Reducing complexity at Procter & Gamble

- A complexity approach towards product portfolio management –

Master Thesis Industrial Engineering & Management
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23-03-2012

Public version

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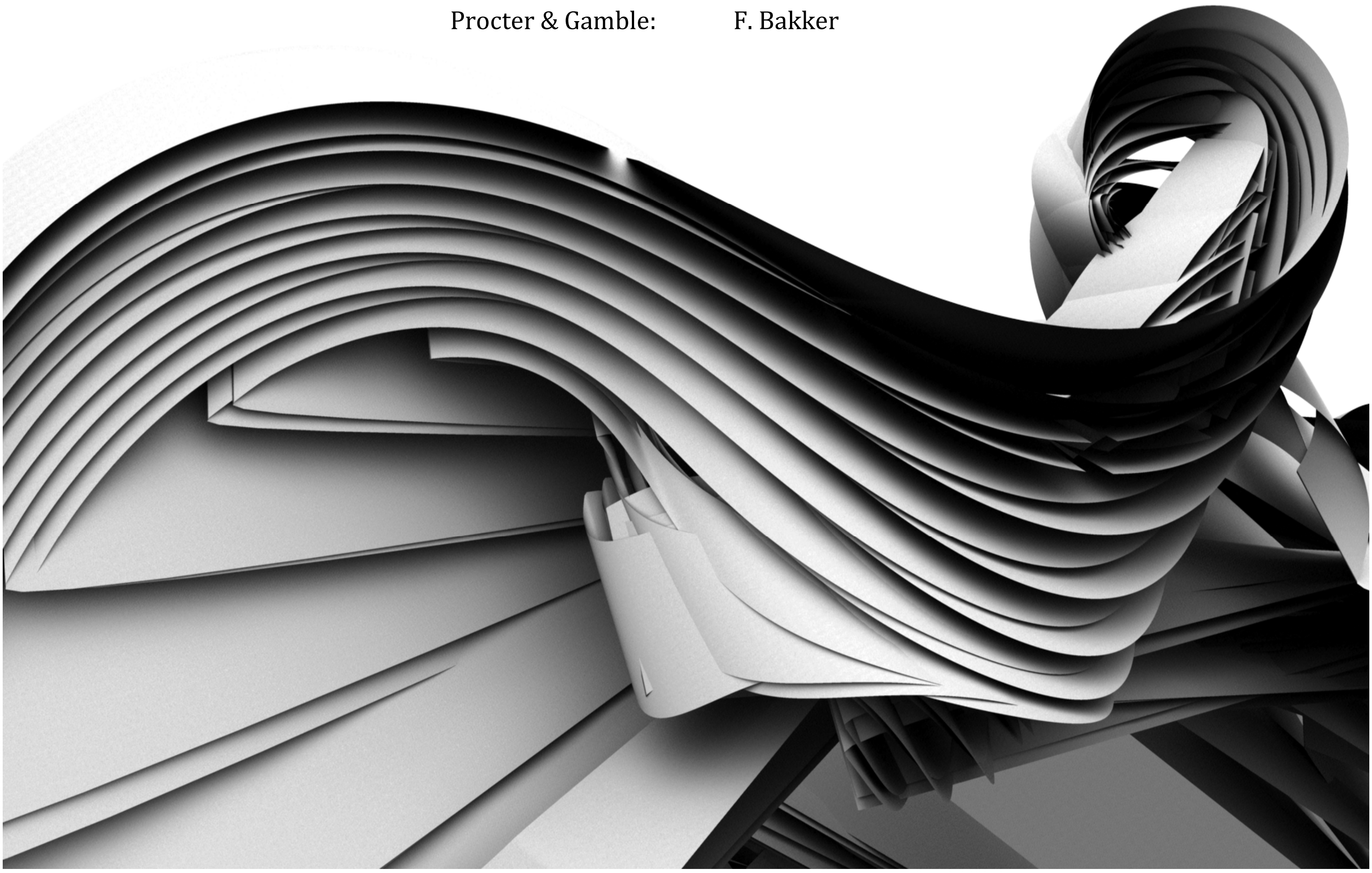

Glossary

Abbreviation	Description
APB	*Actual Portfolio Benefits;* conceptualization of total received benefits (TRB) that provides the actual benefits received by offering a portfolio
BE LUX	*Belgium & Luxembourg*
BNL	*Benelux;* Belgium, the Netherlands and Luxembourg
BOM	*Bill of Material*; list of (sub) components of a product
CBD	*Customer Business Development;* sales department of Procter & Gamble
EAN	*European Article Number;* external identification code of a SKU
F&A	*Finance & Accounting;* financial department of Procter & Gamble
FMCG	*Fast Moving Consumer Goods;* industry selling consumption goods to consumers through retail channels
FTE	*Full Time Equivalent;* refers to 1 employee working 1 year full time (2080hrs)
GBU	*Global Business Unit;* global sub-organization of Procter & Gamble concerned with products within a specific category
MDO	*Market Development Organization;* regional organization concerned with adapting global product assortment to regional market.
MS&P	*Market Strategy & Planning;* organizational function coordinating market strategies.
NL	*The Netherlands*
PVP	*Portfolio Value of a Product;* metric for the added value of a SKU, measured by the difference in total portfolio value <u>with</u> and <u>without</u> a specific product
RBU	*Regional Business Unit;* see GBU
SKU	*Stock Keeping Unit;* product or components that is sold and/or kept in stock. SKUs can refer to single products, bundles and displays.
SNO	*Supply Network Operations*; the logistics department of Procter & Gamble
TD-ABC	*Time-Driven Activity Based Costing;* a cost accounting model based on the principles of Activity Based Costing as introduced by Kaplan (1983).
Tier	A specific set of SKUs in a portfolio that offers the same equity at a comparable price and are therefore considered to be substitutes of each other.
TIR	*Total Inverted Resources;* sum of all required resources to maintain a product portfolio within the organization
TPC	*True Portfolio Costs;* conceptualization of total invested resources (TIR) that indicates the true costs involved in maintaining a portfolio.
TPV	*Total Portfolio Value;* the difference between total received benefits (TRB) and total invested resources (TIR)
TRB	*Total Received Benefits;* sum of all benefits received from a product portfolio in the organization
TVC	*Total Variable Costs;* sum of all variable costs (VC) for a specific product portfolio
UoM	*Unit of Measure*
VC	*Variable costs;* required consumption costs of each item being produced
WE	*Western Europe*

Management Summary

In an industry as competitive as the Fast Moving Consumer Goods (FMCG) industry, continuous innovation and operating with business excellence are key drivers for success. Many organizations tend to use differentiation of products, processes or services as the key enabler to outperform competitors. However, despite the obvious business rationale behind differentiation, only few firms are truly able to cope with the increasing complexity that comes with increased differentiation.

Research motivation

Within Procter & Gamble Benelux, we observed this very same trend, as the number of SKUs has increased over the past 2 years, while the sales *per* SKU have decreased. Consequently, there is a clear mismatch between the invested organizational resources (here conceptualized by the number of SKUs) and the benefits received (i.e., the sales) for these 'expenditures'. Despite previous attempts to tackle this increasing complexity, Procter & Gamble has not been able to develop the organization-wide supported approach needed to permanently ban complexity from the organization.

Research goal

This research aims to contribute to managing the increasing complexity within Procter & Gamble by defining and implementing a more effective complexity management process, ultimately with the goal to *reduce the organizational complexity of Procter & Gamble Benelux.*

Research design

To contribute to finding the best possible understanding of the concept of complexity, we performed an extensive literature study to identify a common-shared and widely supported definition of organizational complexity and its drivers, thereby focussing *on product portfolio complexity* in particular. We used a qualitative approach to provide a clear assessment of the landscape of product portfolio complexity. Building on this qualitative understanding, we proposed several metrics to quantitatively track (product portfolio) complexity and drive action to *reduce* product portfolio complexity for Procter & Gamble. We synthesized the *qualitative* insights and *quantitative* metrics into a decision support model to reduce product portfolio complexity, and applied this decision support model to Procter & Gamble's product category Oral Care.

Conclusions

'Complexity' by itself does not exist, as it is merely the result of an expected outcome given a certain input. We therefore proposed to define complexity as: *the results of the relation between invested organizational resources and received benefits for these investments.* Furthermore, even though many consider complexity to be a negative phenomenon, it is not by definition undesirable, as certain levels of complexity may actually add some sort of value to an organization. We therefore focused on reducing 'bad' (i.e., non-value-adding) complexity, while allowing for 'good' (value-adding) complexity to exist within the organization. Using the *objective* and *subjective* drivers for product portfolio complexity as identified from literature and adapting them to fit the specific business environment of Procter & Gamble, resulted in our proposition for the *5C framework for product portfolio complexity* (see Figure 1). This framework *qualitatively* shows us what drives complexity to exist in the product portfolios of Procter & Gamble. To shape the *quantitative* understanding of product portfolio complexity, we used the metrics from the SPO-program of Procter & Gamble to gain *initial insights* in a portfolio's complexity.

Building on our complexity definition and the 5C framework for product portfolio complexity, we developed the metric *Portfolio Value of a Product* (PVP), which indicates the added value of a SKU to a portfolio, by comparing the portfolio's value with and without that specific SKU. Based on the fundamentals of our complexity definition, 5C framework and PVP-metric, we developed a decision support model to reduce product portfolio complexity within Procter & Gamble Benelux. ………*Missing section, not available in public version*……… Analyzing the results of our decision support model with regard to the SKU-profiles.

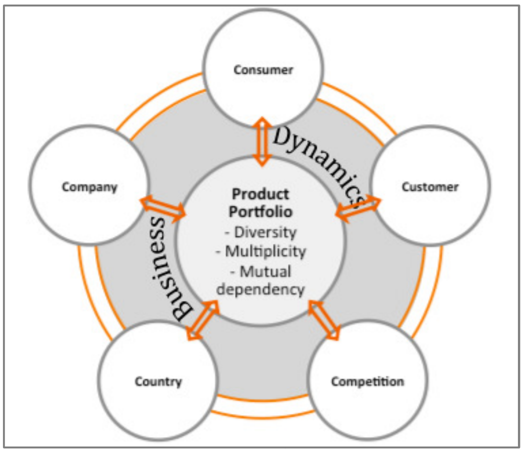

Figure 1 - 5C framework for product portfolio complexity

Analyzing the results of our decision support model with regard to the SKU-profiles, shows that on the one hand the outcomes *are supported by* the complexity-causing business dynamics from the 5C framework, while on the other hand they *provide support for* the identification of these very same complexity-causing business dynamics. We therefore concluded that the decision support model has a high level of practical relevance for Procter & Gamble. Finally, critically reviewing the case study and the model outcomes led to the identification of several improvement opportunities to make the decision support model match reality even better.

Recommendations

- *Sustain focus.* Although this research covered a lot of ground in the field of complexity management and provided very valuable insights, it is merely one of the many steps needed to constitute a less-complex organization. Procter & Gamble should sustain the strong focus on *conscious* portfolio decision-making to completely ban *non-value-adding* complexity from the organization.
- *Control product portfolio complexity*. Even though this research delivered the tools to *understand* and *improve (i.e., reduce)* product portfolio complexity, Procter & Gamble should continue to work on designing solid approval-processes to pro-actively *control* the creation of non-value-adding SKUs and prevent the portfolio from regaining complexity.
- *Reduce complexity in the Oral Care portfolio*. ………*Missing section, not available in public version*………
- *Further strengthen and re-apply the decision support model.* After reducing complexity in the Oral Care portfolio, Procter & Gamble should re-apply the decision support model to their other portfolios. Moreover, we recommend Procter & Gamble to further strengthen the model's match with practice by evaluating assortment options other than SKU-rationalization, incorporating the influences of a competitor's portfolio composition, and by using a dynamic approach and incorporating cross-product elasticity effects to strengthen the relation between additional substitutes and additional percentage of sales recovery.

We conclude this research with the notion that while our approach heavily contributed to managing product portfolio complexity and helped to derive a less complex product portfolio for Oral Care, the challenges presented by other types of complexity provide many additional opportunities to improve the effective use of all organizational resources. Moreover, having (senior) management support and closely aligning the timings of assortment changes with retailers remain critical success factors to deliver a sustainable complexity reduction.

Preface & acknowledgements

Fools ignore complexity. Pragmatists suffer it. Some can avoid it. Geniuses remove it.

(Alan Perlis)

This report is the final result of my master thesis performed at Procter & Gamble Benelux in the partial fulfilment of the requirements for the degree of Master of Science in Production and Logistics Management.

First of all, I would like to thank my first supervisor from the University of Twente, Peter Schuur, for his unconditional creativity and passionate guidance over the past six months. His broad interest in the subject of complexity management continuously challenged me and resulted in the best possible coverage of a notoriously difficult topic. Moreover, I sincerely appreciate his flexibility and cooperation in making appointments and providing feedback. Furthermore, I would like to thank my second supervisor from the University of Twente, Henk Kroon, for his valuable insights and feedback with regard to the financial aspects of this thesis.

Next, I would very much like to thank my company supervisor, Ferry Bakker, for his inspiring support and constructive approach that greatly dedicated to the results of this research. His profound business knowledge combined with an endless drive for improvement truly helped me to deliver a research with a high level of practical relevance. In this context, a special thanks to Yannick Vergouwen, for introducing me into the world of Procter & Gamble and closely supporting this research.

Finally, I would like to thank my friends and in particular my family for their unconditional support throughout my years in college.

Eef-Jan den Hartog,

Rotterdam, March 2012

Table of content

1. Introduction

This report describes the master thesis for the study Industrial Engineering & Management performed in the field of complexity management. This first section provides a short introduction into the company where this research was executed: Procter & Gamble. We briefly discuss the history of Procter & Gamble, complemented with a few basics on the Benelux Market Development Organization (MDO) in section 1.1. Section 1.2 then provides a description of the different product categories as offered by Procter & Gamble.

1.1. Procter & Gamble's history

Procter & Gamble was founded in 1837 by William Procter, an English candle maker and James Gamble, an Irish soap producer. In a time where brands did not exist yet, let alone the infrastructure to support a local or even a global market, they began to build their business, driven by the simple philosophy to deal honestly and directly with those who bought and used their products. In the 1850's, their candles became one of the first known trademarks, identified and recognized by consumers for their quality. Three decades later, in 1879, Ivory soap became one of the earliest mass-marketed consumer brands. Many of the innovations and new brands that followed were driven by consumer interaction, as Procter & Gamble actively used the consumers' needs and experiences to make their every-day life easier.

In the decades that followed, Procter & Gamble built further on becoming the world's leading manufacturer of consumer goods, with the introduction of Tide, Crest, and many other products and brands worldwide. Since 1837, Procter & Gamble has introduced and developed over 300 brands, including 24 billion dollar brands, and is currently one of the largest fast moving consumer goods organizations in the world, selling products in over 160 countries with a turnover of 83 billion dollar in the fiscal year 2010-2011. Nowadays, Proctor & Gamble aims to touch and improve 6 billion lives, every day.

The operations of Procter & Gamble in the Netherlands are part of the Benelux MDO, which also targets the Belgian and Luxembourg markets. Some key data related to the Benelux MDO is listed in Table 1.

Metric	Value
Turnover (2010-2011)	
Product portfolio size	
Gross profit (2010-2011)	
Number of Employees	
Cases shipped (2010-2011)	

Table 1 - The BNL MDO (P&G, 2011) **MM=Million**

1.2. Procter & Gamble's product categories

All products and brands developed by Procter & Gamble are divided into six categories. The organizational structure from a Global Business Unit (GBU) perspective is largely based on these categories. The six categories, with some of their premium brands, are listed below.

- Beauty Care (e.g. Wella, Max Factor, and Olay)
- Grooming (e.g. Braun and Gillette)
- Health Care (e.g. Always and Oral B)
- Snack & Pet Care (e.g. Pringles and Iams)
- Fabric Care & Home Care (e.g. Ariel, Dreft, and Duracell)
- Baby Care & Family Care (e.g. Pampers and Bounty)

Even though the specific brands and associated products may differ per geographic region, these categories are the basis for Procter & Gamble's product offerings worldwide.

2. Research design

To conduct this research in a structured way, this chapter first outlines the motivation for this research, followed by the goal and scope of the research, the research questions and (research) methods used and finally states to whom this research may be of interest.

2.1. Research motivation

For any Fast Moving Consumer Goods (FMCG) organization, the ability to win in the market, every day, is the key driver for business success. In a market that is highly competitive, this is never an easy task; every part of the organization has to perform optimal in order to succeed. And even if it does, success and continuously winning in the market is never a given. In order to maximize the chance of success, it is essential to make sure all organizational efforts are directed to products, processes, actions, initiatives and potential product launches that contribute to the competitiveness of the organization.

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These SKUs can be divided into base products and customized product. Base products are part of the regular assortment and are always ‘single product’ (e.g. 1 bottle or case), whereas customized products are essentially based products that have been modified or combined to fit specific retailer or customer requirements. In an attempt to battle this increasing complexity, several programs have been initiated in the past. Most of these projects were based on a simple *Cut-the-tail* approach, where products that did not meet a certain threshold were removed from the portfolio. These thresholds were mostly based on simple, one-dimensional measures, such as shipment volume or number of SKUs in the portfolio. Even though this type of method is relatively simple, it has several distinct disadvantages that strongly hampered its applicability (and thus its success and impact on managing the portfolio’s complexity).

First and foremost, the fact that these thresholds were based on simple measures (volume, number of SKUs) excluded other important costs and benefits from the analysis. Second, it is inappropriate to measure all products to the same scale; some low-volume products may contribute little revenue but open up opportunities in new markets or segments. Finally, cut-the-tail approaches are by definition *reactive*, as they evaluate a current portfolio, thereby missing the opportunity to *proactively* manage complexity (Olavson & Fry, 2006).

Even though previous attempts to reduce complexity did not yield the desired results, the insights developed in the field of complexity reduction and portfolio optimization have only strengthened the need for an organization-wide supported approach to complexity within Procter & Gamble. This research aims to contribute to this by exploring the concept of complexity and identify improvement opportunities.

Research goal: *Reduce the organizational complexity of Procter & Gamble Benelux*.

2.2. Research questions

In order to structure this research, it is divided into several steps: the research questions. By answering these research questions, we will gain insights into the different dimensions of complexity and how to reduce this within the organization. Consequently, the central research question is:

To what extent can we reduce organizational complexity for Procter & Gamble, in particular for the product category Oral Care?

As mentioned earlier, several approaches have previously been introduced within Procter & Gamble to reduce complexity. By answering the central research question, this research will build on previous approaches and further contribute to managing complexity within Procter & Gamble. We believe that any improvement effort (whether on complexity or any other organizational process) will consist of a cycle of three elements, each representing a key step in the management process. First, we need to fully **understand** all aspects of what we are managing. Second, organizations will always try to **improve** their processes (or products for that matter) in any way possible, in order to maximize internal efficiency and ultimately create competitive advantage (e.g. in scale, price, service, etc.). And finally, after realizing improvements, organizations will try to **control** these improvements in order to make them sustainable. As business environments (internally as well as externally) are continuously evolving, organizations need to constantly adapt as well, making this process a continuous cycle (see Figure 2).

