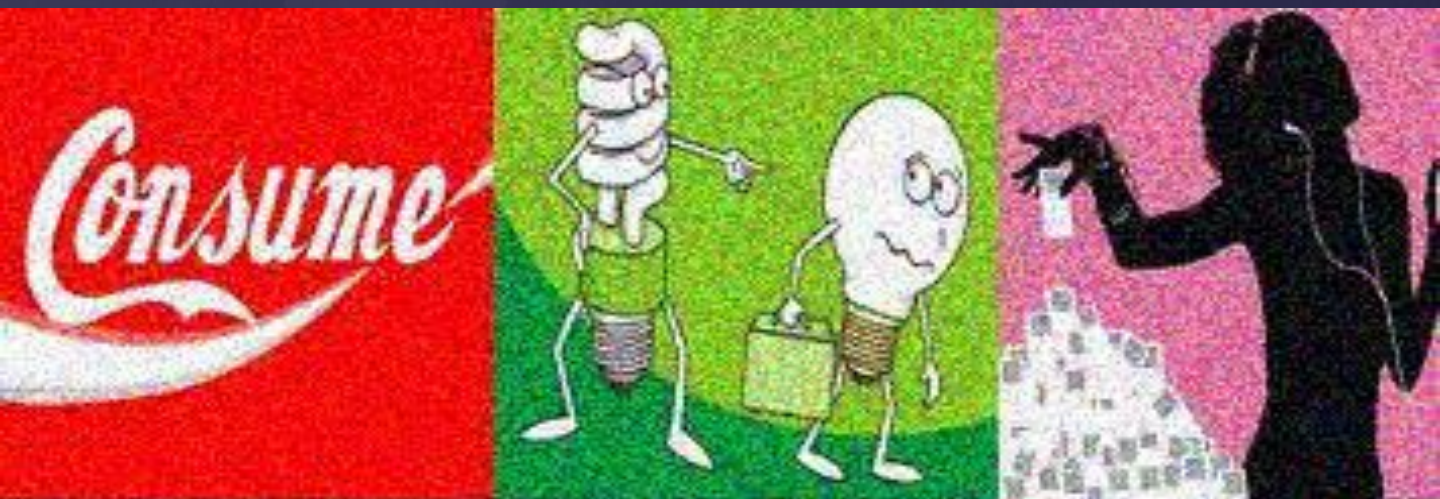


Master Thesis

Business Potential of Product Lifetime Extension and Modular Product Design Applications

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Business Potential of Product Lifetime Extension and Modular Product Design Applications

- Explorative Study -

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Abstract

Purpose – Short product lifetimes has led to formation of a so-called ‘throw-away society’ and excessive waste. One of the suggested possible solutions to this problem is the development of new business models based on product lifetime extension. This thesis examines product lifetime in the contexts of strategy formulation and potential of product lifetime extension from the perspective of producers. In addition, it explores how companies pursue modular product design in their strategies in relation to product lifetime extension.

Design/methodology/approach – The theoretical part summarizes the literature on product lifetime and obsolescence, strategy formulation and product lifetime extension. To design the research, the conceptual model derived from the literature review is deployed. Further, this thesis explores the expert views towards product lifetime extension stemming from different science fields. Moreover, the case study approach is used to investigate managerial practices and attitudes in three companies that produce durable goods.

Findings – The study shows that product lifetime extension driven business models should be based on services, not leading to increasingly excessive waste generation. However, such a service approach is more feasible in B2B context, while B2C companies struggle in finding revenue sources for product lifetime extension. By implementing modular design strategies, B2C companies seek for recurrent revenues and admit that upgradable design aimed at frequent transactions between company and consumers does not lead to more environmentally sustainable business models.

Practical implications – The thesis puts forward some recommendations for companies that explore the potential of product lifetime extension. Product lifetime extension should focus on re-thinking customer relationship management, shifting from transactions to relationships. Secondly, upgradable design through modular product lifetime extension represents a solution to deal with ‘psychological obsolescence’ problem. To strategize for product lifetime extension, the company should understand the on-going evolvments of consumer needs and develop upgrade roadmaps.

Originality/value – This thesis considers a broader view of product lifetime extension from a strategy perspective.

Keywords: Product lifetime, product lifetime extension, modular design, strategy, product obsolescence

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1 Introduction

In the past, consumer durables were viewed as investments designed to last as long as possible. Since the middle of the twentieth century, products with shorter lifetimes have become a trend in consumer durables industry mainly driven by the need for cost reductions in order to meet “price points,” convenience of disposability and fashion appeal (Cooper, 2010).

Since then, capitalistic economies have enjoyed prosperity based on ever-increasing production and consumption with marketing techniques deployed to create and evoke new consumer needs. This eventually led to the emergence of business models with frequent repurchase regarded as the main business goal. To increase product sales by triggering consumers to purchase more frequently, manufacturers have been producing products with shorter lifetimes (Mont, 2008).

