three phases: planning, conducting and reporting. In the first phase, a search string was developed to explore the literature for the challenges of portfolio rationalization. Keywords were chosen to balance precision and specificity, being sufficiently broad so as not to artificially restrict the number of studies but specific enough to find only the studies related to the topic ([Cooper, 2010](#)). The initial search string was developed in collaboration with other researchers to guarantee a complete overview and reduce the risk of omitting keywords and synonyms. Two literature databases, Scopus and Web of Science, which cover relevant management and engineering journals, were selected to conduct the research. Using the advanced search in both databases and limiting the search to English-language papers only, we collected and stored 69 articles. The search string used for the Scopus (Elsevier) database was:

*TITLE-ABS-KEY ("product complexity reduction" OR "product vari\* reduction" OR "sku rationalization" OR "product vari\* management" OR "product portfolio rationalization" OR "product portfolio reduction") AND TITLE-ABS-KEY ("barrier\*" OR "challenge\*" OR "problem\*" OR "issue\*") AND LANGUAGE (English).*

The search string used for Web of Science (Thomson Reuters) database was:

*TS= ("product complexity reduction" OR "product vari\* reduction" OR "sku rationalization" OR "product vari\* management" OR "product portfolio rationalization" OR "product portfolio reduction") AND TS= ("barrier\*" OR "challenge\*" OR "problem\*" OR "issue\*"); additional filters applied: LANGUAGE: (English).*

The search results, after removing duplicates arising in both WOS and Scopus, yielded 45 papers. Hereafter, criteria were applied to the abstracts of the remaining articles. Articles that discussed the application of PVM methods or the impacts of PVR strategy in the abstract were assessed for full-text reading. The abstract screening resulted in a sample of 23 articles. The text of one article was not accessible. A full-text screening was then performed, and a sample of five articles was identified as the core of this SLR. Understanding that there may be some related works which were not retrieved with this keyword structure, the researchers decided to expand the analysis to other works found in the SLR papers' references and in the identified papers. As a result, a final sample of nine articles was identified as the core of this literature review (Figure 2).



**Figure 2.** Steps in the literature review

The methods of the nine papers are shown in Table I.

**Table I.** Identified papers

No.	Authors	Method
1	Bech et al. (2019)	Case study
2	Enz et al. (2019)	Case study
3	Ferreira & Correia-Stein (2017)	Literature review
4	ElMaraghy et al. (2013),	Conceptual
5	Berman (2011),	Conceptual
6	Byrne (2007)	Conceptual
7	Sloot et al. (2006)	Case study
8	Appelqvist & Gubi (2005)	Case study
9	George and Wilson (2004),	Conceptual, Case Study

## 2.2 Identified PVR barriers

PVM is the topic of a large number of research papers and recent books. However, the interdependencies across themes that make variety management so challenging have received little attention in the research literature (Ramdass, 2003). When narrowing the focus to papers with an explicit focus on barriers to implementing a PVR strategy, the literature is even sparser. For this reason, we include literature on PVM, while delimiting our analysis to the parts of these papers that deals with PVR-related issues. On this basis, in the following, we

discuss identified reasons why a company decided to initiate a PVM or PVR program, the methods applied, the business context and the barriers to implementation.

Bech *et al.* (2019) conducted a case study within a Danish manufacturer of breads and pastries with the goal of investigating challenges and experiences of product and process variety management in the process industry. The reasons for adopting initiatives of product and process variety management are related to the long development phase of new products, which involves high costs related to product development, prototyping and pilot production, increasing time-to-market. The authors identified seven main challenges regarding variety management: (1) Difficulties in delaying the point of product differentiation due to the nature of the process utilized in the food industry; delaying the point of product differentiation represents an effective means of addressing product variety. (2) Difficulties in product testing and determining the effects of the tests; knowledge of the production process and the products was lacking, and the effects of the tests were not documented. (3) No standard interfaces between the parts of the product; the product cannot be viewed as a mechanical assembly of parts. (4) Lack of waste transparency, which results in not knowing the product's cost to produce. (5) Cognitive complexity in the production setup. (6) Due to the lack of examples from the process industry, the company has not prioritized the analysis of the benefits of having a product family. (7) Challenges in translating customer requests to parameters of the product and process; the process and product variety are not closely linked with customer wishes.

Enz *et al.* (2019) conducted a single case study to analyse the implementation of a SKU rationalization project by a restaurant chain and its food distributor. The authors explored the factors that favour the success of a SKU rationalization project and provided seven propositions that help to achieve an efficacious and sustainable SKU rationalization. The case company owned and operated more than 500 stores, and it decided to use a single food distributor to achieve economies of scale. The restaurant chain implemented a portfolio reduction strategy with the aim of substituting some of the proprietary SKUs with customer items. The proprietary SKUs were increasing costs and complexity for both the restaurant chain and the food distributor. The authors recognised five main barriers during the implementation of the strategy. First, marketing, sales, R&D, manufacturing, procurement and finance assessed the importance of a given SKU differently. The different departments had conflicting goals that affected and were affected by the decision to add or eliminate SKUs. Second, if the executive team did not define strategic guidelines for SKU rationalization, communicate the guidelines across the organization and enforce their implementation, functional managers may inadvertently or purposely try to influence the results of the SKU rationalization project to favour the objectives of their function. Third, different interpretations of the financial impact of SKU proliferation were shaped by the positions held in the organization. This was due to a lack of information about all the factors that influenced the results and the overall picture. Fourth, the lack of a formal implementation framework contributed to the failure to solve the problem of SKU proliferation. Fifth, the first-year savings were the lowest because the team needed to identify the information requirements, generate reports and analyse the data. Without senior management support, there may have been pressure to drop the effort after year one on the grounds that the savings were not worth the effort.