As the central research question cannot be readily answered, we formulated several sub-questions that will help us to answer the central research question and ultimately achieve our research goal. As the goal of this research was set to *reduce the organizational complexity for Procter & Gamble,* this research will cover the first two phases of the cycle in Figure 2 (**Understand** and **Improve)**. Each of the sub-(research) questions will thus be part of one of these phases and is briefly discussed below.

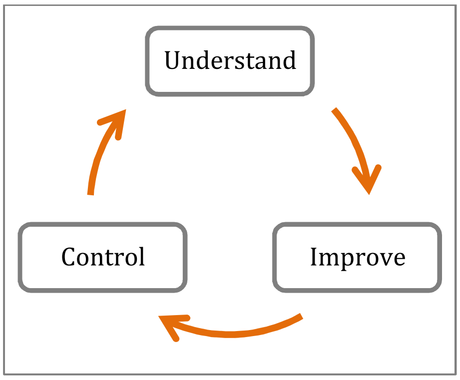


Figure 2 - improvement cycle

UNDERSTAND

Research question 1: How do we define complexity and what are drivers for complexity?

The term 'complexity' has many definitions. In order to provide this research with a well-established base, we need to find a commonly shared and understood *definition of complexity*. Besides defining complexity, we need to establish what the *drivers of complexity* are, as they will form the starting point of this research. This will, amongst other things, involve a clear understanding of the current state of the business and past events that shaped the business environment.

Research question 2: How do we measure complexity?

As this research aims to reduce complexity, it is eminent to be able to *quantify complexity*. By *defining measures (*or *performance indicators)* that fit the established definitions and drivers of complexity (research question 1), we can keep track of complexity and quantify the results of our improvement efforts. These measures need to be actionable (e.g. we should be able to draw conclusions from them and intervene accordingly).

IMPROVE

Research question 3: How do we reduce complexity?

After establishing what complexity is, what it is driven by (research question 1) and how we can keep track of it (research question 2), this section will synthesize the definitions, drivers and metrics into a decision support model that will actually *reduce* complexity for Procter & Gamble.

Case study: Application of the decision model on a product portfolio.

After the decision support model has been developed, we would like to see how it performs in practice. The model will therefore be applied to one of Procter & Gamble's product categories to determine the best possible product portfolio for that specific category.

Research question 4: What lessons can be learned from the case study?

After applying the developed decision support model to a product category and identifying its best possible product portfolio, this section will focus on the *lessons learned* from the application of the model. We will therefore verify the model outcomes with practice and assess the robustness of the model. Any additional insights will be proposed to incorporate into the decision model.

2.3. Scope definition

In order to come to a thorough analysis within the given time frame, it is of key importance to set a well-defined scope. Due to limitations in time, this research will not focus on the entire (global) organization of Procter & Gamble, but on a specific product category and a specific geographic region. This will not only reduce the complexity of the research, but also facilitate the development of an on-hands analysis that can easily be re-applied to other product categories.

This research will focus on the product category Oral Care. As this category encompasses a diverse range of products (toothbrushes, pastes) and customers (food, non-food and drug), any analysis developed and tested for this category will be re-applicable to other product categories and geographies. Furthermore, the 3rd step in the management cycle from Figure 2 (**Control**) is outside the scope of this research, as we specifically aim to provide Procter & Gamble with a hands-on method to *reduce* organizational complexity. Obviously, certain elements of this research may be extremely useful when *controlling* complexity, but that will remain outside the scope of this research. Concluding, the following aspects will be excluded from this research:

- Non-Benelux products
- Products other than Oral Care
- Any analysis needed to **Control** complexity

2.4. Research method

In order to answer the research questions from section 2.2, some sections of this research may require extensive literature research, whereas other sections rely more on information available within Procter & Gamble (or a combination of both). This section outlines the appropriate research method and corresponding data source for each research question.

A combination of literature research, data analysis, interviews, brainstorm sessions, and assessments will be used in this research. The available data sources are Procter & Gamble (employees (E) as well as databases (D)) and scientific literature. The research questions, their corresponding research method and data source(s) are summarized in Table 2.

	Research question	Research method	Data source
1	Definition and drivers of complexity	- Literature research - Interviews	- Scientific literature - Procter & Gamble (E)
2	Measuring complexity	- Literature research - Interviews - Data review	- Scientific literature - Procter & Gamble (E) - Procter & Gamble (D)
3	SKU portfolio improvement model	- Brainstorm - Assessment	- Procter & Gamble (E) - All
-	Case study	- Data review - Assessment	- Procter & Gamble (D) - Procter & Gamble (E)
4	Lessons learned	- Assessment	- Procter & Gamble (E)

Table 2 – research method and data source

2.5. Research interest

First of all, this research will provide the management of Procter & Gamble with extensive insights into all aspects of organizational complexity. This will allow them to better understand their business environment and more importantly provide a wide-supported base for improvement efforts.

Second, this research will serve as a reference project to the company. Other product categories within Procter & Gamble might benefit from experiences gained during the application of the decision model and they can reapply these experiences on their own products portfolio.

2.6. Deliverables

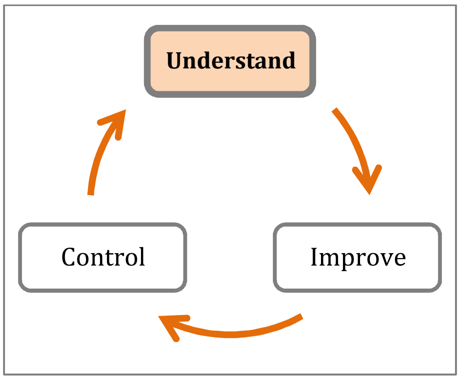
This section outlines the specific deliverables of this research. Some of these deliverables aim to increase understanding of complexity within the organization, whereas others are more on-hands results of the complexity reducing efforts of this research project. The actual deliverables are listed below.

- A conceptual framework of complexity, its drivers, and metrics
- A hands-on toolkit to reduce complexity within Procter & Gamble Benelux
- The best possible product portfolio for Oral Care
- Recommendations to further reduce complexity within the organization

2.7. Thesis outline

The remaining chapters of this thesis will discuss the research questions as defined in section 2.3. First, chapter 3 will provide the definitions of and drivers for complexity, followed by a historical perspective and application of the complexity framework to Procter & Gamble Benelux (research question 1). After defining complexity and its drivers, chapter 4 will discuss how we can measure complexity within the organization (research question 2). In chapter 5, the definitions, the drivers, and the measures of complexity will be synthesized into a decision-supporting model to improve a given product portfolio (research question 3). After the methodology has been developed, it will be applied to the product portfolio of Oral Care in chapter 6 (case study). Chapter 7 will discuss any additional insights gained from the application and include these into the decision methodology (research question 7). Finally, chapter 8 will provide the main conclusions of this research and recommendations for further research.

UNDERSTANDING COMPLEXITY



The first part of this research will answer the first two research questions and will help us to **understand** organizational complexity from both a *qualitative* perspective (research question 1, Chapter 3) and a *quantitative* perspective (research question 2, Chapter 4).

3. Definition, dimensions and drivers of complexity

The term complexity has had many definitions and is used to describe products, processes and/or organizational functions that are perceived as challenging (Closs et al. (2008)). As this research aims to reduce complexity, it is important to develop a shared and supported definition of complexity and its drivers. This will not only facilitate the analysis of complexity itself, but also provide us with a shared ‘language’ when discussing complexity. Section 3.1 discusses the nature of complexity (section 3.1.1), its definition and different types of complexity (section 3.1.2), followed by a description of the drivers of product portfolio complexity in section 3.1.3. Section 3.2 then applies these newly developed concepts to Procter & Gamble Benelux, in order to come to a framework for complexity (and related complexity drivers) that is supported throughout the organization.

3.1. Definition and drivers of complexity

Complexity of organizations and their environments has been the subject of research for many years. For at least three decades, it has been argued that organizations and their environments are becoming more and more complex (Emery & Trist, 1965). Sources of this increasing complexity are (amongst others) enhanced competition, increased regulation, internationalization, and accelerated technological change (Hamel & Prahalad, 1994). Other authors discuss the managerial consequences of this rising complexity and the organizational requirements to successfully cope with this increase (Ackhof, 1996). Despite the increasing impact of organizational complexity on day-to-day business, only few researchers have explicitly studied the nature of complexity and its dynamics (Bayus & Putsis, 1999) (Emery & Trist, 1965) (Vasconcelos & Ramirez, 2011).

The following sections try to fill this gap in literature by assessing the nature of complexity (section 3.1.1), the different types of organizational complexity (section 3.1.2) and their drivers, particularly for product portfolio complexity (section 3.1.3). To do so, we critically review existing literature on these three topics (nature of complexity, types of complexity, and drivers for product portfolio complexity) and propose approaches to mend its shortcomings for this research.

3.1.1. Definition and nature of complexity

The concept of complexity has been extensively studied in literature. In general, most studies on this concept either 1) attempt to define factors that influence complexity and their dynamics (Fischer & Ittner (2009), Novak & Eppinger (2001), Mason (2007), Moldoveanu & Bauer (2004), and Wang et al. (2009)) or 2) investigate the effect of complexity on organizational performance. Especially in the latter type of studies, we see many authors that parallel increasing complexity in organizational functions with negative implications on the organization (e.g. increasing workload, decreasing levels of profit, decreasing supply chain performance) (Bozarth et al (2009), Choi & Krause (2006), Closs et al. (2008), and Jacobs & Swink (2011)). Recall that we already identified a similar relation within Procter & Gamble (see again **Error! Reference source not found.**). In line with this, we propose to use the following definition for organizational complexity.

Organizational complexity results from the relation between invested (organizational) resources and benefits received for these investments

To the best of our knowledge, all previous studies performed on the concept of complexity generally aim to *reduce* complexity. Contrary to that, we believe that not every increase in complexity necessarily worsens organizational performance and that simply *reducing* complexity is too short-sighted. We believe that there should be a distinction between 'good' and 'bad' complexity. We propose to define this distinction as the *nature of complexity*.

The *nature of complexity* defines the fundamental difference between complexity that has a positive yield for the organization (e.g. by increasing market share), and complexity that does not add any value. Reflecting this notion on previous studies on the concept of complexity, we conclude that they have all focused on reducing non-value-adding complexity. We acknowledge that this will most probably have the largest impact on the organization and is therefore extremely useful to investigate, but also argue that some level of complexity might actually contribute to the organization. We therefore propose to define the *nature of complexity* as a combination of the level of added complexity vs. the level of added value (see Figure 3). We explicitly do not define 'added value' or 'level of added complexity' into more detail, as it might limit the applicability of this framework. By keeping this rather broad definition, we are able to use this framework and assess 'complexity' regardless of the organizational function, process or product it relates to.

High added value	GOOD (Maintain)	OVERCOMPLEX (Simplify)
Low added value	UNDERVALUED (Scale-up)	BAD (Avoid)
	Low level of added complexity	**High level of added complexity**

Figure 3 – the nature of complexity

Each quadrant encompasses organizational functions, processes and/or products that include a specific level of complexity and adds value to the organization. Each of the quadrants is briefly discussed.

- *GOOD*; a low level of added complexity that indeed yields high added value for the organization is most favourable, and organizations should strive to keep their functions, processes and/or products in this quadrant.
- *UNDERVALUED*; functions, processes and/or products with a low level of added complexity that only yields a limited level of added value to the organization should be scaled-up to achieve a high(er) level of added value without gaining complexity.
- *OVERCOMPLEX*; functions, processes and/or products that deliver significant added value to the organization with a high level of added complexity should be simplified to reduce complexity without comprising on the level of added value.
- *BAD*; a combination of low added value and high complexity is highly unfavourable and should be avoided by organizations whenever possible.

The single most important thing we learn from Figure 3 is that complexity is not by definition unfavourable. To fully capture this mind-set, it is eminent to keep in mind that 'reducing' complexity from this point on in this research relates to reducing 'bad' complexity, while simultaneously allowing for 'good' complexity to exist within the organization. The following sections derive a more precise focus on organizational complexity.

3.1.2. Types of complexity

In general, complexity has been recognized as being a multifaceted concept. Webster (1964) defines complexity as "1a: the quality or state of being composed of two or more separate or analyzable items, parts, constituents, or symbols 2a: having many varied parts, patterns or elements, and consequently hard to understand fully 2b: marked by an involvement of many parts, aspects, details, notions, and necessitating earnest study or examination to understand or cope with." This description highlights the various ranges of organizational aspects that are all termed 'complex'. Moreover, previous studies on the concept reveal an even larger range of perspectives on organizational complexity. Authors in many disciplines have discussed the concept of complexity, ranging from complexity definitions in the field of physics and biology (Mazzocchi (2008), and Kauffman (1993)), management information technology (Meyer & Curley (1991)) and operations research (Eglese et al. (2005)). Most authors however tend to review complexity from an *organizational perspective*, by focusing on for example organizational design complexity (Chowdhurry (2011), Daft (1983), Moldoveanu & Bauer (2004), Scott (1992). But also complexity from a product design perspective (Griffin (1997a, b), Kaski & Heikkila (2002), Gupta & Krishnan (1999), Tatikonda & Stock (2003)) and manufacturing perspective (Deshmukh et al. (1998), ElMaraghy & Urbanic (2004), Flynn & Flynn (1999), Hu et al. (2008)) received considerable attention in previous studies. Yet another set of authors discuss organizational complexity from a supply chain perspective, by reviewing how complexity in supply chains effects operational performance (Bozarth et al. (2009), Choi & Krause (2006), Fisher et al. (1999), Novak & Eppinger (2001)). Another common perspective amongst authors is complexity encompassed in a product portfolio and particularly relates to complexity driven by differentiation (Closs et al. (2008), Fischer et al. (1995), Lubben (1988)). Besides the 'internal' perspective on *organizational complexity*, some authors focus on 'external' *organizational* complexity, encompassed in the ever-changing business environments firms operate in (Adler et al. (2011), Mason (2007), Vasconcelos & Ramirez (2011)).

Although these studies are very useful to provide insights into the dynamics of complexity in different fields and the influence complexity has on organizational performance, they all constitute a rather narrow view on organizational complexity by focusing on a <u>single</u> perspective (e.g. organizational design, supply chain, manufacturing). This narrow perspective, in most cases created to isolate complexity in a specific organizational function, allows the authors to analyze its effect in great detail and propose solutions to reduce complexity. We believe however, that by upholding this narrow perspective, they ignore the fact that organizational complexity is indeed a *multifaceted* concept, consisting of coherent types of complexity rather than a readily separable set of types that can be discussed individually. There are a few authors that share this believe and uphold an integrated approach to organizational complexity. Wang & von Tunzelmann (2000) for example define 4 (interacting) types of organizational complexity in a single framework:

- *Complexity in (product) technology*; technologies can be thought of as either *artefacts*, defining technology as being equipment and hardware oriented, or as *bodies of knowledge*, in which case technology is more personal and software oriented.
- *Complexity in delivering markets*; market delivery complexity is concerned with customer diversity and market dynamics. Customers may differ in terms their geographic, demographic, and other social characteristics, whereas market dynamics include factors as the stages of market evolution and competition, all influencing decision how to best deliver to the market.

- *Complexity in production process*; the production process can be divided into labour processes (the way labour is constituted and coordinated), capital processes (idem, but for equipment), and information processes. The latter refers to the explicit information and knowledge content of the production process.
- *Complexity of administration and management*; complexity from a management point of view relates to the size of the organization and inherently to the organizational structure.

Moreover, the paper of Wang & von Tunzelmann (2000) investigates the conditions under which complexity in different dimensions or functional areas may be coactive or conflicting, thereby truly assessing the coherence of different types of organizational complexity within the firm. As our research aims to provide a wide-supported base or 'language' to discuss complexity, we propose to extent the framework by adding two types of organizational complexity that have not been specifically addressed by Wang & von Tunzelmann (2000), but do contribute to the complexity of organizations:

- *Environmental complexity*; complexity caused by the ever-changing nature of the business environment. This can be caused by for example changing regulations, market trends, changing consumer needs, etc. Even though the true reason of change may be (far) outside the organizations scope, its ramifications will influence the organizations complexity as the organization tries to adapt their products and/or processes to best fit their business environment (Adler et al. (2011), Mason (2007), Vasconcelos & Ramirez (2011)).
- *Product portfolio complexity*; complexity related to the inherent characteristics of a product portfolio, which is mainly driven by differentiation to satisfy specific customer requirements (Closs et al. (2008), Fischer et al. (1995), Lubben (1988)).

Complementing the typology from Wang & von Tunzelmann (2000) with the two types of complexity as described above, we propose to describe organizational complexity by six (interacting) types of complexity (see Figure 4). We have redefined the complexity types of Wang & von Tunzelmann (2008) to better fit our framework.

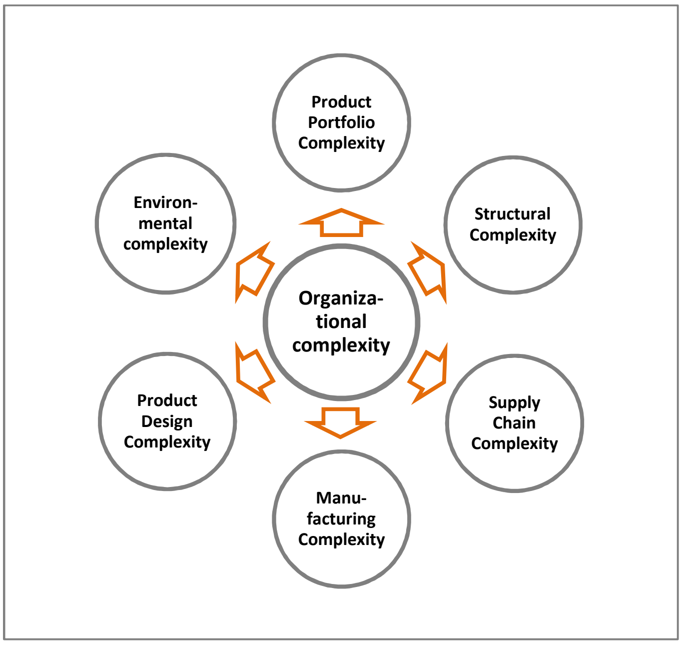


Figure 4 – types of complexity

Table 3 summarizes the proposed types of complexity that together encompass all elements of organizational complexity, a proposed definition synthesized from literature, the related complexity type from the framework of Wang & von Tunzelmann (2008), and previous studies performed on that specific type of complexity.