Managerial design decisions, such as limited technical life design, design for limited repair, design aesthetics that lead to reduced satisfaction, design for fashion, or design for functional enhancement through adding or upgrading product features led excessive consumption of natural resources and aggravated effects on environment (Guiltinan, 2009). As environmental impact grows with the quantity of that product produced, used and disposed of (Scheer and Rubik, 2006), all industrial societies create a disproportionate (relative to a pollution share of the world’s pollution) amounts of waste. Waste and pollution is the price society pays for increasing levels of production and consumption. Every year 20-50 tons of e-waste are generated globally, which corresponds to over 5% of municipal solid waste worldwide (Greenpeace, 2011).

Some economists have argued that increased economic growth does not necessarily mean increased consumption of physical goods (Næss, 2006). Today more and more scholars propose to seek for new sustainable business models aimed at creating welfare without generating tremendous amounts of waste (Næss, 2006; Rosen, 2001; Eweje, 2011). Guiltinan (2009) suggests that environmental concerns about shorter product lifetimes and increasing levels of waste could be addressed at two levels: (1) the designers and engineers responsible for choosing specific components, materials, architectures, and interfaces, and (2) marketing and business strategists. Concludingly, a closer look should be taken into possible ways to change production and consumption patterns.

THESIS OBJECTIVES AND RESEARCH QUESTIONS

Given an observation that short product lifetimes have been commonly favoured across industries and thus embedded in their strategies and business models, this thesis aims to conceive the main factors that would reinforce companies pursue a contrary strategy – making products for longer use. By exploring company managers’ attitudes towards product lifetime extension in the contexts

of strategy formulation, product development and design processes, this thesis investigates the conditions under which companies are inclined to extend product lifetime. Thus, the following research question will be addressed:

Research question : What are the strategic drivers of product lifetime extension?

In this thesis, drivers for product lifetime extension are explored in terms of strategy formulation, competitive advantage realization, product development process and perception of product lifetime in product value propositions.

Even though extending product life is one of the hopeful approaches to reduce environmental issues, many products are thrown away not because of the end of their technical lifetime, but of psychological obsolescence of functions and performance. Nepal et. al (2007) therefore suggest that products should be designed products to be functionally upgradable. Thus, the second objective concerns the fact that product value lifetime, not physical lifetime, is what actually terminates the life of a product, and in order to extend product life products should be designed to have functional upgradability. Essentially, the second research part explores the applications of modular product design for product lifetime extension:

Research sub-question: What are modular product design applications for product lifetime extension?

CONTRIBUTION

This master thesis aims at contributing to the research field by a variety of aspects. First, it intends to investigate the main considerations in product lifetime extension strategic choice. A comprehensive literature review sheds some light on how firms make their strategic choices from the strategy formulation to product design phases. Moreover, factors that might influence the company's inclination to longer lasting products are examined. Furthermore, by using the case method approach, this study explores marketing-related practices pertaining to product lifetime extension. The further analysis sheds some light on modular product design applications for product lifetime extension in the marketing context. Modularity is a familiar concept to engineers; however, it has been poorly explored at marketing and strategic management levels. Case studies serve to understand how modular product design helps build value propositions and validate the strategic viability of this business approach. As a result, this thesis gives some guidelines for the implementation of product lifetime extension.

STRUCTURE

The thesis is organized as follows. The first part of this thesis consists of a literature review that integrates the theory on product lifetime and obsolescence, strategy formulation, product development and modular design.

Based on reviewed literature and propositions derived from it, the conceptual framework provides basis for the further research and analysis. The second part of the thesis represents analysis and discussion of conducted interviews with experts in the fields of sustainable development, eco-innovations, and industrial design. The expert views provide a general overview of the topic and help strengthen the discussion based on the literature review. The third part of this study presents three business cases. The case-study approach serves to identify current business considerations and address research questions. Finally, limitations, findings and managerial implications are discussed and propositions for future research are put forward.

2 Literature Review

This chapter focuses on relevant literature overview to provide a strong basis for the further research. The first part of this section defines product lifetime concept and its links to the terms of ‘durability’ and ‘quality’. Further, the thesis describes product obsolescence from both consumers’ and manufacturer’s standpoints and investigates the root-causes of planned obsolescence. To explain strategic drivers for product lifetime extension, the literature on strategy and competitive advantage is reviewed. As product lifetime an important product design element, the thesis summarizes literature on the existing links between product development process and product lifetime. The last part intends to look into modularity concept, its types and benefits that are achieved when modularity approach is embedded in the strategy.