Ferreira and Correia-Stein (2017) presented a systematic literature review concerning the impact of product variety on operations management, concluding that product variety has been one of the key conflicts between manufacturing and sales departments. However, they did not go into detail about particular types of barriers.

ElMaraghy *et al.* (2013) presented the drivers of product variety – a product's benefits, associated complexity and cost – throughout the product's entire life cycle. The authors indicated that product variety creates both challenges and opportunities for firms and

highlighted how product variety leads to conflict between supply chain managers and marketing managers. While marketing managers are rewarded with higher revenue when they increase product variety to satisfy customer request, supply chain managers prefer less product variety to increase efficiency.

[Sloot et al. \(2006\)](#) evaluated the short- and long-term effects of a 25% item reduction on category sales. The case study was conducted in collaboration with a Dutch retailer. The retailer's aim was to save costs in the supply chain and to reduce complexity by decreasing the number of items in various categories. The original plan was a major assortment reduction, with an estimated cost savings higher than four million euro per year. However, the company feared that a big assortment reduction might affect its category sales. Therefore, the researchers conducted a pilot project in one category. Regarding the execution of the assortment reduction, the authors highlighted a significant potential barrier: an exclusive focus on short-term sales effects that leads to an incorrect conclusion. The time span for analysing the effect of an assortment rationalization should be long enough to include long-term effects.

We identified other research projects in which a product variety management approach was adopted. However, the challenges met by the authors during the PVM approach were not indicated in the papers. As these projects might be interesting for the reader, we briefly cite them here. [Alfaro and Corbett \(2003\)](#) analysed the pooling effect under suboptimal inventory policies and nonnormally distributed demand. [Escobar-Saldivar et al. \(2007\)](#) adopted a product variety management approach in the painted sheet metal industry. [Ding and Sun \(2007\)](#) applied Data Envelopment Analysis (DEA) models to analyse product complexity related to product variety and tested these tools in a US automobile plant. [Malinowski et al. \(2018\)](#) applied SKU rationalization in the form of a variant of product substitution to an industrial packaged supply chain problem.

[Berman \(2011\)](#) described how a firm can limit product proliferation without incurring reduced sales or lowering consumer loyalty. He identified five main barriers to an effective product proliferation reduction program: (1) An all-things-to-all-people orientation – many managers keep excessive assortments of poorly-selling products out of concern for losing customers to competitors; (2) product proliferation as part of a barrier to entry strategy – major brands can attempt to control shelf space such that third-tier brands are precluded from entering the market due to an absence of available sales surface; (3) product proliferation as a low-risk strategy to increase sales – a product manager may be more highly regarded in his company if he develops new products that are redundant rather than increasing profits by reducing SKUs; (4) improper management of product life cycles – firms add new products without removing existing products in the life stage of maturity or decline; (5) reluctance of managers to prune products due to the fear of harming positive relationships with customers.

[Byrne \(2007\)](#) presented a different and truly strategic approach to SKU optimization designed to eliminate high-volume but unnecessary SKUs. The author states that companies usually cut 30 percent of slow-moving, low-volume SKUs. This approach is necessary and commendable, but not strategic. To get the full benefits of a SKU optimization, companies need to focus on the high-volume SKUs. The author identified two entry barriers to the rationalization approach presented: (1) SKU optimization is often run by the supply chain department with the goal of reducing operational costs and complexity, while marketing and sales departments complain that eliminating the latest promotion pack will negatively affect brand equity; (2) a lot of SKUs are not created for the consumer, but for retailers – manufacturers invent numerous new SKUs and special packs to keep all customers happy. When eliminating higher volume SKUs, there will be a backlash from the customers.

[Appelqvist and Gubi \(2005\)](#) used simulation tools to evaluate and quantify the benefits of postponement for a consumer electronics company. In the case study, the benefit of postponement is first evaluated qualitatively through interviews, followed by a quantitative study using discrete-event simulation. The authors identified two barriers. First, they described



that the idea of applying a postponement approach had been suggested for some time but never implemented due to a lack of quantitative evidence. Second, showing a potential for savings raises the question of who will benefit from the savings. The case company bears the cost of developing and manufacturing products while savings occur at the retail outlets.