Complexity type	**Proposed definition**	**Related complexity type[1]**	**Previous studies**
Product portfolio complexity	*Complexity driven by offering product variety to fit specific customer needs and business requirements*	Not applicable	Closs et al. (2008) Fischer et al. (1995) Jacobs & Swink (2011) Lubben (1988)
Structural complexity	*Complexity driven by the structure and size of the (management) organization and decision making processes*	"Complexity of administration and management"	Chowdhurry (2011) Daft (1983) Moldoveanu & Bauer (2004) Scott (1992)
Supply chain complexity	*Complexity caused by the design and layout of the supply chain*	"Complexity in delivering markets"	Bozarth et al. (2009) Choi & Krause (2006) Fisher et al. (1999) Novak & Eppinger (2001)
Product design complexity	*Complexity related to the number of components, design decisions and functions of a (new) product architecture*	"Complexity in (product) technology"	Griffin (1997a,b) Kaski & Heikkila (2002) Gupta & Krishnan (1999) Tatikonda & Stock (2003)
Manufacturing complexity	*Complexity caused by the set-up and execution of the manufacturing process*	"Complexity in production process"	Deshmukh et al. (1998) ElMaraghy & Urbanic (2004) Flynn & Flynn (1999) Hu et al. (2008)
Environmental complexity	*Complexity driven by the ever-changing environments firms operate in*	Not applicable	Adler et al. (2011) Chao & Kavadias (2008) Mason (2007) Vasconcelos & Ramirez (2011)

Table 3 - types of complexity and their definitions

Due to limitations in time, we cannot cover all types of complexity as detailed and extensive as is required for a thorough understanding of its dynamics. This research will therefore focus on product portfolio complexity, as its ramifications touch almost all other functions of the organization (Fischer et al. (1995), Lubben (1988), Closs et al. (2008)), and thereby provides the best possible coverage of the concept given the available time and resources. To understand why product portfolio complexity so closely interacts with other functions of the organization, consider the following; as the marketing function drives additions and changes to the portfolio, engineering must perform additional design work, accounting must create an infrastructure to track the new product, sales agents must determine how to change product presentations, R&D

[1] As defined by Wang & von Tunzelmann (2008)

may need to refine technology to make it more robust, the factory must determine how to integrate the new product into the existing (production) mix, and supply managers must incorporate new purchases into the supply base. Hence, the challenges presented by product portfolio complexity are pervasive and moreover connects with (almost all) other organizational functions (Jacobs & Swink, 2011). However, by upholding this perspective on product portfolio we uphold an 'internal' view on complexity, thereby ignoring complexity of environments, even though we defined this as being a complexity type influencing organizational complexity. We acknowledge the fact that complexity of business environments is indeed an essential part of assessing the concept of complexity for organizations, but we intent to develop a framework that will help us understand and eventually reduce the organizational complexity within Procter & Gamble Benelux. As most drivers of *environmental* complexity will be outside our scope of influence, this type of organizational complexity will not be discussed any further during this research.

In order to reduce the complexity of the organization, we (thus) have to reduce the complexity of the product portfolio. A first step in reducing product portfolio complexity is to analyze what actually drives this type of complexity.

3.1.3. Drivers of product portfolio complexity

The concept of portfolio complexity has received considerable attention in literature and most often relates to identifying opportunities and risks of investment portfolios (e.g. Doemer et al. (2004)), project portfolios (e.g. Bardhan et al. (2004)) or portfolios of stocks (e.g. Maringer (2005)). Besides this perspective that relates to 'intangible' portfolios, a second major research stream explores the concept of portfolio complexity from a more tangible perspective, by focusing on *product* portfolios. Even though studies within this second research stream differ in scope, they all refer to product portfolio complexity in terms of either *multiplicity* (Baldwin & Clark (2000), Bozarth et al. (2009), Novak & Eppinger (2001)), *diversity* (Berger et al. (2007), Chao & Kavadias (2008), Price & Mueller (1986)) or *interrelatedness* (Choi & Krause (2006), Closs et al. (2009), Mazzocchi (2008))[2]. Some authors even extent this commonality and combine these perspectives by stating that "objects (tangible or intangible) are deemed to be complex if they are made up of a *multiplicity* of *diverse*, *interrelated* elements" (Jacobs & Swink (2011)).

As discussed in section 3.1.2 however, complexity can no longer be assessed with just an *objective* scale (where we solely assess each organizational aspect on its complexity); understanding how complexity interacts between its different dimensions and functions within the firm (its *subjective* nature) has become a prerequisite for successful (strategic) decision-making. We argue that this notion is equally valid when assessing product portfolio complexity, and we should therefore make a distinction between *objective* complexity and *subjective* complexity of a product portfolio. We will discuss both objective and subjective product portfolio complexity in order to fully understand what drives product portfolio complexity.

For conceptual clarity we stress that we do not consider the operational processing requirements associated with a product portfolio. We uphold a sharp distinction between the composition of a product portfolio and the operational processes required to manage and

[2] See (Jacobs & Swink, 2011) for an extensive sample list of research on product portfolio complexity

deliver the portfolio. Maintaining this distinction allows us to analyze the drivers of product portfolio complexity without regard to its outcomes. In fact, we believe that while product portfolio characteristics and operational processing requirements are related, options for processing methods almost always exist such that the relationship between product and process designs is not fully constrained or deterministic. We therefore propose to define (objective and subjective) drivers of product portfolio complexity in terms of the inherent characteristics of the product portfolio, as opposed to defining it in terms of its potential impacts.

Objective complexity

Objective complexity relates to complexity rooted in the *composition* of the product portfolio. In order to identify drivers of objective product portfolio complexity, we therefore relate to dimensions impacting this very composition. We propose three drivers of objective product portfolio complexity, directly stemming from the main dimensions of portfolio complexity as defined in (almost) all literature on product portfolio complexity: *diversity*, *multiplicity*, and *interrelatedness*. The first two definitions can be readily used, but we propose to use a different term to refer to *interrelatedness*, in order to avoid confusion later in this research. We propose to rename this objective driver to *mutual dependency,* whilst upholding its original definition. Each of these drivers will be briefly discussed, to clearly understand their impact on product portfolio complexity.

- *Diversity*; diversity refers to the *number of product-segments in a portfolio that offer a unique value* to the customer. Take for example the product portfolio of an automobile manufacturer; it might offer small city cars, family cars, small vans and trucks and (luxury) business cars. Each segment offers a unique value to its customer.
- *Multiplicity*; multiplicity of a product portfolio refers to the *number of products offered within a certain segment* of the portfolio. Recapturing the example of the automobile manufacturer; the manufacturer might offer 3 different models of small city cars, 5 different family cars, 4 business cars, etc. The multiplicity within the segment differentiates the product portfolio even further.
- *Mutual dependency*; this driver of product portfolio complexity refers to *substitution and complementation dynamics* of a portfolio. If we for example eliminate a certain product from our portfolio, customers may convert to a substitute, either within our own portfolio or that of a competitor. Similarly for complementary products; eliminating one product might strongly influence demand on its complementary products. This driver of product portfolio complexity is most difficult to manage, as it requires extensive understanding of the inter-product-relations within the portfolio.

Subjective complexity

Besides objective complexity, the interaction between the product portfolio and other (organizational) dimensions is equally important. We propose to define this driver of product portfolio complexity as *relatedness*. Relatedness refers to the inevitable *interaction between organizational dimensions and the product portfolio*; these organizational dimensions influence and simultaneously benefit from the composition of the product portfolio. To the best of our knowledge, no authors have explicitly defined the organizational dimensions that constitute the subjective complexity driver relatedness. We believe however that these organizational functions significantly complicate the developed of the best possible product portfolio, and should therefore be identified explicitly.

As product portfolios are established and maintained to satisfy (differentiated) consumer needs (Wang & von Tunzelmann, 2000), the first and foremost dimension of subjective product portfolio complexity is the *consumer* itself. Consumers have specific needs, and if these are fulfilled by the offered product portfolio, consumers 'reward' the company by actually buying the products. As firms are rarely the sole provider of specific products, the presence of *competition* and more specific their actions in the marketplace is a second dimension that actively determines the composition of the product portfolio. More than often, companies introduce products that are almost identical to competitor offerings to safeguard their own market share. But even a well-established portfolio may not be successful everywhere it is offered, as specific regions require specific products. Take for example McDonald's; even though the Bic Mac has been the most successful product of their portfolio, it is not offered in India, as the Hindu do not eat beef. Hence, the *geography* where a portfolio is offered will also influence its composition. In most organizations, decisions on which consumer needs to target, how to deal with competition and where to offer the products are inherently embodied in the organization's strategy. We however prefer to list *strategy* at a separate dimension of relatedness, as a firm's strategy encompasses the rationale behind the product portfolio. It relates to *why* product portfolios are composed in the way they are, whereas the other dimensions relate to executing the strategy in the best possible manner. Concluding; we propose 4 dimensions that constitute the (subjective) complexity driver relatedness:

- Consumer
- Competition
- Geography
- Strategy

We explicitly do not consider external dimensions (e.g. market trends, regulations), as organizations are generally not able to influence these. It is therefore meaningless to adopt them into our framework, as we aim to identify drivers and dimensions of product portfolio complexity that can be changed by the firm and in doing so actually reduce product portfolio complexity. Figure 5 summarizes the (objective and subjective) drivers of product portfolio complexity. Remember that the (subjective) driver *relatedness* is here represented by its 4 dimensions; consumer, competition, geography, and strategy. This framework then serves as a graphical illustration of our proposal on the 'landscape of product portfolio complexity' and displays how the different elements we have discussed in this section relate to each other.

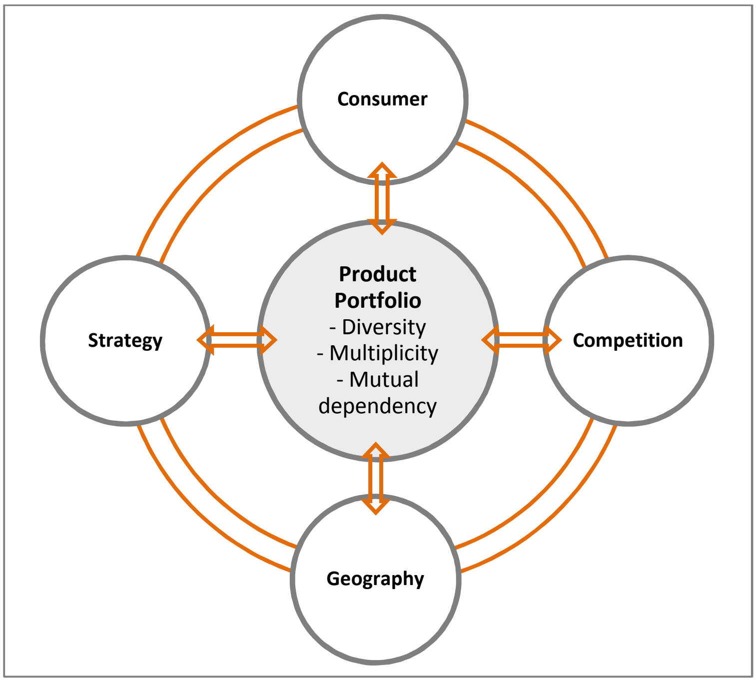


Figure 5 – framework of drivers of product portfolio complexity

After establishing this theoretical framework, that illustrates the different elements of project portfolio complexity, the remainder of this research aims to reduce this type of complexity. Therefore, this theoretical framework will be customized to fit the specific business context of Procter & Gamble in the next section, to better understand product portfolio complexity. Recapture from section 3.1.1 that complexity is not inherently undesirable, and that by solely focusing on *reducing* complexity, we might miss opportunities that indeed have a positive contribution to the organization. We will therefore focus the rest of this research on finding a *best possible product portfolio*, rather than simply *reducing* product portfolio complexity.

The best possible portfolio will offer the best possible mix of products in terms of *diversity*, *multiplicity* and *mutual dependency* that satisfies the requirements represented by Consumers, Competition, Geography, and Strategy. By focusing on finding the best possible portfolio rather than simply reducing complexity, we ensure a) all undesired complexity is removed from the portfolio and b) any complexity left indeed has a positive contribution to the portfolio (this statement closely aligns with the rationale from section 3.1.1).

The best possible product portfolio will always be the portfolio with the lowest level of (undesired) complexity.

3.2. Product portfolio complexity at Procter & Gamble

This section will adopt the developed framework for product portfolio complexity to Procter & Gamble. Therefore, we will first provide an organizational perspective on the products and innovations, the structure of the organization, and complexity management at Procter & Gamble Benelux. This organizational perspective allows us to understand how the product portfolio of Procter & Gamble became as complex as it is today. Second, we will apply the framework from section 3.1.3 to Procter & Gamble, to set a common shared starting point for improving their product portfolio (section 3.2.2). Section 3.2.3 then discusses the individual dynamics in the business processes of Procter & Gamble that impact the composition of the product portfolio, which eventually impacts the complexity of the product portfolio.

3.2.1. Organizational perspective

Products and innovations

For any FMCG organization, but for Procter & Gamble in particular, innovation is the key driver for competitive advantage. Innovation in this perspective can be divided into ‘commercial innovation’, where for example advertisements change but the product itself remains the same, and ‘product innovation’, where entire new products are launched. In a business where maintaining the status quo equals losing in the market, Procter & Gamble continuously searches for opportunities to innovate, both on a commercial level and on a product level.

Besides innovation, developing or entering markets constitute a second major source of competitive advantage for Procter & Gamble. *Developing* new markets are (most often) a direct result of product innovations, whereas *entering* (existing) markets is either driven by product and/or commercial innovations, or acquisitions of existing brands. We have listed some of the most influential product launches and brand acquisitions of Procter & Gamble from the last decade, to better understand the composition of the current product portfolio.

- *Gillette;* on October 1st 2005, Procter & Gamble completed the acquisition of The Gillette Company. From that point on, not only Gillette, but also Duracell batteries became part of Procter & Gamble’s product portfolio.
- *Launch of Gillette Fusion Proglide*; in January 2011, Procter & Gamble launched Gillette’s latest razor in the Netherlands; the Gillette Fusion Proglide. The latest development in razor technology made this introduction a renewed driver of market share for Procter & Gamble, but also added a significant number of new products to the portfolio.
- *Launch of Oral B paste*; after years of developing the Oral B brand with manual and electric toothbrushes, Procter & Gamble decided to combine their knowledge on dentifrice (gained from brands as Crest) and the image of Oral B as being the preferred brand of dentists, by launching Oral B paste in February 2009. Oral B paste now constitutes about one-third of all products of the product category Oral Care.
- *Launch of Wella professional;* in 2003, Procter & Gamble acquired Wella, a well-known coiffeur brand selling high-end equipment and products to hair salons for professional purpose. In 2008, Procter & Gamble launched Wella Professional, an entire new line of hair care products fit for retail. This launch caused a significant expansion of the product portfolio.

There are many more examples of new product launches or other initiatives that have had an impact on the composition of Procter & Gamble's current product portfolio, but the previous list is merely intended to provide some perspective rather than an extensive overview. Besides the products themselves, the way the product portfolio (or the organization for that matter) is managed, represent another key aspect in understanding the product portfolio complexity challenges of Procter & Gamble Benelux.

Organizational structure

Each product in the product portfolio of Procter & Gamble is part of a specific product category. These product categories can be considered as individual (sub) portfolios, each encompassing different (type of) products, serving different consumer needs and targeting specific markets. Each product category is managed by two organizational bodies within Procter & Gamble: the Regional Business Unit (RBU) and the Market Development Organization (MDO). The RBU provides direction by leveraging global strategies into regional strategies and tunes the global portfolio of a specific category to fit the region. The MDO then manages the portfolios of all RBUs in a specific geographic region, thereby fine-tuning the different portfolios to best fit the target geography. For Western Europe, all RBUs are managed from Geneva, whereas the MDOs represent different geographic regions, which can consist of multiple countries (e.g. Nordic encompasses Norway, Sweden and Finland). This structure is depicted in Figure 6. The columns represent the different RBUs (or product categories) whereas the rows constitute the different MDOs. For visual clarity, not all product categories and MDOs are listed, but their organization is no different than the ones that are.

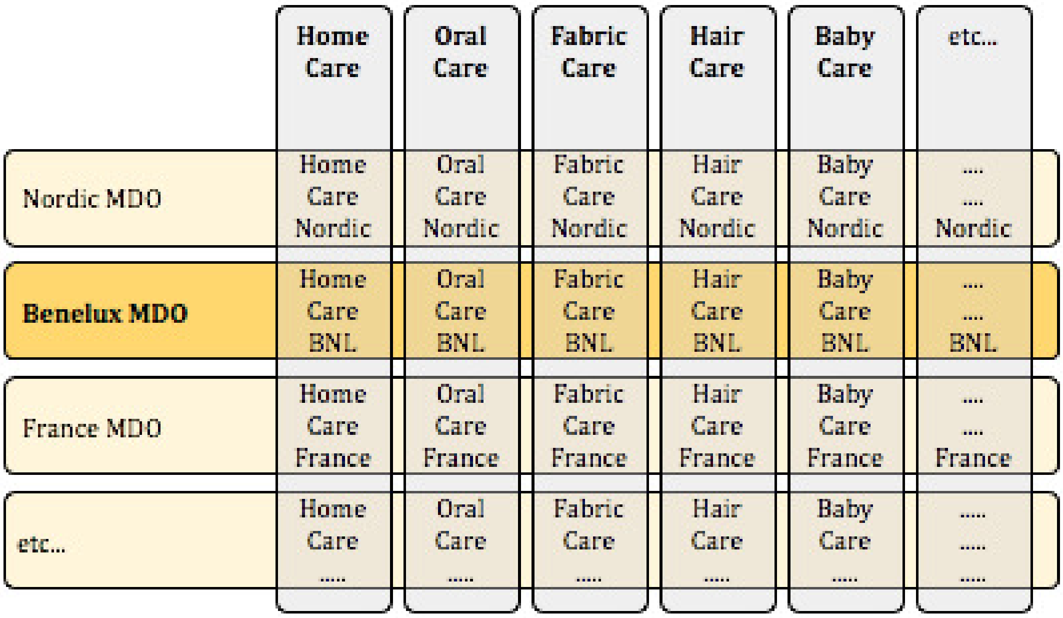


Figure 6 - organizational matrix Procter & Gamble (P&G, 2011)

Product definitions at Procter & Gamble

At this point, we introduce a more precise definition of 'products', to avoid confusion in the remainder of this research. We propose to use the term Stock Keeping Unit (or SKU) instead of 'product', as this term is also used at Procter & Gamble. A SKU can be anything from an individual product to an entire store-ready display. Each SKU can thus have 1 or multiple individual products in their Bill of Material (BOM. Customers can then order this SKU using its European Article Number (EAN); the *external* identification code used within Procter & Gamble. As this research is set out to find the best possible product portfolio, we will focus on products on a SKU-level rather than on a FPC-level. The underlying dynamic is however (very) relevant to keep in mind, at it might cause additional complexity.

Complexity management at Procter & Gamble

As mentioned earlier, the concept of complexity management is not new to Procter & Gamble. In the past, they have implemented several approaches to deal with SKU portfolios that are becoming increasingly complex. We will present a brief overview of these approaches.

- *Cut-the-tail approaches*; these approaches focus on removing SKUs from the portfolio that do not meet a certain threshold. This threshold was based on a simple, one-dimensional measure; the number of SKUs in the portfolio.
- *Kill/Cure approaches;* these approaches are basically an extension of the *cut the tail* approaches and are used to assess what to do with the underperforming *tail* of a SKU portfolio.
- *1 in - 1 out approach;* this rationale was implemented in an attempt to prevent the SKU portfolios from gaining complexity and simply states that for every SKU to be introduced, an existing SKU should be removed from the portfolio.

Despite the simplicity of these approaches (or perhaps even *because of* the simplicity), they never truly found their way into the organization. There are several reasons for this: first and foremost, the fact that these thresholds were based on a simple measure (number of SKUs) excluded other important costs and benefits from the analysis. Second, it is undesired to measure all SKUs on the same scale; some low-volume SKUs may contribute little revenue but open up opportunity in new markets or segments. Third, these approaches where mostly driven by internal analysis from a supply chain perspective, thereby encountering tremendous resistance from other, more external oriented departments such as marketing and sales. Finally, the first two approaches are by definition *reactive*, as they evaluate an already existing portfolio, thereby missing the opportunity to *proactively* manage complexity (Olavson & Fry, 2006). The *1 in – 1 out* rationale was introduced to cover this, but the fact that it was never endorsed within the organization strongly decreased its effect.

In order to provide the organization with a commonly shared understanding of portfolio complexity, the next section will apply the framework for SKU portfolio complexity from section 3.1.3 to fit the business context of Procter & Gamble.

3.2.2. Adopting the complexity framework for Procter & Gamble

The framework of section 3.1.3 provides a valid starting point for understanding product portfolio complexity, but in order for the framework to be endorsed within the organization, it needs to be adapted to fit the specific business context of Procter & Gamble. This section assesses what parts of the framework can be readily used and what drivers should be adapted to best represent the business context of Procter & Gamble.

Recall from section 3.1.3 that we differentiate between *objective* and *subjective* drivers of product portfolio complexity. The drivers of *objective* product portfolio complexity as defined in our framework (diversity, multiplicity and mutual dependency) can be readily applied to Procter & Gamble, as they provide an accurate representation of complexity inherent to the composition of the SKU portfolio. The *subjective* driver of product portfolio complexity (relatedness) and its dimensions (consumer, competition, geography, and strategy) do require adjustments in order to accurately represent the business context of Procter & Gamble. We will discuss each of the four dimensions as defined earlier and our proposition to match these dimensions to the business context of Procter & Gamble.

- *Consumer* - the term consumer is used within Procter & Gamble to identify the external entity that purchases products in-store**.** There is however a second, closely related, but distinctly different entity that is equally important; the *customer*. The brief descriptions below clarify this difference and represent our proposal to redefine this dimension.
  - *Consumer* - the consumer actually purchases the products in-store. Influenced by all different kinds of preferences (age, culture, income, etc.) and marketing efforts (in-store advertisement, commercials, etc.), the consumer makes the final decision on what products to purchase from the offered product portfolio.
  - *Customer* – Procter & Gamble deliver most of their products to retailers, and only seldom directly to the end-users of the products (the consumer). As the retailers make the final decision on what part of the product portfolio as offered by Procter & Gamble is displayed in their stores, they represent an equally important entity as the *consumer*.
- *Competition* - the competitiveness of any company closely relates to how well it performs compared to competition. In a market as competitive as the FMCG market, strategies, actions, products, and initiatives launched by competitors have a direct influence on the composition of a product portfolio. This influence of competition on the portfolio is two-fold; a portfolio might contain very innovative products, introduced to outperform competitors on new (part of the) market(s), as well as defensive products, that are present to protect market share in parts of the market dominated by competitors. Therefore, competition remains a very important dimension in our complexity framework.
- *Geography*; although P&G aims to deliver similar brands and products in all parts of the world, the actual product portfolio is influenced by demographic dimensions (language, culture, wealth, etc.) of the market. This may result in country or regional specific products. As this phenomenon mostly occurs on a country level and products are also referred to as such within Proctor & Gamble, we propose to redefine this dimension as *country*.
- *Strategic*; strategy in this context relates to the rationale behind the product portfolio and encompasses *why* product portfolios are composed in the way they are. As Procter & Gamble's strategy is the result of company principles, company strengths, and company targets, it relates to more than just the *product portfolio strategy*. We therefore propose to redefine this dimension as *company.*

Table 4 summarizes the application of the theoretical model to Procter & Gamble as described above and lists the 5 (new) dimensions that together form the *subjective* driver of product portfolio complexity *relatedness*; the 5 C's of product portfolio complexity.

Dimension from theoretical framework	Dimension re-defined
Consumer	Consumer
	Customer
Competition	Competition
Geography	Country
Strategy	Company

Table 4 - redefining dimensions of *relatedness*

Each of these (new) dimensions of *relatedness* can then be substituted in our framework (see again Figure 5) to create a framework of drivers for product portfolio complexity that is customized to the business context of Procter & Gamble (see Figure 7). This framework will help to create a common understanding or 'language' when discussing product portfolio complexity, and moreover provides a starting point for identifying what specific dynamics actually drive product portfolio complexity within Procter & Gamble.

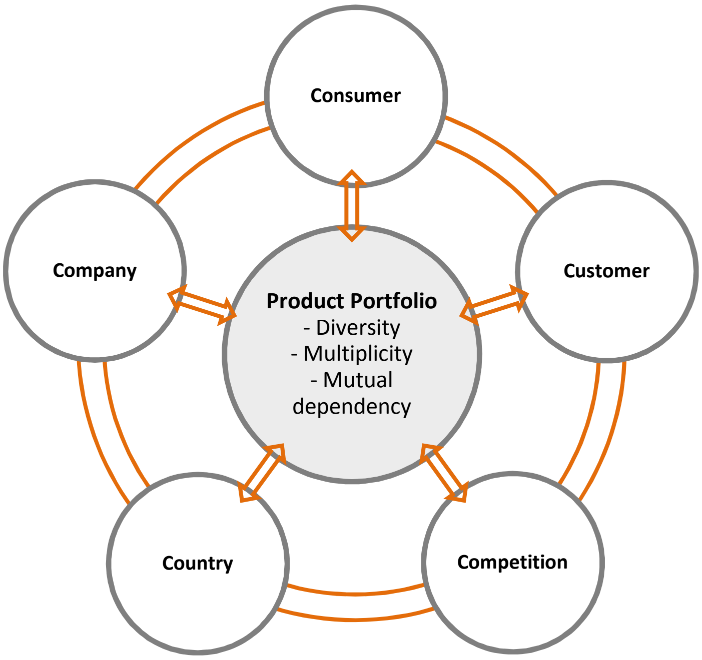


Figure 7 - framework of drivers for product portfolio complexity for Procter & Gamble

From Figure 7 we see that the five dimensions directly influence the composition of the product portfolio, as the composition of the product portfolio will be such that it satisfies the business requirements of the five dimensions. These dimensions then provide guidance when searching for specific business dynamics that create (or have created) the complex product portfolio of Procter & Gamble. At this point, we thus state that the dynamics resulting from the dimensions of the *subjective* complexity driver '*relatedness'* directly influence the composition of the product portfolio (and thus the *objective* drivers of product portfolio complexity). To clarify this, consider the causal model in Figure 8, where we have depicted the various drivers, business dynamics and their relation to the complexity of the product portfolio. Recall however that the relation between *subjective* and *objective* drivers is bilateral, as the product portfolio is ultimately meant to satisfy the requirements as set by the different dimensions. From Figure 8 we also see that the 'business dynamics' are not yet known. In order to reduce product portfolio complexity, it is essential to identify these dynamics.

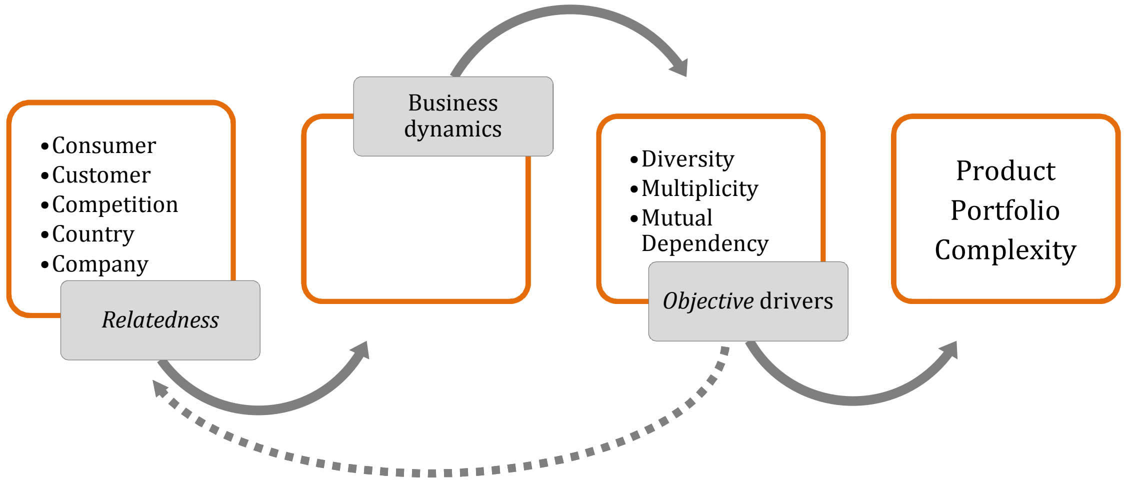


Figure 8 - causal model of product portfolio complexity

If we combine Figure 7 and Figure 8, we can derive a single framework for product portfolio complexity within Procter & Gamble, which we proposed to refer to as **the 5Cs of product portfolio complexity** (see Figure 9).

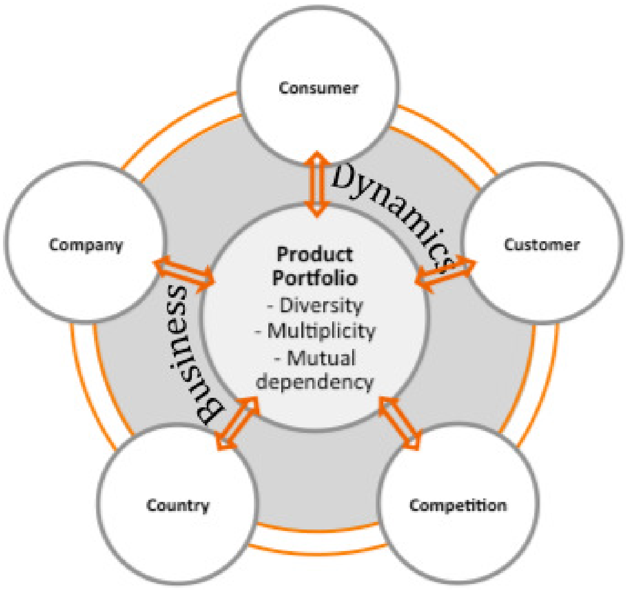


Figure 9 - the 5Cs of product portfolio complexity

3.2.3. Dynamics influencing a portfolio's composition

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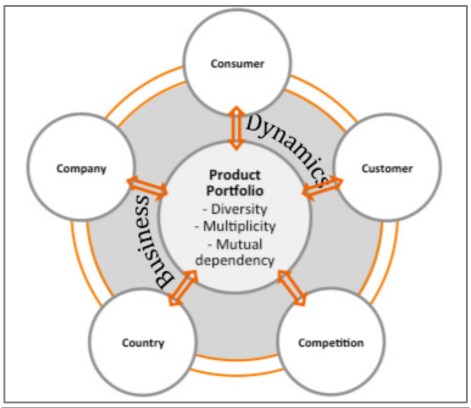
We would like to stress at this point that the business dynamics that influence the composition of the product portfolio should at this point <u>not</u> be considered as negatively impacting the organization. Recall from section 3.1.1 that we should assess the added value that each of these dynamics is creating <u>first,</u> before we can decide what dynamics to control, reduce or avoid within the organization. In order to better assess the added value of these dynamics, the next chapter will discuss our proposal to quantify complexity (and its added value) within Procter & Gamble.

CHAPTER SUMMARY

In chapter 3, we have extensively discussed the concept of complexity from a **qualitative perspective**. This final section summarizes the most important elements of this previous chapter.

- Organizational complexity results from the relation between invested (organizational) resources and benefits received for these investments.
- Complexity is not by definition a bad thing. In order to differentiate between 'good' and 'bad' complexity, we should first assess whether or not the processes/products under consideration add value to the organization (see again Figure 3 – the nature of complexity).
- Organizational complexity can be divided into 6 types: product portfolio complexity, structural complexity, supply chain complexity, manufacturing complexity, product design complexity, and environmental complexity. The remainder of this research focuses on product portfolio complexity, as its ramifications touch (almost) all other functions of the organization (see again Figure 4 – types of complexity & Table 3 - types of complexity and their definitions).
- Combining the two previous statements, this research thus aims to **find the best possible product portfolio**, as this will **eliminate all <u>non-value-adding</u> complexity** from the portfolio, while simultaneously **allowing for <u>value-adding</u> complexity to exist**.
- Product portfolio complexity is driven by 1) the objective complexity drivers *diversity, multiplicity,* and *mutual dependency* and 2) the subjective driver *relatedness*, encompassing five different dimensions (consumer, customer, competition, country, and company). The proposed framework for product portfolio complexity within Procter & Gamble represents the starting point of our improvement efforts (see again Figure 7 - framework of drivers for product portfolio complexity for Procter & Gamble).
- Finally, the 'business dynamics' describe how the requirements of the different dimensions impact the composition of the portfolio in terms of diversity, multiplicity and mutual dependency (see again Figure 8 - causal model of product portfolio complexity).
- All of the above can be summarized in the *5C framework for product portfolio complexity*. This framework enables Procter & Gamble to understand the *qualitative* aspects of product portfolio decision making.



We will use the *5C framework* both to *quantify* product portfolio complexity (chapter 4) and to assure that our decision model in chapter 5 best reflects the portfolio dynamics from practice. Ultimately, the *qualitative* insights and relatedness of the different product portfolio complexity drivers from the *5C framework* should be closely approximated by our decision model in order to **compose the best possible product portfolio**.

4. Metrics for complexity

After developing the qualitative framework for product portfolio complexity as we did in chapter 3, we need a more quantitative, data driven understanding of product portfolio complexity to further enable us in finding the best possible product portfolio. As a result, we have to develop metrics that encompass the relational and combinatorial dimensions of complexity and that are predictive of various performance outcomes (Closs et al., 2008). This chapter will contribute to that by developing metrics that will help to identify the complexity contribution of different SKUs in a portfolio. Therefore, we discuss two perspectives on metrics for product portfolio complexity. First, we discuss in more detail the metrics used today for measuring product portfolio complexity within Procter & Gamble (section 4.1), and build on this by selecting additional metrics for product portfolio complexity that will enable us to find the best possible product portfolio in section 4.2.

4.1. Metrics for product portfolio complexity within Procter & Gamble

This section is not available in the public version

4.2. Additional metrics to quantify product portfolio complexity

Even though the metrics from section 4.1 help us to gain insights into the complexity of a portfolio, they do not provide a decision on which SKUs to include or exclude from a portfolio. In order to provide Procter & Gamble with a more detailed insight into their portfolio (on a SKU level) this section will discuss metrics that can provide these insights.

Resorting back to literature, we see that the topic of portfolio management has been extensively studied. As a portfolio generally relates to a (sub) set of objects that have to be managed simultaneously, it applies to a wide range of research fields. This diverse approach is also reflected in literature. Some of the more common research fields include project portfolios (e.g. Bardhan et al., 2004), financial portfolios (e.g. Luehrman, 1998), and product portfolios (e.g. Jacobs & Swinks, 2011). But also less straightforward extensions such as customers or supplier portfolios (e.g. Wagner & Johnson, 2004) are being discussed in literature. Some authors even address specific challenges in simultaneously managing *multiple* portfolio types within a single organization (e.g. Tikkanen et al., 2007).

In general, research in the field of portfolio management has aimed to determine the most profitable or valuable combination of objects in a portfolio. Despite the numerous papers available on both complexity (see again chapter 3) and portfolio management, to the best of our knowledge, no authors have specifically combined the two and approached portfolio management from a complexity perspective. As a result, there are very few metrics available that support the complexity approach towards product portfolio management. Table 5 summarizes a literature review performed by Jacobs & Swinks (2011) and contains conceptualizations of product portfolio complexity for the three (objective) drives of product portfolio complexity. Even though this level of conceptualization goes beyond previous approaches in literature in terms of combining complexity with portfolio management, is still does not provide guidance on how to continue towards finding a best possible product portfolio (with the lowest level of complexity).

Driver	Name	Measure
Multiplicity	Portfolio size	# of SKUs
Multiplicity	Products per function	# of products/# of functions
Mutual Dependency	Commonality index	# unique/# total
Mutual Dependency	Dependency index	# changing/# possible changes
Mutual Dependency	Density	# ties/# of max possible ties
Diversity	Age entropy	Σ (% total age) x Ln (1/% total age)
Diversity	Newness	# new/ # total
Diversity	Knowledge heterogeneity	Σ λ × distance × uniqueness/size
Diversity	Gini coefficient	Σ distance magnitude/2 × avg distance x (number of items)^2

Table 5 - metrics for portfolio complexity (Jacobs & Swinks, 2011)

The metrics as described in Table 5 can again help us to gain insights in a portfolio, but do not allow us to make decisions on what SKUs to prefer over others when assessing their complexity, as the metrics are (again) not applicable on a SKU-level. In order to mend this shortcoming, we will revisit some of the theoretical concepts as previously discussed in this research and build on these to derive the prescriptive metrics that we need to establish the product portfolio with the lowest level of undesired complexity.

Recall from section 3.1.1 that *complexity results from the relation between invested (organizational) resources and the benefits received for these investments.* This definition readily shows that there are three aspects that require a thorough understanding in order to quantitatively assess complexity, i.e., the invested resources, the benefits received for these investments and the balance between the two. We will elaborate on each of these aspects below, as their conceptualization is key for achieving our research goal. As the *balance* between 'invested resources' and 'received benefits' ultimately defines whether or not there is (bad) complexity present in the product portfolio, we propose to discuss this aspect first and subsequently review the remaining two aspects.