George and Wilson (2004) discuss how portfolio simplification (rationalization) is a key aspect for managing complexity in a company. The authors state that, with the elimination of low economic profit products and services, a company can free up resources to provide better services to the customer and to allow them to focus more on the remaining (profitable) products/services. In this chapter, we identified four barriers that may arise when adopting a rationalization strategy: (1) while most companies understand the dynamic of the product/service life cycle, very few companies have methodologies in place for managing the end of a life cycle, and consequently, functional groups in the organization tend to blame each other for the creation of complexity; (2) companies may believe that their products and services represent significant diversification and stability of revenues and that a reduction of the portfolio's breadth would mean a permanent reduction in revenue; (3) if the product/service rationalization includes a large section of the portfolio, managers and staff responsible for that segment of products may think they will lose their job; (4) the 'core competencies' (what the company does well) can constrain a company to a market where it cannot earn positive economic profits and become an obstacle to portfolio simplification.

The authors also introduce the case of Intel, a multinational semiconductor manufactory company. Intel was well known as a producer of computer memories, and that was their core business. The company was also developing microprocessors for specific customers. When the memory market started to become more capital-intensive, with tighter margins, the CEO decided to apply a portfolio simplification strategy with the intent of focusing on microprocessors and scuttling memory. During the rationalization process, the CEO met two main challenges: (1) the majority of Intel managers and executives who had memory as a core competence didn't support the transition and became obstructive for the process – their internal competency represented Intel's main barrier to taking the rationalization action; (2) concern over what the company's customers would think.

### 3 CLASSIFICATION OF BARRIERS IDENTIFIED IN THE LITERATURE

The identified papers included different ways of organizing barriers to PVR. In this context, [Enz et al. \(2019\)](#) explored the factors that favour the success of SKU rationalization projects and provided seven propositions that help to achieve an efficacious and sustainable SKU rationalization. We used these seven propositions as a basis for building the classification system for the barriers. In fact, the propositions are the enablers that favour the success of SKU rationalization projects, and we used the categories made by the authors as an inspiration for our classification. The seven propositions are related to the following topics: executive sponsorship, organizational alignment, cross-functional integration, financial information, collaboration, implementation framework and long-term focus ([Enz et al., 2019](#)). Those categories, however, only partially reflect the barriers found in the literature.

[Ramdas \(2003\)](#) organized variety creation decisions into four key decision themes: dimensions of variety, product architecture, degree of customization and timing. Similarly, he sorted variety implementation decisions into three key decision themes: process and organizational capabilities, points of variegation and day-to-day decisions. By process capabilities, the author means manufacturing/service process flexibility and technology; organizational capability comprises ease of interaction between organizational entities, ease of interaction across functions and across development projects and the firm's ability to measure the revenue and cost implications of its variety-related decisions.

It is easy to see how organizational capability, as described by [Ramdas \(2003\)](#), includes organizational alignment, cross-functional integration and financial information presented by [Enz et al., \(2019\)](#). The PVR project should be aligned with corporate goals and strategies, and its support for the company strategy should be clearly communicated across the organization ([Enz et al., 2019](#)). However, the strategy of the company can contrast with the goals of PVR. For example, at the retail store level, product proliferation is used as part of a barrier to entry strategy, with the goal being to preclude third-tier brands from entering the market ([Berman, 2011](#)). A lot of SKUs are not created for the consumer, but for retailers. Manufacturers invent numerous new SKUs and special packs to fulfil the unique needs of different classes of trade. Moreover, product managers are usually more highly regarded for developing new products rather than increasing profits by reducing SKUs. The barriers related to the company strategy are grouped in the category *strategy and organizational alignment*. We used the category *data/information quality* in our classification, which includes not only financial information but also quantitative data, misinterpretation of data, and lack of data and information.

Conflict between departments was indicated as a barrier in four articles. [Ferreira & Correia-Stein \(2017\)](#), [ElMaraghy et al. \(2013\)](#) and [Byrne \(2007\)](#) identified the same cause of the conflict: product variety creates both opportunities and challenges for firms and it requires a trade-off between balancing the increase of revenue and the corresponding costs. While marketing managers are rewarded with greater revenue when they increase product variety, supply chain managers prefer less product variety to increase efficiency and decrease operational costs. The conflict between marketing and manufacturing has gone on for many decades ([Shapiro, 1977](#)), and firms face this conflict when they implement a PVM strategy. [Enz et al., \(2019\)](#) extend the tensions between functions to marketing, sales, R&D, manufacturing, procurement and finance. The functions assess the importance of a given SKU differently and have conflicting goals that affect and are affected by the decision to add or eliminate SKUs. These barriers are grouped in the category *cross-functional integration*. The causes of the resistance of top management are varied. In the Intel case study, for example, [George and Wilson \(2004\)](#) indicated the internal competency of the managers as Intel's main barrier for taking the rationalization action. The core competence of the managers was computer memory. When the CEO decided to cut memory products and focus on microprocessors, most of Intel's managers and executives would not make the transition and became obstructive to the simplification strategy. [Berman \(2011\)](#) observed that the reluctance

of managers to prune products is particularly applicable in a business-to-business environment. The category *executive sponsorship* collects the above-mentioned barriers.