4.2.1. The balance between invested resources and received benefits

During this research, we specifically set out to find the best possible product portfolio for Procter & Gamble, as this will inherently contain the lowest level of undesirable or 'bad' complexity. Recall that 'bad' complexity is complexity in the product portfolio that does not add value. In a portfolio in which <u>all SKUs</u> add value, we (thus) have no 'bad' complexity. This portfolio could then indeed encompass a level of 'good' complexity, but as all SKUs individually add value to the portfolio, this actually delivers value *to* the organization rather than withholding it *from* the organization. Thus, in order to assess the nature of complexity (good vs. bad) we must understand what the (added) value of a SKU in a portfolio is. We therefore propose to introduce the Portfolio Value of a Product (PVP), which has the following definition.

PVP$_\alpha$: difference in total portfolio value <u>with</u> and <u>without</u> SKU α

The Total Portfolio Value (TPV) in this definition relates to the total *profitability* of a specific portfolio in the organization in a specified time-period and is calculated using Equation 1.

Equation 1

$$\mathbf{TPV = Total\ Received\ Benefits\ (TRB)\ from\ a\ portfolio - Total\ Invested\ Resources\ (TIR)\ in\ a\ portfolio}$$

If we then rewrite the definition of PVP, denoting the TPV of a portfolio *without* a given SKU α as TPV^{α}, we result in Equation 2.

Equation 2

$$\mathbf{PVP_{\alpha} = TPV - TPV^{\alpha}}$$

If we then substitute Equation 1 in Equation 2, we have derived a formulation for PVP_{α} containing all the components from our complexity definition (see Equation 3). The α denoted in superscript again refers to respectively the total received benefit or total invested resources *without* a given SKU α.

Equation 3

$$\mathbf{PVP_{\alpha} = (TRB - TIR) - (TRB^{\alpha} - TIR^{\alpha})}$$

To clarify the relations as stated above, consider the following example. A product portfolio with 50 SKUs had a TPV of one million euro in 2011. After we remove SKU α from this portfolio, both TRB and TIR decrease, resulting in TRB^{α} and TIR^{α}. The difference between these two results in TPV^{α}, in this example valued at 953,867 euro, again over 2011. The PVP of SKU α (PVP_{α}) then equals 46,133 euro.

From both Equation 2 and Equation 3 we see that a SKU can have a positive as well as a negative PVP. SKUs with a *positive* PVP add value to the portfolio and inherently cannot contain a level of 'bad' complexity. If we thus remove all SKUs from the portfolio with a *negative* PVP, we result in a portfolio that contains only value adding SKUs (and inherently no 'bad' complexity). By upholding this approach, we still allow for value adding or 'good' complexity to be present in our portfolio. We could argue at this point that by further simplifying the level of 'good' complexity, the TPV could potentially be increased even further, but we leave this out of scope for the time being, as we believe that the largest improvement potential lies with reducing 'bad' complexity versus further simplifying 'good' complexity.

From Equation 3, we note that the conceptualization of both TIR and TRB is critical for determining the Portfolio Value of a Product. The following sections will discuss our proposal to substantiate these two terms.

4.2.2. Total Invested Resources

During previous sections, we deliberately refrained from giving a precise definition of 'resources' to allow for a broad, complexity driven approach towards finding the best possible product portfolio. This section will elaborate on the conceptualization of 'invested resources' and discuss our proposal to quantify this aspect of the PVP.

In order to maintain a certain product portfolio, organizations need to rely on a large number of resources, e.g. Human Resources, Physical Resources (e.g. buildings and equipment), Information Resources and Financial Resources. As we are considering the total invested resources to maintain a certain product portfolio, we propose to use a cost-approach towards these resources for two reasons. First of all, there is a tremendous pressure on reducing costs within Procter & Gamble, as cost-management has become key in outperforming competitors in the non-growing market for consumer goods (P&G, 2011). Secondly, by upholding a cost-approach, we allow for a common approach amongst the different types of resources, as we can determine the cost of each resource needed to maintain a certain portfolio (admitted that for some resources this is not as straightforward as for others).

Any cost-structure related to (physical) products usually consists of a fixed and variable part, where fixed costs relate to having the opportunity to use a resource whereas variable costs relate to the actual usage of the resource. Consider for example a manufacturing facility. The costs related to the actual building and its maintenance are fixed, irrespective of the number of products produced in this factory. The costs of for example maintaining machinery, raw materials and packaging are variable, as they are determined by the actual number of manufactured products. The same reasoning also holds for other types of resources.

We propose to conceptualize the 'total invested resources' by the true cost of maintaining a portfolio, or true portfolio costs, using the following relation.

True Portfolio Costs (TPC) = fixed portfolio costs + variable portfolio costs

Quantifying these cost elements using the same unit of measure (e.g. dollar or euro) will allow us to determine the TPC for a given portfolio. We will therefore elaborate on each of these elements.

Fixed costs

Fixed costs result from *offering* a product portfolio in the first place. Recall that we are trying to determine the PVP for each SKU, which was defined as the difference between TPV and TPV^{α}. As both these parts will require 'having' the same resources, the fixed costs will be equal on both sides of the equation and can thus be left out. This line of reasoning is valid as long as a decision on whether or not to rationalize a SKU does not make 'having' a certain resource superfluous. As we are trying to identify the best possible product portfolio given a *currently existing* product portfolio, we assume that this will never be the case, as we always will have at least one SKU in our portfolio needing a specific resource. To fully understand this assumption, consider again the toothpaste example. If a current portfolio contains both toothpastes and toothbrushes, we can decide to rationalize certain types of toothpaste (e.g. no longer selling extra-mint flavour toothpaste), but we will never decide to stop selling toothpaste altogether, as this represent a business decision far beyond the scope of this research. We are thus always required to 'have' resources to produce and sell toothpaste, regardless of the types of toothpaste we decide to be in the portfolio.

Variable costs

Variable costs (VC) are costs resulting from using a specific resource, and (thus) increase with every SKU we produce. As the term 'SKU' does not allow us to make a distinction between individual items (e.g. 1 bottle of shampoo) and SKUs as part of a product line (e.g. an anti-dandruff shampoo), we propose to define two types of variable costs that reflect this subtle difference: *item-dependent variable costs* and *SKU-dependent variable cost*. Obviously, the two are related using the total shipment volume (see Equation 4).

Equation 4

$$\textbf{SKU dependent VC} = \textbf{item dependent VC} * \textbf{shipment volume}$$

During this research, all calculations will be done based on SKU-dependent variable costs. Any data that is only available on item level will be converted to represent the SKU-dependent VC using the relation from Equation 4. In order to calculate the total variable costs (TVC) of a certain portfolio, we need to aggregate the SKU-dependent VC's for each SKU and then sum these over all SKUs in the portfolio.

As we now understand how variable costs are built up in a certain portfolio, let us return to the different resources that we require (and their inherent costs) for maintaining a certain portfolio. In order to assure a thorough coverage of all resources and cost involved, consider a typical (yet simplified version of an) end-to-end supply chain for any product category of Procter & Gamble Benelux (see Figure 10).

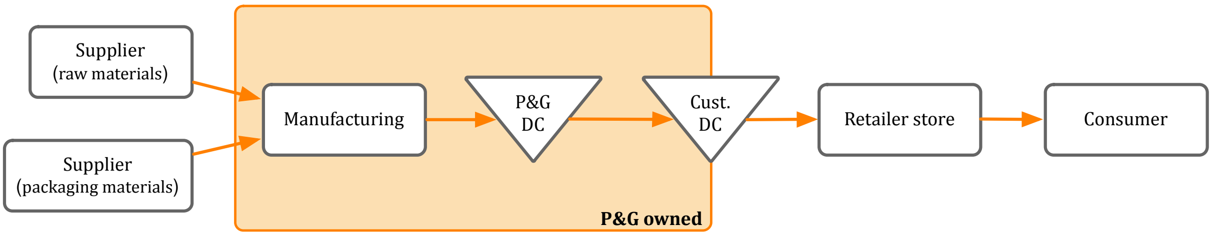


Figure 10 - end-to-end supply chain (P&G, 2011)

In this end-to-end supply chain, Procter & Gamble controls (and thus incurs costs for) all processes between receiving the raw materials and delivering finished products to the customer's distribution centre (DC). From the supply chain depicted Figure 10 we can already identify three types of variable costs that are incurred for every item that is produced, shipped and sold. These variable costs are:

- ***Procurement costs***; represent the costs involved when purchasing the raw materials and packaging material.
- ***Manufacturing costs***; represent the costs occurred for manufacturing one item of a specific product (e.g. one bottle of shampoo)
- ***Transportation costs***; represents the costs to transport a finished item, and consists of two parts: transportation from the factory to Procter & Gamble's distribution centre (DC) and transportation from Procter & Gamble's DC to the customer's DC
- ***Inventory costs;*** costs to store a finished item in Procter & Gamble's DC.

Within Procter & Gamble, the first 2 types of variable costs and transportation to Procter & Gamble's DC are aggregated and represented by the Total Delivery Costs (TDC), which leaves us with 3 types variable costs (see Figure 11).

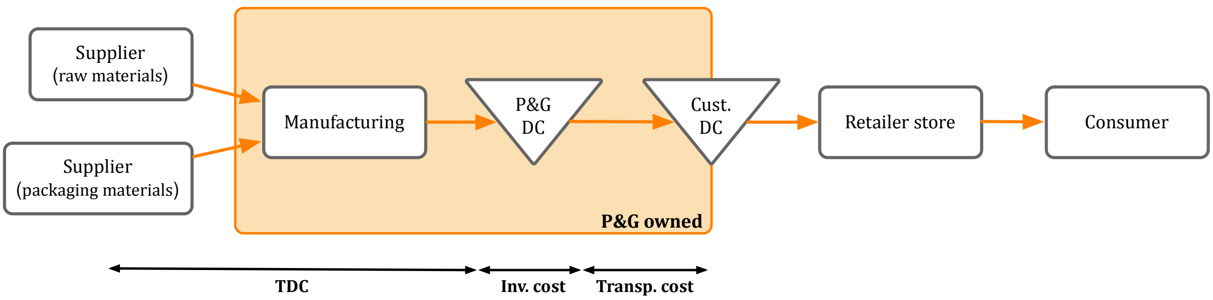


Figure 11 - variable costs in an end-to-end supply chain (P&G, 2011)

This cost-structure applies to all base SKUs. For customized SKUs however, there is an additional cost component that represents the cost required for the customization activity (e.g.

bundling, composing a display, etc.). This additional customization cost is referred to as the customization up-charge.

- **C**ustomization **U**p-charge additional variable cost that only applies to customized SKUs (for base SKUs, this up-charge is zero).

Obviously, when considering the total variable costs of a customized SKU, we also need to consider the TDC costs of the *single* items that are in the bill of material of the customized SKU, as customized SKUs are created *after* manufacturing and *before* they are placed on stock in Procter & Gamble's DC. Consider for example a bundle of two tubes of toothpaste. We thus use the TDC of a single tube <u>twice</u> and add the customization up-charge for bundling. Besides the variable costs related to the supply chain, there are also variable cost that relate to promotional budgets from both marketing and sales. Within Procter & Gamble, this type of costs is referred to as Market Spending Activity costs, or MSA.

- ***MSA** Costs*; incurred costs for marketing and sales support for a SKU

MSA costs can be reflected for each SKU in the portfolio by dividing the total MSA budget of a portfolio over the SKUs that were promoted. In order to differentiate between SKUs that absorbed little promotional support and SKUs that received considerable promotional support, we use the percentage of (historical) <u>sales value</u> as allocation factor (see Equation 5), as this aligns with Procter & Gamble's internal accounting principles. After removing SKU α from the portfolio, we thus no longer need to promote it in the market and the total MSA budget will decrease.

Equation 5

$$\mathbf{MSA_{\alpha} = MSA * \frac{GIV_{\alpha}}{\sum_{\alpha} GIV_{\alpha}}}$$

So far, we have not considered any costs of labour. Labour costs are present in every step of the supply chain, which makes them a critical part of our calculation of the total portfolio costs (TPC) of a product portfolio. However, each of the variable costs directly resulting from the supply chain (TDC, transportation costs, and inventory costs) represents the cost <u>including</u> *direct* labour, which only leaves us to consider the *indirect* labour cost.

- *Indirect **L**abour costs*; refers to costs of labour that is not specifically spent on a specific item or SKU but rather on *activities* that relate to multiple SKUs or even entire brands or portfolios (e.g. marketing and sales support)

As indirect labour *costs* are a direct derivative from indirect labour *time,* we need to gain insights in the types of activities performed by the different departments in the organization and the time required to perform these activities. We then need to assign the time needed for these activities to a specific SKU (or group of SKUs) in order to gain insights in what the indirect labour costs are for these SKUs. In essence, this line of reasoning closely relates to Time-Driven Activity Based Costing (TD-ABC) as introduced by Kaplan & Anderson in 2004. While the exact assignment of (indirect) labour time (and cost) to specific SKUs or SKU-segments is a separate research all together, we do propose to provide a rough indication, as it will strengthen our analysis significantly. We will therefore briefly review the most important elements of TD-ABC and apply it to gain insight in the indirect labour costs for the SKUs in a portfolio.

The origin of ABC dates back to 1983-1984, although the term "Activity Based Costing" was not coined at that time yet. The origin of the concept grew out of dissatisfaction with the dominating costing procedures at the time, variable costing and traditional full costing, which were argued to be obsolete in modern manufacturing environments. Traditionally, ABC is a two-stage procedure in which cost of resources in the first stage are allocated to activities to form Activity Cost Pools, which in the second stage are allocated to cost objects based on the object's use of the different activities. Cost objects here is a generic term relating to for example products, services and/or customers (Kaplan, 1983).

Traditional ABC models however have some practical limitations that prevented large scale adoption. First of all, the time and cost demands of creating and maintaining an ABC model for large organizations are quite severe. As the number of activities and cost objects expands, the complexity of the ABC model expands as well, requiring excessive amounts of calculating capacity, making the model far from agile. Second, as the assignment of activity costs pools to cost objects is done based on the *portion* of the time required, it does not account for resources being idle. This issue is inherently related to the interview and survey process of ABC. When people estimate how much time they spend on a list of activities handed to them, they invariably report percentages adding up to 100. Therefore, cost driver rates are calculated assuming that resources are working at full capacity, whereas we know that operations often run at considerably less than their full capacity (Kaplan & Anderson, 2004).

In order to overcome these barriers, Kaplan and Anderson introduced a revised model in 2004, referred to as Time Driven Activity Based Costing (TD-ABC). For each group of resources, TD-ABC requires estimates of only two parameters: 1) the cost per unit time of supplying resource capacity and 2) the consumption of capacity (unit times) by the activities the organization performs on products. We will use a modified (and very simplified) version of TD-ABC to gain insights in the indirect labour time/costs absorbed by different products. Therefore, both parameters as described above will be developed for a product portfolio within Procter & Gamble.

- *Cost per unit time of supplying resource capacity*; recall that we use TD-ABC to approximate the total indirect labour costs for each of the products in a portfolio. In this reasoning, the *resource capacity* thus refers to indirect labour, which means that the cost per unit time essentially relates to the *cost per unit of indirect labour*. As not all (time) units of indirect labour can be equally valued (e.g. marketing time may be more expensive than sales time), we propose to divide the *resource* indirect labour into 5 categories, coherent with the 5 departments within Procter & Gamble: Customer Business Development (CBD or sales), Marketing, Supply Network Operations (SNO or logistics), Customization, and Finance & Accounting (F&A). The costs per unit indirect labour for each of these 'resources' will have to be determined. Obviously, a 'unit' here relates to a chosen time-span, e.g. one minute, one hour, etc. Table 6 depicts the different *resources*, and needs to be filled further to represent the actual unit cost per resource for Procter & Gamble.

Resource	Cost per unit time
CBD	€ .../min.
Marketing	€ .../min.
SNO	€ .../min.
Customization	€ .../min.
F&A	€ .../min.

Table 6 - costs of resources

- *Consumption of capacity (unit times) by the activities performed on products;* besides determining the unit cost of supplying resource capacity, we need to understand *what* *activities* these resources perform on different SKUs in a portfolio and *how many time units each activity requires* in order to derive the total cost of indirect labour for a specific SKU. Rather than using specific activities we propose to use the 'profile' of a SKU to determine the consumption of resource capacity for a specific SKU. A *SKU-profile* relates to the inherent characteristics and evolvement of a specific SKU. To determine these characteristics, we revert to the business dynamics as discussed in section 3.2.3, as they provide the characteristics that allow us to determine a SKU's profile (see Table 7). For every individual SKU we should then evaluated which of the listed characteristics apply to that specific SKU. The unique set of characteristics that is relevant for a specific SKU eventually determines its profile.

Characteristic	Applicable?
Base SKU	Yes/No
Display SKU	Yes/No
Bundle SKU	Yes/No
In-out SKU	Yes/No
Soft change	Yes/No
Hard change	Yes/No
New product launch	Yes/No
Defence SKU	Yes/No
Promotional SKU	Yes/No

Table 7 – SKU characteristics

Each of the characteristics in Table 7 requires a specific number of time units from a specific resource (e.g. a base SKU requires 2 hours/week from Marketing, 4 hours/week from SNO, etc). Combining the *activities that require resource capacity* and the *resources themselves* results in Table 8 that should then be filled with the required time units (e.g. minutes) for each characteristic/resource combination.

Characteristic	CBD	Marketing	SNO	Customization	F&A
Base SKU	... min.	... min.	... min.	... min.	... min.
Display SKU	... min.	... min.	... min.	... min.	... min.
……	……	……	……	……	……
Promotional SKU	... min.	... min.	... min.	... min.	... min.

Table 8 - resources and activities

Multiplying each of the entries in Table 8 with its respective unit cost from Table 6, results in Table 9. Aligning Table 9 with the profile of a specific SKU tells us which characteristics (and its inherent time/costs) are relevant for that SKU, and eventually allows us to derive the total indirect labour costs for that specific SKU.

Characteristic	Applicable?	CBD	Marketing	SNO	Custom.	F&A	Total
Base SKU	Yes/No	€ ...	€ ...	€ ...	€ ...	€ ...	€ ...
Display SKU	Yes/No	€ ...	€ ...	€ ...	€ ...	€ ...	€ ...
……	……	……	……	……	……	……	……
Promotional SKU	Yes/No	€ ...	€ ...	€ ...	€ ...	€ ...	€ ...
	Total	€ ...	€ ...	€ ...	€ ...	€ ...	€ ...

Table 9 - indirect labour costs per SKU

4.2.3. Total Received Benefits

As with 'invested resources', we also deliberately refrained from giving a precise definition of 'benefits' during the previous sections, again to allow for a broad, complexity driven, approach towards finding the best possible product portfolio. This section will discuss the conceptualization of 'received benefits' and with that our proposal to quantify this aspect of determining the PVP.