Inspired by Ramdas (2003), we introduced *product architecture* and *manufacturing process* as categories in the classification system. Product architecture comprises the barriers to a PVM strategy related to the nature and the architecture of the products. Manufacturing process comprises the barriers related to technologies, decoupling point, logistics and supply chain elements. Companies do not usually have methodologies in place for systematically managing the end of a life cycle (Berman, 2011; George and Wilson, 2004). PVR strategy requires a formal *implementation framework* that helps to implement the strategy in a structured manner (Enz et al., 2019). The implementation framework supports the resolution of the conflicts, the achievement of consensus within the team, the analysis of the existing portfolio and the creation of a new SKU methodology. Collaboration with the main customers and suppliers during the PVR strategy can provide the opportunity to obtain bigger benefits (Enz et al., 2019). In this way, the company can satisfy the suppliers/customers without creating a new SKU and come to an agreement on which SKU they should discard. The lack of *customer/supplier collaboration* during the PVR strategy will lead to a disappointing customer experience and is a sure way to hurt the company’s brand image.

Another barrier we identified is related to *fears and negative beliefs* that companies and employees have in the early stages of a PVR strategy. Examples of these common beliefs are given in the literature by George and Wilson (2004), Sloot et al. (2006) and Berman (2011): concern about what the client will think, fear that significant assortment reduction might affect the category sales, the belief that a reduction of portfolios means a reduction in revenue, fear of losing an important client to a competitor for even one item and, for the staff responsible for the products affected by rationalization, fear of losing their job. This category is not highlighted in the literature analysed, but it has a big impact on the implementation of a PVR strategy. For this reason, we decided to include this topic in the final classification system.

In the end, we identified the following nine categories for the classification of the barriers:

1. Cross-functional integration
2. Strategy and organizational alignment
3. Executive sponsorship
4. Fears and negative beliefs
5. Data/information quality
6. Implementation framework
7. Product architecture
8. Customer/supplier collaboration
9. Manufacturing process

Using these nine categories, the barriers described in the previous subsections may be categorized as shown in Table II.

**Table II.** Barriers identified in the literature

	Barriers	Category	Reference
1	The nature of the process utilized in the case company results in difficulty in delaying the point of product differentiation. The task is difficult because the differentiation happens in the mixing process, before the process becomes discrete. The semi-manufactured products cannot be kept in stock in order to make the customization later, since the products decay.	Manufacturing process / product architecture	Bech et al. (2019)
2	Knowledge of the production processes and the correlation with the ingredients in the dough is lacking, and tests have to be performed in the production setup. The	Data/information quality	

	effects of the tests are not documented, which results in significant testing.		
3	There are no standard interfaces between the parts of the product (a dough, a shape with a filling and a topping). The product cannot be viewed as a mechanical assembly of parts.	Product architecture	
4	The case company experiences challenges with the cost of products due to lack of waste transparency. The physical waste is not logged per product, which results in not knowing the product's cost to produce. In conclusion, the company is lacking information on the product's performance in production.	Data/information quality	
5	The production process is, today, solely operator-driven. Thereby, cognitive complexity exists in the case company.	Manufacturing process	
6	Even though the durable goods industry has seen good results, exploring the benefits of applying a product family has not been prioritized. One of the reasons for this lack of prioritization is the lack of examples from the process industry.	Data/information quality	
7	It has been a challenge to translate customer requests to parameters of the product and process. As a result, the process variety and the product variety are not closely linked with customer wishes. Finding a systematic way of establishing the product and process variety which encompasses customer requests has not been in focus at the case company.	Customer/supplier collaboration	
8	The importance of a specific SKU is likely to be viewed differently by marketing, sales, R&D, manufacturing, procurement and finance, which usually have conflicting goals that affect and are affected by the decision to add or eliminate SKUs. There is tension between functions in the area of SKU rationalization.	Cross-functional integration	
9	It is necessary to align SKU rationalization objectives with the organization's goals and strategies. If the executive team does not define strategic guidelines for SKU rationalization, communicate the guidelines across the organization and enforce their implementation, functional managers may inadvertently or purposely try to influence the results of the SKU rationalization project to favour the objectives of their function.	Strategy & organizational alignment	
10	Due to a lack of information about all the factors that influenced the results and the overall picture, different interpretations of the financial impact of SKU proliferation were shaped by the positions held in the organization.	Data/information quality	Enz <i>et al.</i> (2019)
11	Lack of a formal implementation framework contributed to the failure to solve the problem of SKU proliferation.	Implementation framework	
12	The first-year savings were the lowest because the team needed to identify the information requirements, generate reports and analyse the data. Without senior management support, there may have been pressure to drop the effort after year one on the grounds that the savings were not worth the effort.	Strategy & organizational alignment / executive sponsorship	
13	Product variety has been one of the key conflicts between manufacturing and sales departments.	Cross-functional integration	Ferreira and Correia-Stein (2017)
14	Customers prefer broad product lines, and therefore, marketing managers are rewarded with greater revenue when they increase product variety. Supply chain managers, on the other hand, prefer less product variety to increase efficiency, which may reduce revenues and profits. Unfortunately, firms face this product variety conflict between supply chain managers and marketers with limited predictive ability.	Cross-functional integration	EIMaraghy <i>et al.</i> (2013)
15	An all-things-to-all-people orientation: many managers keep excessive assortments of poorly-selling products out of concern for losing customers to competitors. They fear losing an important client to a competitor for even one item.	Fears and negative beliefs	
16	Product proliferation as part of a barrier to entry strategy: at the retail store level, major brands can attempt to control shelf space such that third-tier brands are precluded from entering the market due to an absence of available sales surface.	Strategy & organizational alignment	Berman (2011)
17	Product proliferation as a low-risk strategy to increase sales: in many cases, a product manager may be more highly regarded in his/her company for developing new products that are redundant with existing ones rather than increasing profits by reducing SKUs.	Strategy & organizational alignment	
18	Improper management of product life cycles: firms add new products without removing existing products that are in the life stage of maturity or decline.	Implementation framework	