When discussing the received benefits from a specific portfolio, these benefits are actually the rewards of offering the product portfolio to the market. In general, we can distinguish between two types of benefits an organization receives from offering a portfolio to the market.

- *Financial benefits*; financial benefits relate to the value of the actual sales, e.g. turnover, net realization or any other financial metric used to indicate the actual sales value. Financial benefits focus purely on what an organization receives from the market and should thus be considered without regarding any type of costs.
- *Non-financial benefits*; non-financial benefits then represent a much broader scope on rewards coming from the market, and relate to benefits as for example brand/company image and consumer loyalty. Intuitively, we can argue that these (non-financial) benefits indeed deliver a form of value to the company, quantifying this type of benefit is however very difficult.

In the remainder of this research, we will focus only on the *financial* benefits of SKUs in a portfolio, for several reasons. First of all, the non-financial benefits of a portfolio or individual SKUs are extremely hard to assess, as it involves a very detailed understanding and knowledge of the market and its inherent dynamics. Second, even *if* we would be able to assess this non-financial benefit, we would have to convert it into a financial metric to be able to include it in our PVP analysis. Where assessing the non-financial benefits was extremely hard in the first place, converting it into a financial metric would be near impossible. Third, any product portfolio, its value and performance within Procter & Gamble is nowadays primarily judged on its financial performance. Our proposal to consider the *financial* benefits would align with this reasoning. Finally, we believe that any portfolio decisions based on non-financial benefits are best left to those most knowledgeable anyway (e.g. market/company experts), making it superfluous to include in our analysis at this point. Concluding, we propose to evaluate the 'received benefits' from a portfolio by its *financial benefits*. There are a number of metrics available to evaluate the *financial benefits* of a portfolio within Procter & Gamble, e.g. net realization, net outside sales, gross invoice value, and many others. In order to stay in line with previous metrics as discussed in section 4.1, we propose to evaluate the financial benefits from a portfolio by using the Gross Invoice Value (GIV) of all SKUs in a portfolio.

Actual Portfolio Benefits (APB) = Total Gross Invoice Value of portfolio

Within Procter & Gamble, GIV is reported on a SKU-level for a given time horizon (e.g. per month, per 3 months, etc). In order to evaluate the actual portfolio benefits, we thus need to sum the GIV of a specific SKU over all SKUs in the portfolio (see Equation 6).

Equation 6

$$APB = \sum_{\alpha} GIV_{\alpha}$$

APB = Actual Portfolio Benefits
GIV_{α} = Gross Invoice Value of SKU α

In order to provide the required data for the different costs and benefit elements as described in section 4.2, we need to gain a thorough understanding on how each of the elements is constituted. While this understanding is key to *derive* the input data of our decision support model, the compilation of the data *itself* is less relevant. Consider therefore Table 10 that lists for each element the appendix discussing its derivation into more detail.

Element	Appendix
Costs	
TDC	Appendix D
Inventory costs	Appendix D
Transportation costs	Appendix D
Customization Up-charge	Appendix E
MSA costs	Appendix E
Indirect labour costs	Appendix F
Benefits	
Gross Invoice Value	*Not applicable*

Table 10 - input data and matching appendix

Even though we now have leveraged some aspects of our *5C framework for product portfolio complexity* into prescriptive metrics, we do believe that the true effect of complexity has not been sufficiently covered. The following section therefore discusses our proposal on how to capture the full effect of complexity on portfolio decision-making.

4.3. Capturing complexity; an opportunity-cost approach

So far, we have uncovered how to provide an indication of the added value of a specific SKU to a portfolio (expressed in the PVP-value), given the presence of other SKUs in that very same portfolio. To truly quantify complexity however, we again resort to our definition of complexity from section 3.1.1, were we stated that *complexity results from the relation between invested (organizational) resources and the benefits received for these investments.* From the *5C framework* (see again section 3.2) we see that two of the key complexity drivers for product portfolio complexity relate to the coherence (or relations) of SKUs in a portfolio (i.e., *interrelatedness* and *mutual dependency*). Our definition also shows that complexity is the *result* of this very same coherence. Following this line of reasoning, we believe that the true effects of complexity will only be revealed when we start *changing* a portfolio's composition by adding/removing SKUs, which is exactly why we determined the PVP of a certain SKU as the *difference* between the total portfolio value with and without that SKU. In essence, we only capture the true effects caused by a portfolio's complexity if we apply changes to a portfolio's composition. We therefore propose to use an *opportunity-costs approach* to reveal the effect of complexity on a portfolio's value, as this approach allows us to consider different scenarios and especially their effect on both invested resources (TPC) and received benefits (APB). Obviously, the *scenarios* in this case refer to 1) a portfolio with SKU α and 2) a portfolio without SKU α.

Before we discuss in detail how we propose to conceptualize this approach, we do acknowledge that *if* we would perfectly execute an (TD) Activity Based Costing analysis, we would already be able to reveal all possible costs and benefits for every possible portfolio composition (and thus also with and without SKU α). However, perfectly executing a foul-proof ABC analysis by far outranges the scope of this research, both in terms of available time and resources. We therefore propose to approximate the full-size ABC approach by using the aforementioned opportunity-cost approach. This entails applying the opportunity-cost principles to both the received benefits (APB) and invested resources (TPC).

4.3.1. Complexity effect on Actual Portfolio Benefits

If we would assess the effect of removing a SKU from a portfolio on the Actual Portfolio Benefits, we would see a decrease in benefits that equals the total financial benefits of that specific SKU (see Figure 12). In other words, if we remove a SKU from a portfolio, our APB decrease with the total sales value of the SKU we remove.

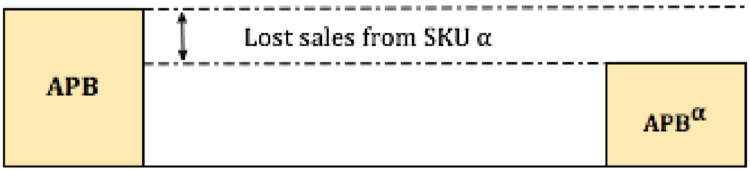


Figure 12 - simple relation between APB and APB^{α}

However, as a SKU is always part of a portfolio, it would be highly unrealistic to assume that removing a specific SKU would not affect the other SKUs in the portfolio. Assuming the total demand for a specific type of product remains the same, a consumer that can no longer purchase his/her preferred SKU in-store because we removed it from the portfolio, will most probably buy a substitute SKU in order to satisfy its need. This substitute-SKU will most probably be a slightly different variant, either from the same brand as the SKU he/she was looking for, or from a different brand. In case the consumer decides to buy a substitute-SKU from the same brand, the decision to remove a certain SKU from the portfolio will thus simultaneously increase the financial benefits for some of *the remaining SKUs in the portfolio*. We call this the sales recovery of SKU α. Ultimately, the APB^{α} is a result of both the decrease in sales caused by the removal of SKU α and the increase of sales caused by the sales recovery of SKU α by the remaining SKUs in the portfolio (see Figure 13).

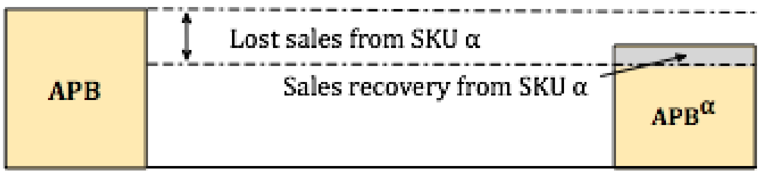


Figure 13 - complex relation between APB and APBα

From Figure 13, we see that in order to derive the APB^{α} value, we need to quantify both the decrease caused by the lost sales from SKU α and the increase of sales from the remaining SKU in the portfolio. We will discuss both factors below.

Lost sales from SKU α

Assessing the lost sales from removing a SKU from a portfolio is quite straightforward. Recall that we defined the APB by the total Gross Invoice Value of all SKUs in a portfolio. The lost sales from SKU α then equal its total Gross Invoice Value (GIV_{α}).

__Increased sales for remaining SKUs__

When we consider the effect of increasing sales for SKUs that remain in the portfolio, we need to understand the following aspects:

- *Assess what percentage of (lost) sales from SKU α can be recovered by the portfolio*; this aspect strongly depends on the number of substitutes in our portfolio, as they are the ones purchased by consumers instead of SKU α. We will elaborate on *how* to determine what SKUs are substitutes in section 5.1.3. Essentially, the number of substitutes conceptualizes the objective driver *multiplicity* from our *5C framework for product portfolio complexity* (see again section 3.1.3). Obviously, a larger number of substitute-SKUs in our portfolio will increase the probability that a consumer will re-purchase from our portfolio. We propose to conceptualize this aspect by the **percentage of sales (volume) recovery from SKU α**. This percentage depends on the nature of the products and the number of substitute-SKUs in the portfolio. The percentage of sales recovery (SR) differs for different types of consumer-goods and strongly coheres with a consumer's brand loyalty. The SR-value for toothpaste within Procter & Gamble for example equals 33%, which means that (on average) 33% of consumers that cannot purchase their desired SKU in-store, will purchase a substitute-SKU from the same brand, given we have at least 1 substitute available within that brand (P&G, 2010). However, when assessing consumer brand-switching behaviour and its effect on future sales, we should also consider consumers that previously bought a different brand and now switch to our brand. This means that previous purchasing experiences will affect the next purchasing decision of a consumer. In general, consumer brand switching (or brand choice) behaviour can be represented using a two-stage Markov-chain (see Figure 14).

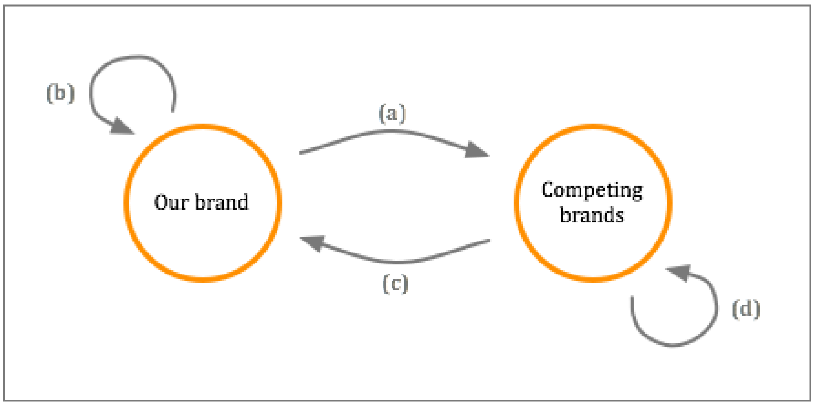


Figure 14 - 2-stage Markov chain for brand switching behaviour

The transition probabilities then represent the percentage of consumers that switch from our brand to a competitor (a), that remain loyal to our brand (b), that switch from a competing brand to our brand (c), and that remain loyal to a competing brand (d). These switching and retention probabilities strongly depend on the type of products and the competitors offerings. Obviously, the steady-state probability of being in state "Our brand" will ultimately determine how much sales we can recover after removing SKU α. From research, we know that the steady-state probability for 'Our brand' equals 0.33 for Oral Care products of Procter & Gamble. However, as we change a portfolio's composition, the values for (a), (b), (c), and (d) might change, resulting in different steady-state probabilities. As gaining these insights by far outranges the scope of this research, we propose to use the value we know from previous research. Moreover, consumer switching behaviour also depends on the number of substitutes in a portfolio. As the number of substitute-SKUs in a portfolio increases, the probability that a consumer will find a substitute-SKU that closely resembles its original choice will increase as well. We assume that with an increasing *number* of substitutes, the degree of differentiation between substitutes will decrease, increasing the probability that a consumer will find (and purchase) a substitute-SKU from our portfolio, as they better resemble SKU α. Though this relation may be straightforward from an intuitive perspective, quantifying it certainly is not. The only way to fully understand the exact mechanisms of this relation is to set up a full-size experiment exploring the relation between the number of substitutes and the sales recovery within a certain brand. As such an experiment is beyond the scope of our research, we propose to use a simple, linear relation and assume that with every additional substitute (with regard to having <u>one</u> substitute in the first place), the percentage of sales recovery will increase with a fixed percentage (see Equation 7). We readily see that even though the <u>total percentage</u> of sales recovery increases with a larger number of substitutes, the sales recovery <u>per substitute-SKU</u> decreases. This closely aligns with the assumption that the total demand for a certain group of products (e.g. toothpaste) will remain equal in the market, meaning that additional substitutes will not increase the total market demand and therefore recover a decreasing percentage of sales per additional substitute.

Equation 7

$$\mathbf{SR_{\alpha.n} = SR + SRI_n * (n - 1)}$$

$SR_{\alpha,n}$ = sales recovery of SKU α, given it has n substitute-SKUs (0-1)
SR = probability of consumers buying a substitute-SKU from our portfolio, given we have at least 1 substitute-SKU (0-1)
SRI_n = fixed sales recovery increase for each additional substitute-SKU
n = number of substitute-SKUs in our portfolio (n = 2,....)

- *Determine how these recovered sales are divided amongst the substitute-SKUs*; Even though a substitute-SKU may closely resemble the removed SKU α, it might not be equally preferred amongst consumers. The simplest way to assess this preference is by evaluating the historical sales of the substitute-SKU(s). We therefore assume that every substitute-SKU in the portfolio will **recover a percentage of the sales that is proportionate to its sales volume**, compared to the *other substitute-SKUs*. Even though these historical sales were based on the fact that our portfolio *still contained SKU α* (which will influence the actual sales volume of its substitutes), we assume that the (normalized) historical distribution of sales between the remaining SKUs provides a good indication of consumer preferences. By upholding this assumption, we indirectly also assume that the removal of SKU α has no effect on the *shelving* of SKUs in the retailer store. However, as we remove SKUs that are on the shelf in a retailer's store, the 'empty' spot on the shelf has to be filled again. Generally, this can be done in two ways. Either the spot is filled with one of the SKUs from our brand that was already on that shelf, which result in one SKU being shelved on two spots (referred to as 'double facing'), or it is filled with a SKU from a competing brand, which will impact the strength of our product line-up (i.e., the range of product choices that in on the shelf) and thus a consumer's perception of our assortment. From previous research, we know that both effects, known as respectively *main space* and *cross space elasticity*, have an (additional) effect on the sales performance of (substitute) SKUs (see e.g. Corstjens & Doyle, 1981). As quantifying the actual *elasticity factors* to determine the impact of both effects is a separate research all together, we prefer to uphold the approach as stated in the beginning of this section and assume the sales recovery of substitute-SKUs will increase proportionate to their (historic) sales volume. The Sales Recovery per Substitute-SKU *v* is then given in Equation 8.

Equation 8

$$\mathbf{SRSS_{v,\alpha}} = \frac{\mathbf{SV_v}}{\sum_v \mathbf{SV_v}} * \mathbf{SR_{\alpha,n}} \qquad \forall\, v,\alpha$$

$SRSS_{v,\alpha}$ = Percentage of Sales Recovery for Substitute-SKU v, which is a substitute for SKU α (0-1)
SV_v = Sales volume of substitute-SKUs v
$SR_{\alpha,n}$ = Percentage of Sales Recovery of SKU α, given it has n substitute-SKUs (0-1)

We then combine Equation 7 and Equation 8 to derive a formula for APB^{α}, depending on the Sales Volume, Recovered Sales and (unit) Price of the substitute-SKUs.

Equation 9

$$\mathbf{APB^{\alpha}} = \sum_{v} \left[\left(\mathbf{SV_v} + \left(\mathbf{SSRS_{v,\alpha}} * \mathbf{SV_{\alpha}} \right) \right) * \mathbf{P_v} \right]$$

APB^{α} = Actual Portfolio Benefits <u>without</u> SKU α
SV_{α} = total sales volume of SKU α
$SRSS_{v,\alpha}$ = Percentage of Sales Recovery for Substitute-SKU v, which is a substitute for SKU α (0-1)
P_v = unit (sales) price of substitute-SKU v

Obviously, recovery of sales is not relevant if our portfolio does not contain any substitutes; in that case, $SR_{\alpha,n}$ will equal 0 and the APB-decrease will equal the total Gross Invoice Value of SKU α. Recall that our research set out the find the best possible portfolio given the <u>current</u> portfolio, and that we the relations as described above are used to assess the impact of removing a SKU from the portfolio. The relations can however also be used to assess the effect of <u>introducing</u> new SKUs to the portfolio. Instead of assessing the *sales recovery* of substitute SKUs, we then assess the *cannibalization* of substitute SKUs; by introducing a new SKU, part of the sales from closely related SKUs (i.e., the substitutes) will shift to the new SKU. Hence, the proposed formulas can thus be used to assess both the introduction and rationalization of SKU to/from a portfolio. This research will however, as stated in chapter 2, focus only on the latter of the two. In order to elaborate on the relations as described above, recall our toothpaste example.

<u>EXAMPLE</u>

Assume we now have three comparable toothpastes in our portfolio, with GIV_{α}, SV_{α} and P_v as in the first table. The APB in this example then equals € 434,600. Assume we want to calculate APB^2; the Actual Portfolio Benefits after removing SKU-2 from the portfolio. We know that the SR for toothpaste equals 33%, and for this example let's assume the SRI equals 5% (each additional substitute-SKU recovers 5% extra sales).

SKU α	total GIV_{α}	SV_{α}	P_v
1	€ 134,400	80,000	€ 1.68
2	€ 178,000	100,000	€ 1.78
3	€ 122,200	65,000	€ 1.88
	€ 434,600	245,000	

	n= 2
$SR_{2,2} = SR + SRI_2 * (2-1)$	0.38

We then fill in Equation 7 for n=2 to derive the $SR_{2,2}$ value (see second table). This means that if we discontinue SKU-2 from our portfolio, we expect to recover 38% of its sales volume with the remaining two SKUs. If we then apply Equation 8, we can calculate what the sales volumes of the remaining SKUs (SKU-1 and SKU-3) will be.

For SKU-1 $\longrightarrow$ $SRSS_{1,2} = \frac{SV_1}{\sum_v SV_v} * SR_{2,2} \longrightarrow \frac{80{,}000}{80{,}000 + 65{,}000} * 0.38 = 0.21 = 21\%$

For SKU-3 $\longrightarrow$ $SRSS_{1,3} = \frac{SV_3}{\sum_v SV_v} * SR_{2,2} \longrightarrow \frac{65{,}000}{80{,}000 + 65{,}000} * 0.38 = 0.17 = 17\%$

This indicates that SKU-1 will recover 21% of the lost sales volume from SKU-2, and SKU-3 will recover 17%. At this point, we can thus calculate APB^2 using Equation 9.

$\mathrm{APB}^{\alpha} = \sum_{v}\left[\left(\mathrm{SV}_{v} + \left(\mathrm{SSRS}_{v,\alpha} * \mathrm{SV}_{\alpha}\right)\right) * \mathrm{P}_{v}\right] \longrightarrow$ APB^2 = [(80,000 + (0.21*100,000)) * 1.68)] + [(65,000 + (0.17*100,000)) * 1.88)] = **€ 323,847**

By removing SKU-2 from the portfolio, the Actual Portfolio Benefits decrease with € 85,515. Similar calculations yield the following results for removing other SKUs.