19	Reluctance of managers to prune products: part of this reluctance may be due to the fear of harming positive relationships with customers. This concern is particularly applicable in a business-to-business environment.	Executive sponsorship / fears and negative beliefs	
20	Attacks on the lowest-volume SKUs are usually run as supply chain initiatives aimed at cutting operating costs by reducing product-line complexity. Often, marketing and sales people complain that eliminating the latest promotion pack will negatively affect brand equity.	Cross-functional integration	Byrne (2007)
21	When eliminating higher-volume SKUs, or trying to eliminate them, be prepared for a backlash. A lot of SKUs are not created for the consumer, but for retailers. Companies don't create five sizes of spicy tomato sauce because they think the consumer wants them but because they have to fulfil the unique needs of different classes of trade. Thus, manufacturers invent numerous new SKUs and special packs to keep all channels happy.	Strategy & organizational alignment	
22	The company feared that a big assortment reduction might affect its category sales.	Fears and negative beliefs	Sloot <i>et al.</i> (2006)
23	The collaborative research project provides some information for the retailer regarding the execution of assortment reduction projects. One key lesson is that an exclusive focus on short-term sales effects leads to incorrect conclusions. Instead, the time span for analysing these effects must be long enough to include long-term effects.	Strategy & organizational alignment / implementation framework	
24	The simulation project was a success that triggered implementation of a new delivery concept. The idea had been suggested for some time but never implemented due to a lack of quantitative evidence.	Data/information quality	Appelqvist and Gubi (2005)
25	Showing a potential for savings raises the question of who will benefit from the savings. In the described setting, the case company bears the cost of developing and manufacturing products while savings occur at the retail outlets.	Customer/supplier collaboration / strategy & organizational alignment	
26	While most companies understand the dynamic of product/service life cycles, very few companies have methodologies in place for systematically managing the end of a life cycle.	Implementation framework / cross-functional integration	George and Wilson (2004)
27	Functional groups in the organization tend to blame each other for the creation of complexity.	Cross-functional integration	
28	Companies may believe that a reduction of the portfolio's breadth means a permanent reduction in revenue.	Fears and negative beliefs	
29	Managers and staff responsible for the segment of products affected by rationalization may think they will lose their job.	Fears and negative beliefs	
30	Core competency as an obstacle to create shareholder value: most companies are stuck in a paradigm where strategic decisions are based on what the company does well (its core competencies) instead of what customers value.	Strategy & organizational alignment	
31	A concern over what the company's customers would think. The company believes that customers will react negatively to the portfolio simplification.	Fears and negative beliefs	
32	Managers and executives with a core competency in the 'rationalized' products don't support the transition and become obsolete and obstructive to the process. This represented Intel's greatest barrier to taking the necessary action for survival.	Executive sponsorship	

## 4. CASE STUDY

### 4.1 Research method

The case study research methodology was adopted to investigate the proposed classification of PVR barriers and, possibly, to identify additional ones. A case study is defined as ‘a study that investigates a contemporary phenomenon (the ‘case’) in depth and in its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident’ (Yin, 2018). This is especially meaningful for the present study, as the barriers in a PVR implementation strategy are not evident or predictable and might be influenced by the market context.

Gammelgaard (2017) describes three types of case studies. First, case studies are often applied to generate theory through inductive exploration of unknown phenomena. Second, case studies are used for deductive theory testing, as described by, for example, Yin (2018). Third, case studies can be used for theory elaboration by utilizing through the use of both inductive and deductive reasoning, as proposed by Ketokivi and Choi, 2014. The present study may be categorized as such a case study, as it both tests the relevance of the PVR barriers identified in the literature (i.e., deductive theory testing) and conduct an inductive exploration to identify additional barriers.

For the setting of the case study, the researchers sought a company that felt the need to implement a PVR strategy and, consequently, had already made the choice to invest in this project. Furthermore, other companies with the same characteristics (worldwide presence, extended enterprise, composed of different business units) can be represented by the chosen case company. The company selected for the case study is a mineral wool production company located in Europe. The company has a market-leading position in the building materials industry and operates over 20 global production facilities with over 10,000 employees. It is composed of 18 individual business units (BU) operating in different markets, with each BU managing its own assortment. Led by the CEO, the company pursued a PVR program in 2015 and achieved operational and financial benefits across multiple factories and sales units. At the beginning of the project, product proliferation was increasing as new variants were added to existing product lines upon customer request. The sales department was not applying any process for removing stock keeping units (SKUs) from the assortment, and in the production, the negative effects of additional product variants were evident.