SKU-1 $\longrightarrow$ APB^1 $\longrightarrow$ **€ 355,510**

SKU-3 $\longrightarrow$ APB^3 $\longrightarrow$ **€ 355,268**

This example readily shows that there is a large difference in APB^{α}-value between the three SKUs. At this point however, we cannot draw any conclusions on what SKU(s) deliver most value, as we must assess the change in the True Portfolio Costs first.

4.3.2. Complexity effect on True Portfolio Costs

Besides the effect of removing a specific SKU on the Actual Portfolio Benefits, we should also assess how this reduction affects our cost-structure, and thus our True Portfolio Costs (TPC). Recall from section 4.2.2 that the True Portfolio Costs consist of fixed and variable costs. In order to capture the complexity effect on the TPC, we will address both types of costs and assess how their structure changes as we remove SKUs from the portfolio.

Fixed costs and complexity

When we discussed fixed costs in section 4.2.2, we stated that as fixed costs are equal for both TPC and TPC^{α}, we do not have to consider them when calculating the PVP_{α}. This line of reasoning is valid as long as a decision on whether or not to discontinue a SKU does not make 'having' a certain resource superfluous. As we assess the removal of one SKU at the time (SKU α), this assumption will indeed be valid for most of the assessments performed on individual SKUs. We thus do not need to consider fixed costs as long as we remain within the *normal utilization base of resources*. The *normal utilization of resources* relates to the range of SKUs that can be delivered by the organization using a specific *base* of organizational resources. For example, a DC has a range of pallet-spots available (e.g. between 1 and 5000), but by using just 1 of them, an organizations incurs the fixed costs of having this DC. So for any number of SKUs between 1 and 5000 (assuming each SKU uses exactly one pallet-spot), these fixed costs will not change. A similar reasoning applies to the other organizational resources. By rationalizing a portfolio, it is not unlikely that after removing several SKUs from the portfolio, the required input needed from a certain resource ends-up below its *normal utilization range.* However, as many (if not all) of the used resources are shared with portfolios other than Oral Care, we will assume that *a decision on an individual SKU will never change the normal utilization base*, as resources will always be needed to deliver other SKUs to the market, either by the portfolio we are considering or another portfolio.

Variable costs and complexity

However, while the *normal utilization base* of organizational resources and thus the fixed costs do not change, the variable costs certainly do. If we remove a SKU from our portfolio, the variable costs for all resources will decrease proportionate to the amount of resources that specific SKU absorbs. For example, if we remove SKU α from our portfolio, we no longer incur costs for SKU α in terms of TDC, inventory, transportation, MSA and customization. However, due to the fact that part of the sales from SKU α will be recovered by its substitute-SKUs, for some of the remaining SKUs, the total variable costs increase proportional to the recovered sales volume from SKU α. Hence, the True Portfolio Costs after removing SKU α can be calculated using the following formula. Obviously, for all remaining SKUs (r) we use the variable costs *including* the recovered sales from SKU α.

Equation 10

$$\mathbf{TPC}^{\alpha} = \sum_{r}\sum_{\beta}\mathbf{VC}(\mathbf{SKU}_{r,\beta}) \qquad \textit{over all } r,\ \beta$$

TPC^{α} = True Portfolio Costs without SKU α
$VC(SKU_{r,\beta})$ = Variable costs of SKU r for resource β
r = Remaining SKUs in portfolio ($r \neq \alpha$)

There is however one type of variable costs where this relation requires some additional explanation: the indirect labour costs. Recall that we determine the indirect labour costs for each of the SKUs in a portfolio using a Time-Driven Activity Based Costing approach. As we remove a certain SKU from the portfolio, the amount of indirect labour spent *on the total portfolio* will decrease as well. In other words, by removing SKUs from the portfolio, we free up indirect labour time within the organization. We now have two basic decisions at hand on what to do with this freed-up time: it could be either reinvested in the *same* portfolio or in *other* portfolios (or other organizational projects). Reinvesting this freed-up time in the *same* portfolio will intuitively result in less delivery errors, higher forecasting accuracy and better marketing and sales support, which will eventually result in better selling and more profitable SKUs in that same portfolio. At a certain point however, having too much time available for a specific SKU will only result in idle time/employees (and thus unnecessarily high labour costs), which will seriously impact the PVP of that SKU. Figure 15 graphically shows this relation.

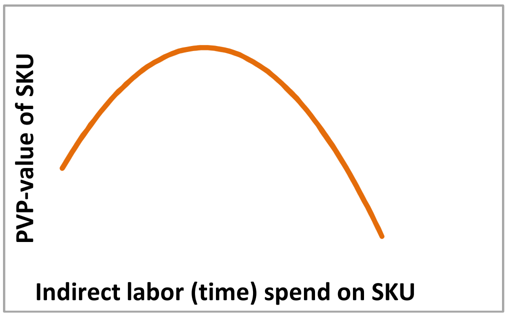


Figure 15 – PVP vs. time spend

To the best of our knowledge, there is no specific data available within Procter & Gamble or in scientific literature to quantify the effect of additional indirect labour time on the sales performance of a SKU. The only reliable way to truly gain quantitative insights in the relation between additional indirect labour time per SKU and the received benefits for that SKU, is by conducting a full size experiment (similar to the one described to gain insights in the relation between percentage of sales recovery and the number of substitutes as discussed in section 4.3.1). However, by focusing on the other component of the PVP (i.e., the costs-component), we are able to include (part of) this effect.

In order to determine what the indirect labour costs will be for the remaining SKUs in the portfolio after removing SKU α, recall from section 4.2.2 that we determined the indirect labour time for each SKU in a portfolio. The total indirect labour time per SKU was an aggregate of the time spent in each of the departments (which was dependent on the SKU-profile). If we now decide to discontinue SKU α, the total (indirect labour) time we previously spend on SKU α, now becomes available. As we based the indirect labour time on *activities* rather than *shipment volume* (as we did with TDC, inventory and transportation), the freed-up time does not necessarily have to be reinvested in the remaining (substitute) SKUs. This closely aligns with the TD-ABC principles, as we use *activities* rather than *volume* as an allocation of costs to resources. Obviously, the time-estimates for each of the activities were based on a certain shipment volume (i.e., the *current* volume) and these estimates may not be valid as the volume significantly increases/decreases. We assume however that the volume will not change to such an extent that we need to reconsider our time-estimates for the activities from section 4.3.1. Concluding, in order to account for (part of) the effect as described in Figure 15, we assume that the freed-up time from removing SKU α will not be reinvested in the portfolio and the indirect labour costs will therefore decrease with the indirect labour costs from SKU α.

To fully understand how the relations described in section 4.3.2 help us to calculate the TPC^{α}, consider the example below.

EXAMPLE

Consider again the toothpaste example from the previous section. Assume now that each of the three types of toothpaste incurs a certain level of variable costs for each of the resources it uses, as displayed in the table below. We assume that these 3 substitute-toothpastes are part of a larger portfolio. The total variable costs of these other SKUs are listed as well.

	TDC	Transp.	Inv.	MSA	Labour	TVC
SKU-1	€ 80,000	€ 4,000	€ 4,000	€ 32,000	€ 6,000	€ 126,000
SKU-2	€ 105,000	€ 6,000	€ 8,000	€ 48,000	€ 2,000	€ 169,000
SKU-3	€ 78,000	€ 2,600	€ 3,900	€ 16,000	€ 10,000	€ 110,500
Other SKUs	€ -	€ -	€ -	€ -	€ -	€ 850,000
					TPC =	**€ 1,255,500**

The True Portfolio Costs are thus € 1,255,500. If we now consider the effect on the variable costs of removing SKU-2 from this portfolio, there are two aspects that influence the TPC^{2}: first, we no longer incur the variable costs of SKU-2 and second, the variable costs of the SKUs that recover some of the lost sales from SKU-2 will increase, as their sales volume will change (this thus holds for all variable costs *except for* indirect labour costs) as we see from Figure 13 and the previous example. Using the different formulas from this section, we derive the following table, constituting the cost structure of the SKUs in the portfolio after discontinuing SKU-2.

	TDC	Transp.	Inv.	MSA	Labour	TVC
SKU-1	€ 100,966	€ 5,048	€ 5,048	€ 40,386	€ 6,000	€ 157,448
SKU-2	€ ----------	€ ----------	€ ----------	€ ----------	€ ----------	€ ----------
SKU-3	€ 98,441	€ 3,281	€ 4,922	€ 16,407	€ 10,000	€ 133,052
Other SKUs	€ -	€ -	€ -	€ -	€ -	€ 850,000
					TPC =	**€ 1,140,500**

After removing SKU-2 from the portfolio, the TPC^{2} has become € 1,140,500, a decrease of € 115,000. Performing similar calculations for SKU-1 and SKU-3 yields the following results.

SKU-1 ⟶ TPC^{1} ⟶ **€ 1,189,443**

SKU-3 ⟶ TPC^{3} ⟶ **€ 1,198,029**

As we now understand how the relations between TPC-TPC^{α} and APB-APB^{α} are constituted, we can calculate the PVP-value of each SKU in our portfolio. These PVP-values will eventually enable us to make well-founded decisions on which SKUs to remove or keep in a portfolio. Consider a final example, where we bring all aspects discussed in chapter 4 together.

EXAMPLE

Consider once again the toothpaste example. The table below summarized the key results from determining the APB^{α} and TPC^{a}-values. Recall from calculating the TPC^{a}-values that we introduced *other (additional) SKUs* that incurred a certain level of variable costs. We assume that these *other SKUs* have a gross invoice value equalling € 900,000 (which makes all APB^{a} values € 900,000 higher than in the APB-example).

	APB	TPC	TPV	PVP
Original Portfolio	€ 1,334,600	€ 1,255,500	€ 79,100	-
Removing SKU α	***APB^{a}***	***TPC^{α}***	***TPV^{α}***	***PVP_{α}***
Removing SKU-1	€ 1,255,510	€ 1,189,443	€ 66,067	€ 13,033
Removing SKU-2	€ 1,223,847	€ 1,140,500	€ 83,347	€ -4,247
Removing SKU-3	€ 1,255,268	€ 1,198,029	€ 57,239	€ 21,861

These results readily show us that not all SKUs add value to this portfolio. The PVP_2 shows that the Total Portfolio Value *without* *SKU-2* is € 4,247 higher than *with* *SKU-2.* In other words, removing SKU-2 actually makes the total portfolio more profitable. On the other hand, the other two SKUs do add value, as the Total Portfolio Value *with these SKUs is higher than without them*. Finally, we see that removing SKU-3 would have a much larger impact than removing SKU-1, as it has a much larger PVP-value.

These calculations show us that even though we had a profitable portfolio to begin with (TPV of € 79,100) where each individual SKU was profitable as well, removing SKU-2 will further increase the Total Portfolio Value to € 83,347.

In this chapter, we derived the various formulas needed to assess the impact of discontinuing SKU α on both the Actual Portfolio Benefits and True Portfolio Costs. We will combine these (quantitative) insights on complexity with our (qualitative) complexity framework from chapter 3 to derive a decision support model that will provide the valuable information needed to make well-founded portfolio decision. For clarity, we have stated all input data needed to calculate the PVP_{α} in Appendix C.

CHAPTER SUMMARY

In chapter 4, we build on our *5C framework for product portfolio complexity* from chapter 3 and extensively discussed the concept of complexity from a **quantitative perspective**. This final section summarizes the most important elements of this chapter.

- Within the SPO-program of Procter & Gamble, several descriptive metrics are available that help us to gain insights in a portfolio and to compare portfolios with each other and over time, based on their SKU-productivity data.
- As both the SPO-program and literature provides limited support in our complexity approach towards portfolio management, we build on our definition of product portfolio complexity from chapter 3 and propose to reduce product portfolio complexity by removing all SKUs that do not add value to the portfolio.
- The added value of SKU α is conceptualized by **Portfolio Value of Product α (or PVP_α)**, which is defined as the difference in Total Portfolio Value (TPV) with and without SKU α.
- The TPV is defined as the difference between total received benefits (conceptualized by the Actual Portfolio Benefits, or APB) and total invested resources (conceptualized by the True Portfolio Costs, or TPC). True Portfolio Costs are calculated using a combination of traditional cost accounting (fixed/variable costs) and TD-ABC. The Actual Portfolio Benefits are calculated using the total Gross Invoice Value (GIV) of SKUs in the portfolio.
- To truly capture the costs and benefits of *complexity*, we propose an **opportunity based costing approach** to reveal the effect of complexity, as this allows us to consider different scenarios (portfolio <u>with</u> and <u>without</u> SKU α) and their effect on both TPC and APB.
- For both the TPC and the APB, we discussed the relations to quantitatively assess the effect of removing SKU α from the portfolio. The most important indices and formulas needed to perform this assessment are listed in the second part of this chapter's summary.
- Finally, Appendix C contains an extensive list with all the input data needed to calculate the TPC and APB-values and eventually assess PVP_α.

We will combine the quantitative relations from chapter 4 with the more qualitative knowledge from chapter 3 to compose a decision support model in chapter 5. This model will enable us towards finding the best possible product portfolio.

Indices	Description	
α	SKU α, with α = 1,2,… (depending on the portfolio size)	
v	Substitute-SKU of α, with v = 1,2,..	
β	resource β, with β =	**T**otal **D**elivery **C**ost (TDC) **T**ransportation (T) **I**nventory (I) **C**ustomization **U**p-charge (CU) **M**arket **S**pending **A**ctivities (MSA) **L**abour (indirect) (L)
k	Department k, with k =	**S**upply **N**etwork **O**perations (SNO) **M**arketing (M) **C**ustomer **B**usiness **D**evelopment (CBD) **F**inance & **A**ccounting (F&A) **C**ustomization (C)

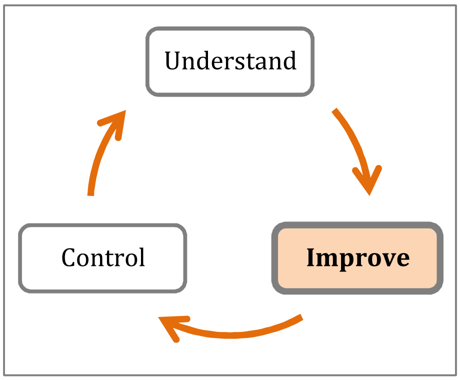
Table 11 - indices to quantify TPV

Formula		Description
True Portfolio Costs; Total Variable Costs		
$\mathrm{VC}(\mathrm{SKU}_{\alpha,\beta}) = \mathrm{VC}(\mathrm{Item}_{\alpha,\beta}) * \mathrm{SV}_{\alpha}$	$\forall\, \alpha, \beta$	Relation between SKU dependent VC and item dependent VC
$\mathrm{TPC} = \sum_{\alpha}\sum_{\beta} \mathrm{VC}(\mathrm{SKU}_{\alpha,\beta})$	*over all* α, β	The total variable costs of all products in a certain portfolio.
$\mathrm{TPC}^{\alpha} = \sum_{r}\sum_{\beta} \mathrm{VC}(\mathrm{SKU}_{r,\beta})$	*over all* r, β	Total Portfolio Costs without SKU α, summed over all remaining SKUs *r*
Actual Portfolio Benefits		
$\mathrm{GIV}_{\alpha} = \mathrm{P}_{\alpha} * \mathrm{SV}_{\alpha}$	$\forall\, \alpha$	Gross Invoice value as product of volume and price
$\mathrm{APB} = \sum_{\alpha} \mathrm{GIV}_{\alpha}$		Total received benefits from a certain portfolio
$\mathrm{APB}^{\alpha} = \sum_{r} \left[\left(\mathrm{SV}_{r} + \left(\mathrm{SSRS}_{r,\alpha} * \mathrm{SV}_{\alpha}\right)\right) * \mathrm{P}_{r}\right]$		APB^{α}-value after removing SKU α from the portfolio
$\mathrm{SRSS}_{v,\alpha} = \frac{\mathrm{SV}_{v}}{\sum_{v} \mathrm{SV}_{v}} * \mathrm{SR}_{\alpha,n}$	$\forall\, v, \alpha$	Actual sales (volume) recovery per substitute-SKU

Table 12 - formulas to quantify TPC

IMPROVING COMPLEXITY

The second part of this research will answer the remaining research questions by combining the qualitative and quantitative aspects of product portfolio complexity into a decision support model that will help us to deliver the best possible portfolio (research question 3, Chapter 5). This decision model will then be applied to the Oral Care portfolio for Procter & Gamble (research question 4, Chapter 6), after which we will validate the model based on its outcomes and incorporate any additional insights into the decision model (research question 5, Chapter 7)



5. Decision support model to reduce complexity

During the previous chapters, we explored the concept of complexity from a *qualitative* perspective by assessing how different drivers of product portfolio complexity interact, and from a *quantitative* perspective by introducing mathematical relations for the interaction between different complexity drivers. This chapter will synthesize these two perspectives into a decision support model that will help us to make portfolio decisions that reduce product portfolio complexity. Even though our decision model goes far beyond any previous approaches, we emphasize at this point that this decision model should be considered as a *supporting* model in portfolio management, rather than an all encompassing guide that can be blindly followed. Nonetheless, the results will prove to be extremely useful for those burdened with making the actual portfolio decisions. We discuss the most important modelling assumptions used for this model in section 5.1, followed by a description of the iterative procedure used in the decision support model in section 5.2.

5.1. Modelling assumptions

As revealed in chapter 4, portfolio decisions never occur in a vacuum and decisions on *one* SKU invariably impact other SKUs in the portfolio. When discussing the effect of discontinuing a certain SKU on the remaining SKUs in the portfolio, we explicitly attempted to at least *discuss* all possible effects of the discontinuation, even though we were not able to *quantify* each relation. In order to take these effects into consideration, we have stated certain assumptions that will enable us to let the decision model *match reality as closely as possible,* while refraining from unnecessarily complicating the model. The last thing we want is to derive an *over-complex* decision support model to reduce complexity. This section reviews the most important assumptions needed to build up the actual decision support model.

5.1.1. Time scale

In sections 4.2.2 and 4.2.3 we explicitly defined how to calculate the True Portfolio Costs and the Actual Portfolio Benefits. What we intentionally left out of this discussion was the time horizon we should use to evaluate both components of the Total Portfolio Value. One could argue that as long as we evaluate both costs and benefits of a SKU on the same time scale (e.g. 3 or 6 months), the *actual* time scale used is rather arbitrary and can (thus) differentiate between SKUs in the portfolio. However, as mentioned earlier, we are not assessing *single* SKUs, but rather SKUs that are part of a portfolio, which invariably entails assessing all SKUs on the *same* time scale to be able to compare their <u>absolute</u> contribution to the portfolio (the PVP_{α}). When determining a useable time-scale, there are two aspects that we have to consider.