Multiple investigators were used to enhance the creative potential of the study and to enhance confidence in the findings (Eisenhardt, 1989). One of the researchers collaborated with the supply chain team between two and four days per week during the entire project period (four years). The main role of the researcher was observing the project team in the SKU rationalization tasks: development of the program, methodology, quantification of the impact and reports to the management. During the PVR program, the researcher had full access to the financial and operational data of the company. A second researcher used qualitative data analysis techniques to understand the managers’ perceptions and identify the challenges that influenced the execution of the SKU rationalization strategy. The researcher involved in this phase did not participate in the SKU reduction project and thus was not influenced by participation in the company’s PVR strategy. The first step was to interview supply chain managers and portfolio managers responsible at the cooperate level. The semi-structured interviews contained questions about the timeline of the strategy, the execution of the project and the barriers encountered.

### 4.2 Case study results

Led by the CEO, the case company set the reduction of product portfolio complexity as a top priority in 2015 and initiated a program to develop methods to address increasing product variety. As mentioned in Section 2.2, the company consists of 18 individual BUs operating in

different markets, with each BU managing its own assortment. Fifteen of the BUs participated in the SKU rationalization project. The main goal of the SKU reduction was to create additional throughput on the production lines and thereby reduce product cost. Unprofitable and low-volume SKUs were targeted for rationalization so that more profitable SKUs could be sold in their place. In order to determine if a SKU was profitable or unprofitable, a threshold of 2000 EUR in contribution margin (CM) per year per SKU was established. Reductions in operational costs resulting from the project were sought by some BUs, but this was not the primary objective of the rationalization.

Full-time collaboration with the company allowed the researcher to observe first-hand the challenges of implementing a portfolio reduction program within an international organization. A number of challenges were observed during the SKU rationalization. First, in the building materials business, some products are sold primarily to building project contractors, and, to win a project bid, the company must be able to provide all requested products, including the low-volume SKUs with low profitability. Thus, the potential revenue of high-volume SKUs is linked to the availability of the low-volume SKUs. Therefore, the company-wide approach to assess profitability at the SKU level couldn't be applied for certain low-volume product segments. Second, the threshold for unprofitable products was heavily critiqued by top managers as being too high for special products that are produced to satisfy large customers. While many of the managing directors of the BUs thought the CM threshold was too high, the CEO thought it was too low, favouring a threshold value closer to 5000 EUR in CM per SKU. Third, not all of the BUs implemented a cross-functional portfolio review to drive assortment changes. To prevent an immediate impact on the customer base, some BUs focused on the simpler task of closing unsold SKUs. In other words, instead of rationalizing the sold SKUs, they simply removed the SKUs that had not been produced or sold in over one or two years. Fourth, the change management process in an organization with distributed decision-making power was quite complex. In the first year of the project, the BUs often questioned and criticized the methods for managing the SKUs and for evaluating the BUs' results. In the first year, some training was needed to explain the expectation of SKU rationalization to the BUs' management. Fifth, the importance of clearly communicating the expected business benefits of the portfolio simplification to all stakeholders was clearly seen in the project. The managing directors who clearly saw how the SKU rationalization would help them meet their financial and operational performance goals were more motivated to execute the project. During the first two years of the project, the expected business benefits didn't permeate the top management, and resistance to the project was evident. Sixth, a further challenge to SKU rationalization was the complex production network setup and the lack of global product management across the BUs. Some BUs operated as production BUs, offering their standard product line and managing the production equipment. Other BUs operated as sales BUs, offering specialized product lines but not directly managing production, instead sourcing the products from the production BUs. These interdependencies between BUs introduced complications into the SKU rationalization process for both sales BUs and production BUs. For example, if a sales BU wanted to close a SKU, they could close the SKU for sale from their organization but could not close it for production themselves; for that, they also needed to coordinate with the production BU to close the SKU. Seventh, another issue related to the production network arose when a certain production BU tried to simplify the products it produced on the manufacturing equipment. During their analysis, the team at the production BU found that their own product lines accounted for a fraction of the SKUs produced while the remainder of the SKUs produced were managed by sales BUs that were unwilling to reduce the product assortments. This complication limited the amount of operational benefits the production BU could achieve and also seemed to dampen their motivation to pursue the project further. Eighth, there seemed to be some cultural and personality factors which affected the execution of the SKU rationalization initiatives across

the BUs. Regarding personality factors, the North American team was headed by a very driven supply chain director who was able to persuade the BU's management team to commit to a drastic SKU reduction (> 50%) at the very onset of the cross-company SKU rationalization initiative. His drive and character were seen across the company as key factors that led to their first mover status in the company and the success of the project in their BU. Regarding cultural factors, there was a clear difference in the initiative shown by the Polish and Russian BUs compared to the German and Dutch BUs. The Polish and Russian BUs appeared to be much more execution-oriented, implementing the guidelines from headquarters with rigor and little resistance. The German and Dutch organizations, however, delayed in execution and required multiple visits and conference calls from the researchers to explain the SKU rationalization methods and potential improvements to be gained. The German and Dutch BUs did not make significant changes until the last year of the project, being two of the last BUs to take action.

The managers interviewed had been aware of the problem of SKU proliferation for a long time, and a few isolated portfolio simplification initiatives were carried out some years before the main project. Five years before the group SKU rationalization, the supply chain department of one BU started a SKU reduction initiative with the goal of improving the efficiency of production. At the same time, the marketing department of another BU ran a similar project with the purpose of increasing capacity in the production site. Slowly, other BUs started to see the operational benefits of these initiatives and began to support the project. The former CEO understood that product complexity was a problem for the company and started focusing a bit more on the rationalization projects. However, he was not persistent, and he did not set the portfolio simplification as a priority for the company. The BU initiatives remained local projects, and the overall project didn't start until the arrival of the new CEO. In 2015, the new CEO saw the big potential of the SKU rationalization strategy, set it as a top priority of the overall company and established the direction to address the product variety reduction. The operations and production manager highlighted how the sponsorship and the directions of the new CEO were relevant to the success of the PVR strategy. To determine the threshold between unprofitable and profitable products, an activity-based costing analysis was performed for a generic, low-volume product that was most representative of the products made by the company. The analysis incorporated existing cost of goods sold figures with analyses of inventory costs, extra waste and manning required for small batches, sales order handling costs and a desired CM. The researchers, together with the company's supply chain team, discovered that 2000 EUR in CM per year was the threshold between profitable and unprofitable products. Initially, the methods of the strategy were not clearly communicated to the BUs, and the top managers heavily critiqued the threshold for unprofitable products. There was a crucial misunderstanding in the communication of the threshold: the BUs were under the impression that all products with a contribution margin below 2000 EUR must be removed. The real goal of the methods was to start analysing those products and take some action to remove/substitute the products or raise their contribution margin (pricing, changing volume, etc.). One more barrier identified by the managers is related to the fear of applying the portfolio rationalization within BUs in which sales were declining. The operations managers of these BUs were afraid to lose more volume in the production line and were reluctant to remove unprofitable products. They would have preferred to keep producing those products in order to run the production lines at full capacity. The managers observed that these fears and the economic factors were related to each other: BUs with good financial conditions were more confident in starting a PVR strategy compared to BUs that had financial issues. Finally, an interesting observation was made by the operations and production manager: *'No matter how you approach a PVR strategy, there will be always some reluctance in the beginning due to the change management. You have to consider the change management factor and that it will decrease over the time'*.

Table III summarizes the barriers to PVR identified in the case study.



**Table III.** Barriers identified in the case study

	<b>Barriers</b>	<b>Category</b>	<b>Reference</b>
1	In the construction business, the company must be able to provide all requested products – both high-volume SKUs and low-volume SKUs. Therefore, the company-wide approach to assess profitability at the SKU level couldn't be applied for this product segment.	Product architecture	Case Study
2	Top managers heavily critiqued the threshold for unprofitable products, which they considered to be too high for special products that are produced to satisfy large customers.	Executive sponsorship	
3	To prevent an immediate impact on the customer base, some BUs, instead of rationalizing the sold SKUs, simply removed the SKUs that had not been produced or sold in over two years.	Implementation framework	
4	The BUs often questioned and criticized the methods for managing the SKUs and for evaluating the BUs' results. Some trainings were needed to explain the expectation and the benefit of SKU rationalization.	Information quality/ Implementation framework	
5	During the first two years of the project, the expected business benefits didn't permeate the top management, and resistance to the project was evident.	Information quality/ Executive sponsorship	
6	The production network and lack of global product management across the BUs created many interdependencies in the SKU rationalization that limited the reductions for some BUs.	Process capabilities	
7	The former CEO was not persistent, and he did not set the portfolio simplification as a priority for the company. The BU initiatives remained local projects, and the overall project didn't start before the arrival of the new CEO.	Executive sponsorship	
8	Initially, the methods of the strategy were not clearly communicated to the BUs, and there was a crucial misunderstanding in the communication of the threshold.	Information quality/ Implementation framework	
9	There was some fear of applying the portfolio rationalization in BUs in which sales were declining. The operations managers of these BUs were afraid to lose more volume in the production line and were reluctant to remove unprofitable products.	Fears and negative beliefs	
10	There seemed to be some cultural and personality factors which affected the execution of the SKU rationalization initiatives across the BUs	?	

## 5. A CLASSIFICATION OF BARRIERS TO PRODUCT VARIETY REDUCTION

Based on the review of the literature and the case study, a final classification of barriers was created. In this context, the barriers identified in the literature and the ones identified in the case study differ in some respects. Specifically, some of the barriers identified in the literature were not identified in the case study. This is not surprising; it can be explained by differences across contexts. In other words, it can be expected that some barriers would only be found in certain cases. Conversely, we could not allocate the tenth barrier found in the case study to any of the classifications derived from the literature. Thus, we propose an extension of the barriers identified in the literature: namely, the category ‘socio-cultural factors’. Socio-cultural factors are one of the main environmental factors that significantly affect the economic activity of multinational companies and their performance (Masovic, 2018). The socio-cultural factors that impact the operations of multinational companies are culture, language, religion, level of education, customer preferences and the attitude of the society towards foreign goods and services (Trehan and Trehan, 2009). Multinational companies should be aware of predominant attitudes, values and beliefs in each host country when deciding to implement a PVR strategy and should anticipate the impact of all socio-cultural factors. The researchers agreed that this new barrier needs its own category in the classification. Therefore, we propose a final classification of the barriers as shown in Table IV.