- *Life Cycle (LC) stage;* the costs and benefits of a typical SKU vary with each stage of its product's life cycle (introduction, growth, maturity and decline (Kotler, 1994)). For example, the costs involved to introduce a SKU to the market will be high, while the level of benefits still has to develop. If we thus assess a SKU in the early stages of its lifecycle, we might find it to be unprofitable and remove it from the portfolio. This SKU however may very well turn out to be a very profitable SKU at a later stage in its life cycle, far offsetting the negative contribution that occurred during its introduction. To prevent this, we decide to only let our model assess SKUs that have been on the market for more than 6 months, as a typical SKU takes about 6 months to go through the introduction phase and starts to develop its full potential by growing (P&G, 2011), as displayed in Figure 16.

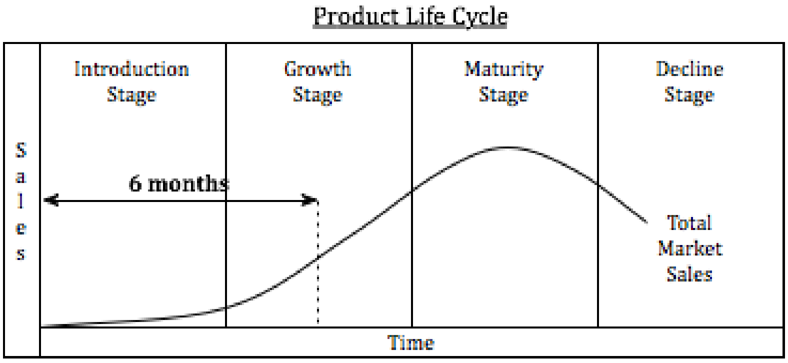


Figure 16 - product life cycle (Kotler, 1994)

- *Seasonality;* Another aspect that may cause us to compare SKUs at an unequal basis is seasonality. Seasonality relates to (predictable) periodic fluctuations on an annual basis and in this case could be important when assessing the benefits of a portfolio. The assessment may deliver very different results depending on the season under consideration (e.g. an ice-cream manufacturer will sell more ice-cream during the summer period). By using a time-scale of *one year*, periods of high sales are counterbalanced with periods of low sales, giving the best overall assessment of a SKU's (sales) performance.

To account for both of these effects, we propose to use the following guidelines for the time-scale in our decision support model. Assess the costs and benefits for SKUs in the portfolio over a time period of 1 year. Costs and benefits of SKUs which have been introduced <u>more</u> than 6 months ago will be extrapolated to a one-year period, as there is hardly any seasonal effect in the Oral Care portfolio (P&G, 2011). SKUs which have been introduced <u>less</u> than 6 months ago will not be assessed with our decision model. Note however that SKUs which have been introduced less than 6 months ago can <u>indeed</u> be substitutes for the SKUs our model does considers (i.e., which are on the market > 6 months). However, as we are unable to provide a reliable estimate of their yearly sales volume due to their relatively short existence, we cannot calculate for these *≤ 6 months SKUs* how many sales they will recover from one of its *> 6 month substitutes*. We therefore leave them out of our assessment.

SKU's on market > 1 year	Assess costs and benefits over 1 year
6 months < SKU's on market < 1 year	Extrapolate to represent costs and benefits of 1 year
SKU's on market ≤ 6 months	Do not assess with model

5.1.2. Base vs. customized SKUs

From previous sections we know that customized SKUs are essentially base-SKU that have been bundled or otherwise modified to either fit specific retailer needs or to support (internal driven) promotions. One could then argue that by removing a base-SKU from the portfolio, all customized SKUs that include <u>that specific</u> base-SKU in their bill of material should be removed as well, as without the base-SKU we simply cannot develop these customized SKU. This assumption would indeed be valid if we would consider a *global* portfolio (e.g. the global Oral Care portfolio). However, as clearly stated in section 2.3, this research focuses on the Oral Care portfolio in the *Benelux*. As a result, we can decide to remove a base-SKU from the Benelux portfolio and *still sell* the customized SKUs requiring this SKU, as the required base-SKU is still being produced (and sold) in <u>other regions</u>. Base and customized SKUs can thus be assessed independently.

Decisions on base SKUs can be taken independently of customized SKUs and vice versa

5.1.3. Substitutes

Recall from section 4.3.1 that part of the sales being lost by removing SKU α is recovered by the substitutes of SKU α. As the percentage of sales recovery strongly depends on the number of available substitutes, clearly defining which SKUs in the portfolio are considered to be substitutes is vital for the outcome of this research. We distinguish four elements that determine whether or not a specific SKU is considered to be a substitute for SKU α. These aspects directly relate to the *consumer, customer* and *country* dimensions from the *5C framework for product portfolio complexity* (see section 3.2).

- *Equity*. A SKU's equity refers to the *perception* and/or *purpose* of a consumer's purchase. If consumers for example want to purchase a toothpaste for sensitive teeth (SKU α), but are not able to find their preferred choice (as we removed SKU α from the portfolio), they will look for other toothpastes for sensitive teeth. They will not consider any extreme whitening toothpastes or simple basic toothpastes, as they do not align with the *perception* of the original purchasing intention (i.e., the toothpaste for *sensitive* teeth). Nor will they consider buying a toothbrush instead as it has a totally different *purpose*. Substitutes will therefore always be comparable to SKU α (the preferred choice) in terms of equity.
- *Price range*. The price range refers to the actual sales price of a specific SKU. When buying a substitute, consumers preferably purchase SKUs that are priced similar to their 'original choice' (SKU α), as similar priced SKUs are perceived as being equally valuable or 'good' as the 'original'. We therefore assume that SKUs can be substitutes if their price is within 15% of SKU α (i.e., no more than 15% higher or lower than SKU α) (P&G, 2011). Difficulties arise when we assess <u>bundles</u> as substitutes. As bundles by definition contain *multiple* items, their sales price will be higher than the price of a single item. This would result in the fact that for example a bundle of <u>three tubes</u> of extra-mint toothpaste is not considered to be a substitute for a <u>single tube</u> of extra-mint toothpaste, which makes no sense from a practical perspective. We therefore compare bundles to single items based on the price per *component* (i.e., the *tubes* from the example), rather than the price per *SKU* to identify whether or not they should be considered substitutes.
- *In-store availability*. In order for a SKU to be a true substitute, one could argue that it has to be available within the same retail store, as this assures the consumer with a *choice* at the actual moment of purchase. This argument is indeed value valid for many consumer goods. However, for beauty and health-related products, consumers are known to be much more loyal to their preferred brand (Gruen, 2002). As a result, consumers will expand their search and visit other stores first, before deciding to purchase a substitute. We therefore assume that the in-store availability of substitute SKUs is not a relevant limitation for our research, meaning that substitute-SKUs can be SKUs that are not necessarily offered by the same retailer.
- *Country availability*. This element should be considered as an extension of the in-store availability as described above. Where we assumed that substitutes do not necessarily have to be offered by the same retailer as loyal consumers expand their search to other retailers, we do assume that consumer loyalty does not span beyond country borders. Hence, SKUs can only be a substitute of SKU α if they are being offered in the same country.

A substitute-SKU *1)* offers the same equity as SKU α, *2)* at a sales price that differs no more than 15% from SKU α, *3)* is not necessarily offered at the same retailer as SKU α, but *4)* is available in the same country as SKU α.

5.1.4. Additional assumptions

When we discussed the various qualitative and quantitative relations on product portfolio complexity during the previous chapters, we followed a line of reasoning that contained some assumptions we did yet not discuss in section 5.1. In order to provide the reader with a full overview of our modelling assumptions, we have restated these assumptions from chapter 3 and 4 below.

- The total percentage of sales recovery will increase with an increasing number of substitute-SKUs in the portfolio.
- The normal utilization base of resources will not change, regardless of any decisions we make on the composition of the portfolio. As a result, any fixed costs do not have to be considered.
- The total demand in the market for a certain group of product (e.g. toothpaste) remains equal.
- The historical division of sales between SKUs provides an indication for the division of sales in the future.
- Changes in sales volume of a SKU (due to sales recovery) will not change the time needed to perform a certain activity and will thus have no impact on the indirect labour costs.

After discussing the underlying assumptions of our decision model, the next section will elaborate on the actual procedure used to assess and reduce product portfolio complexity at Procter & Gamble.

5.2. Decision support model

This section will bring together all the discussed aspects of product portfolio complexity into a decision support model that will enable us towards the best possible product portfolio. In order to fully understand the data used, the actual procedure, and the outcomes of the model, we discuss each of these aspects below.

5.2.1. Data gathering

Recall from chapter 4 that in order for us to perform the actual analysis, we require a large amount of data. Some of this data is readily available, but other types of data require some additional efforts. Appendix C contains a detailed list of all the data needed, complemented with its source. We discussed in detail for each (cost and benefit) element of the PVP analysis how we should derive the required values for each SKU in various appendices (see again Table 10 for the matching appendices). If we want to execute our decision support model, we thus need to gather all the data as mentioned in Appendix C, and use this data to calculate the variable costs and benefits for each SKU in the portfolio we are considering. Therefore, gathering the required data and turning it into the required cost and benefit elements is a crucial first step in our decision model.

1) Gather all data as listed in Appendix C, and use Appendix D, Appendix E, and Appendix F to constitute the required costs and benefits elements for each SKU in the portfolio.

5.2.2. Assessing current state of a portfolio

Recall from section 4.1 that there are several descriptive metric available within Procter & Gamble to gain insights into the current state of a portfolio's complexity. We will use these metrics in our decision support model to provide a preliminary understanding of the level of complexity encompassed in a given portfolio. These metrics also allow us to benchmark the portfolio we are considering with other portfolios or to display a trend over time. Furthermore, it also serves as the 'starting position' of our improvement efforts, which we can relate to after any improvements efforts have been executed to compare the 'current' versus the 'improved' portfolio.

2)	Use the descriptive metrics from section 4.1 to gain insights in the portfolio under consideration, its development over time and to benchmark its level of complexity.

5.2.3. Iterative procedure

After acquiring all the data and turning it into the required costs and benefits elements, we are able to assess the PVP_α-value for each SKU in the portfolio. As the costs and benefits structure of the entire portfolio will change after discontinuing SKU α, we should only consider the effect of removing a *single* SKU at the time. We therefore propose to use an iterative procedure, in which every iteration coincides with the removal of a *single* SKU. During every iteration, we then determine for each of the remaining SKUs in the portfolio their PVP_α-value, using the formulas from chapter 4. Recall that this research aims to find the best possible product portfolio, which was defined as the portfolio that only consists of SKUs that *add value*. After each iteration, we thus remove the SKU from the portfolio with the *most negative PVP_α-value*, as this will deliver the largest improvement in terms of Total Portfolio Value. The portfolio composition after the removal of this SKU (with its 'new' costs and benefits structure) will be the starting point for the next iteration. We continue to perform iterations as long as there are SKUs with a negative PVP_α-value, and only stop if all remaining SKUs have a positive PVP_α-value. By upholding this approach, we are able to derive a portfolio that contains only value adding SKUs and thus no longer contains 'bad' complexity. This approach is summarized below.

3)	Calculate for the current portfolio the APB, the TPC and the TPV
4)	Calculate for each SKU in the portfolio the APB^α and TPC^α
5)	Calculate for each SKU in the portfolio the TPV^α and PVP_α
6)	If $PVP_\alpha \geq 0$ for all SKUs, **stop.** Otherwise remove the SKU with the *most negative* PVP_α, add the recovered sales volume of SKU-α to its substitutes and return to step 3.

5.2.4. Presenting outcomes

As mentioned, our decision model should be used to *support* portfolio management decisions rather than to blindly follow up on its conclusions. This means that not only the outcomes themselves, but also the way they are presented should facilitate decision making. This final section of chapter 5 will therefore discuss the way we present the outcomes of our decision support model.

Before we explain how the results will be depicted, recall from section 2.1 that one of the consequences of the increasing complexity at Procter & Gamble was the increasing workload as perceived by employees. We therefore specifically addressed this aspect by including the indirect labour time (and costs) into our decision model (see again section 4.2.2). Although the ultimate decision criterion should be the PVP-value of a SKU (which inherently encompasses this indirect labour-time aspect) it would be very useful to visualize the *time*-effect as well. In section 4.2.2, we determined for every SKU the amount of indirect labour time we spend on it, in order to calculate its indirect labour costs. We can (re)use this information to gain insights on the *time*-effect of discontinuing a specific SKU. We therefore propose the plot for each SKU its PVP-value and the amount of freed-up time after each iteration.

Using the running example from chapter 4 and plotting the results as described above, we get Figure 17. Recall that in this example we decided to remove SKU-2 from the portfolio, as it has the most negative PVP-value. But what we also learn from this representation is that SKU-1 has a limited PVP-value, whereas it absorbs considerable indirect labour time within the organization. Even though we specifically stated that we use the PVP-value of a SKU as the decision criterion, it may very well be that the actual decision makers have a more developed understanding of the relation between invested time and the profitability of a SKU (see again Figure 15). Their advanced understanding could make them argue that the freed-up time resulting from removing a specific SKU is more valuable than the loss in Portfolio Value (see for example SKU-1). We however believe that in the end it all runs down to the (financial) added value of a SKU and focus therefore on the PVP-value. The representation of Figure 17 obviously supports both types of reasoning.

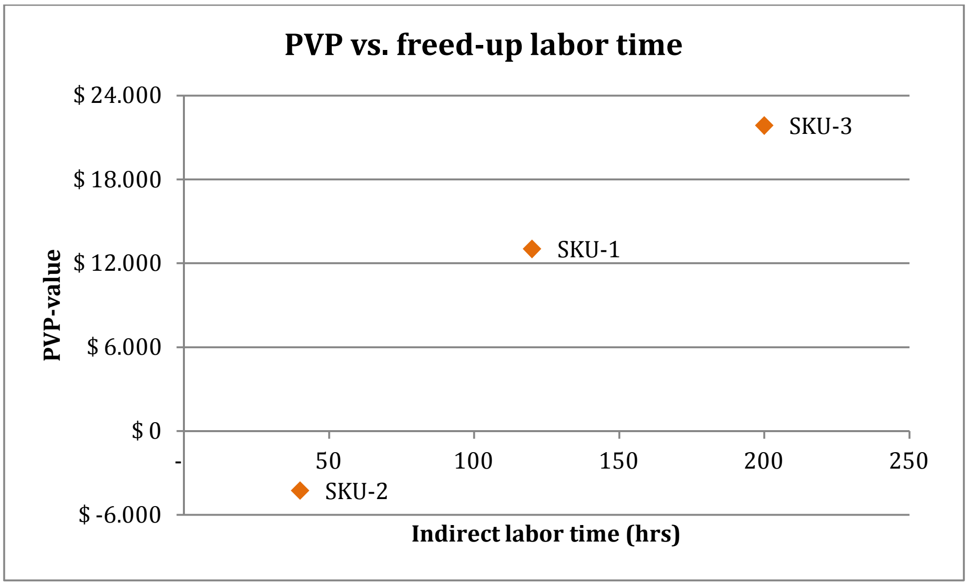


Figure 17 - displaying iteration's result

After exploring the concept of product portfolio complexity from both a qualitative and a quantitative perspective, and bringing the two together in the decision support model as described in this chapter, chapter 6 will discuss the application of our decision support model on the Oral Care portfolio of Procter & Gamble Benelux.

CHAPTER SUMMARY

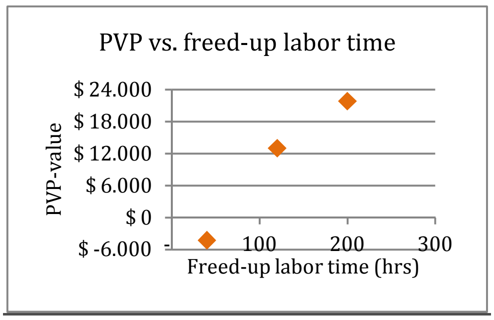
This final section summarizes the most important elements of this chapter and will describe the lay-out of our decision support model. To assure our decision support model does not become overly complex, but still closely resembles reality, we use the following assumption when reviewing a portfolio:

- Assess SKUs on a one-year's time scale. SKUs that have not been on the market for more than 6 months are not assessed. Data from SKUs with a life cycle length between 6 months and 1 year is extrapolated to represent a one-year's horizon.
- Decisions on base SKUs can be taken independently of customized SKUs and vice versa.
- A substitute-SKU offers the same equity as SKU α, at a sales price that differs no more than 15% from SKU α, is not necessarily offered at the same retailer as SKU α, but is available in the same country as SKU α.
- The total percentage of sales recovery will increase with an increasing number of substitute-SKUs in the portfolio.
- The normal utilization base of resources will not change, regardless of any decisions we make on the composition of the portfolio. As a result, any fixed costs do not have to be considered.
- The total demand in the market for a specific type of product (e.g. toothpaste) remains equal.
- The historical division of sales between SKUs provides an indication for the division of sales in the future.
- Changes in sales volume of a SKU (due to sales recovery) will not change the time needed to perform a certain activity on that SKU and will thus have no impact on the indirect labour costs.

Using these assumptions, we apply an iterative procedure that helps us to find the best possible product portfolio.

1. Gather all data as listed in Appendix C, and use Appendix D, Appendix E, and Appendix F to constitute the required costs and benefits elements for each SKU in the portfolio.
2. Use the descriptive metrics from section 4.1 to gain insights in the portfolio under consideration, its development over time and to benchmark its level of complexity.
3. Calculate for the current portfolio the **APB**, the **TPC** and the **TPV**.
4. Calculate for each SKU in the portfolio the **APB^{α}** and **TPC^{α}**.
5. Calculate for each SKU in the portfolio the **TPV^{α}** and **PVP_{α}**
6. If **$PVP_{\alpha} \geq 0$** for all SKUs, **stop**, otherwise **remove the SKU with the most negative PVP_{α}**, add the recovered sales volume of SKU-α to its substitutes and return to step 3.

After every iteration, plot for each SKU in the portfolio its PVP-value versus the freed-up (indirect) labour time in the organization to support decision-making. The next section will apply our decision support model on the Oral Care portfolio Benelux to find its best possible composition.



6. Case study

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7. Case review and model assessment

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8. Conclusion and recommendations

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9. References

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Appendix A the Oral Care portfolio

This Appendix is not available in the public version

Appendix B Interview list & Project team

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Appendix C Input data needed for decision model

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Appendix D TDC, Transportation and Inventory costs

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Appendix E MSA & Customization Up-charge

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Appendix F Indirect labour costs

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Appendix G Substitutes in the Oral Care Portfolio

This Appendix is not available in the public version

Appendix H SKU-profile for Oral Care

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Appendix I Costs and benefits per SKU

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