**Table IV.** Barrier Categorization

<b>CROSS-FUNCTIONAL INTEGRATION</b>	PVR strategies must have cross-functional involvement so that functional biases are understood and addressed. Ease of interaction across functions enhances a firm’s ability to quickly introduce new products.
<b>STRATEGY and ORGANIZATIONAL ALIGNMENT</b>	The way in which the objectives for the PVR project are aligned with corporate goals and strategies should be clearly communicated throughout the organization.
<b>EXECUTIVE SPONSORSHIP</b>	PVR strategy requires executive sponsorship in order to overcome strongly competing functional priorities. The initial phase of the project involves the creation of awareness that SKU proliferation is a priority problem.
<b>FEARS and NEGATIVE BELIEFS</b>	A PVR strategy can scare both management and staff inside an organization. Before the implementation, companies tend to be concerned about losing customers and revenue. During the implementation, the staff may be scared about the changes required by the initiative.
<b>DATA/INFORMATION QUALITY</b>	PVR strategy decisions require the availability of data, revenue and cost information that managers from different functions understand and can trust. This information must be disseminated throughout the organization to build support for the project as well as an understanding of its benefits.
<b>IMPLEMENTATION FRAMEWORK</b>	PVR strategy requires a formal implementation framework. It helps to implement the strategy in a structured manner (resolve conflicts, achieve consensus within the team, analyse the existing portfolio, create new SKU methodology, etc.).
<b>PRODUCT ARCHITECTURE</b>	Architecture is a mayor determinant of how a firm can differentiate and variegates its products. The product architecture can influence the selection of a PVR strategy and its implementation.
<b>CUSTOMER/SUPPLIER COLLABORATION</b>	The benefits of a PVR strategy are greater with key customer/supplier collaboration.
<b>MANUFACTURING PROCESS</b>	Manufacturing process flexibility is a key capability in order to manage the implementation of a variety strategy. Flexible technologies, point of variegation (decoupling point), logistics and supply chain elements can influence the application of a PVR strategy.

**SOCIO-CULTURAL FACTORS**

Society and culture have an impact on every aspect of the overseas business of multinational companies. Although they are not directly included in business operations, they indirectly appear as key elements in shaping how the business is managed. The key socio-cultural factors that have a major impact on the operation of the multinational companies are culture, language, religion, level of education, customer preferences and the attitude of the society towards foreign goods and services.

## **6. DISCUSSION AND CONCLUSIONS**

In this paper, we investigated the barriers to the implementation of a PVR strategy by analysing and classifying the barriers found in the literature and then further exploring these through a case study. The case study partially confirmed the barriers identified in the literature, and it enriched these by introducing a new category of barriers.

### **6.1 Implications for research**

As demonstrated by the literature review, the PVR literature involves different organizations of PVR barriers. This is problematic, from at least three perspectives. First, to further develop PVR approaches, there is a need to understand the issues that companies encounter when engaging in PVR programs so that PVR approaches can provide means for avoiding such issues. Second, research employing a hypothetical-deductive method for exploring characteristics of barriers, such as frequency of occurrence and barrier strength, will not provide full accounts of PVR barriers if leaning on incomplete classifications. Finally, for research discussing PVR barriers, the lack of agreement on PVR barriers makes cross-study comparisons difficult.

This paper addressed these issues by providing a more complete classification of barriers to PVR. Specifically, this study makes three contributions to the research. First, it identifies barriers to the implementation of PVR strategies described in the scholarly literature. Second, it provides a classification system for these barriers. Third, through a case study, an additional category of barriers was identified. Hereby, the paper provides an important contribution to the PVM literature.

### **6.2 Implications for practice**

Practitioners may utilize the PVR barrier classification to anticipate the barriers they will meet while pursuing a PVR program. Such an overview would reveal where the management should focus attention and resources in order to overcome scepticism and even resistance in the implementation of the strategy. In other words, an overview of possible barriers may help companies avoid them through pro-active effort.

### **6.3 Research limitations and further research**

This study has some limitations that may provide worthwhile opportunities for further research. First, the final sample of nine articles identified as the core of the systematic literature review is limited. Additional studies should include the use of new keywords to enrich the search string in order to discover more literature about the challenges facing PVR strategies. Second, the case study research methodology was applied at the aggregated level. This study considered the barriers met during the reduction of product portfolio complexity at the company level. The firm consists of 18 individual BUs operating in different markets, with each BU managing its own assortment. Additional research should study the effects and the challenges of a SKU rationalization at the BU level. It might be interesting to see the difference between the barriers met by the same company at the aggregated and disaggregated levels. However, more research is required, both at the aggregated and disaggregated levels, because the number of studies on the barriers to implementing a PVR strategy is still limited.

The proposed method, a systematic literature review followed by a case study, is useful to obtain an overview of the existing knowledge in the recent literature and to verify and enrich it with a more qualitative study. Using this project as a starting point, additional research should confirm and develop the categorization of the barriers presented in this paper. Case studies of companies that want to apply a PVR strategy might enrich the list of barriers with some real-world examples.

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