2.1 Product Lifetime and Obsolescence

2.1.1 Product Development Process

Product can be conceptualized at different representation levels in forms of functions, components and their attributes as well as product structure and its modules. Such representations compound a holistic view of a product’s inherent features and their interconnections (Xing and Luong, 2009). Roozenburg and Eekels (1991) suggest the following product definition: ‘‘A product is a material system, which is made by people for its properties. Because of these properties it can fulfil one or more functions. By fulfilling functions a product satisfies needs, and this gives people the possibility to realize one or more values’’. The predominant marketing research paradigm is to consider a product as a bundle of well-defined attributes, with price included as an attribute (Srinivasan et al., 1997). While consumers buy products to satisfy their needs, for the manufacturer, a product must fulfil its business economic function, with ecological and societal functions included (such as, employment) (Roozenburg and Eekels, 1991).

Product design accounts for 70% of total product life cycle cost (Nevins and Whitney, 1989) and decisions about it determine most of the development cost. Studies indicate that the best time to extend a product’s lifetime is at the early conceptual design stage where changes are most cost-efficient, yet have the greatest impact over the entire life cycle. As stated by Wilhelm (2012), product design innovations are of great importance, since 90% of environmental impacts are determined at the design stage. Ulrich and Eppinger (1995) group product development activities into five categories, namely 1) concept development - generate the product concept for the product, 2) system-level design - alternative concepts are evaluated and major sub-systems are defined, 3) detailed design - the development of the specific design solutions, 4) testing and refinement, and 5)-production ramp-up (Gupta and Okudan, 2007). Roozenburg and Eekels (1995) suggest that

product development is an early stage of industrial innovation process that encompasses ‘‘all activities that precede the adoption of a new product in a market (or the implementation of a new production process), such as basic and applied research, design and development, market research, marketing planning, production, distribution, sales and after sales service’’.

Thus, product development requires integrated collaboration between people with different competences, such as marketing, design, and production. Such an integrated product development forms a framework for design activity, in which the sum of all product-oriented elements compounds the product policy. The most important strategic components compound the product-market strategy. Therefore, product policy focuses on components that help achieve the company’s goals (Hallstedt, 2008).

Design is therefore an iterative process determined through a set of actions (Roozenburg and Eekels, 1995). Srivasan et al. (1997) posit that a market-driven product development process proceeds through the stages of formulating business and marketing strategy, understanding customer desires within targeted markets, generating product concepts that meet those desires better than competitive products, and eventually choosing one or more for commercialization (Ulrich and Eppinger, 1995). The following performance issues that are required to assess in the decision making process include sales volume, market share, product quality, profitability (ROI) (Lopez, 2005). Product life cycle, the length of each stage, costs and revenues will depend upon actions taken by the marketing manager of the product under internal (production, finance, personnel) and external (competition, regulation, consumer preferences) constraints. On the other hand, the product life cycle is a fundamental variable that guides strategic marketing decisions. The marketing manager decides whether product will enter the market, at what level sales will be maintained, what forms the product will be proliferated to (Day, 1981).

2.1.2 Defining Product lifetime

According to Nes and Cramer (2008), product lifetime starts at the moment of acquisition by a consumer and ends when (1) the product is disposed, or (2) the product is replaced by another product that takes over the particular application. In the similar vein, Stahel (1986) and Cooper (2010) argue that, differently to product durability, product lifetime is largely determined by the user (involving consumer’s behaviour towards a product, or wider, socio-cultural influences), rather than by the manufacturer.

As a result, product’s physical durability defines the upper limit of product life. This limit, however, is rarely reached for most of consumer goods as consumers discard them earlier. Differentiating between the influence of producers and consumers on product life spans, OECD (1982) suggests three following concepts related to product lifetime: ‘technical life’, ‘economically

optimal life' and 'average life in use'. In addition, Cooper (2010) distinguishes between 'service life' and 'replacement life'. According to 'service life' concept, products are physical objects that provide service to the user, hence, product lifetime signifies the duration of time from product acquisition to the end of function. 'Replacement life' implies the period from initial sale to the point at which the owner purchases a replacement regardless of whether or not the original product still functions, and thus this concept is of particular relevance to retailers. The point at which product becomes more expensive to maintain than replace is its end of 'economic life' (Kostecki, 1998; Cooper, 2010). Product life is economically optimal if the discounted present value of the incremental benefits to society from having the product provide services in its primary use for this length of time is equal to the discounted present value of the full incremental social costs (OECD, 1982).

The concept of 'durability' takes a somewhat different perspective with a greater focus on manufacturers' activities. Durability is 'the ability of a product to perform its required function over a lengthy period under normal conditions of use *without excessive expenditure on maintenance and repair*' (Cooper, 2010). In the similar vein, Bradley and Guerrero (2008) describes the term 'durability' as 'the duration of time over which a product design remains viable, such that *all parts required by that design are readily available from original manufacturers*'. Durability implies notions of permanence and longevity and it is often seen as closely tied to reliability (measured in terms of the mean time between failures) and the total length of time the product functions without any problems arising that might compromise its use (Barbiroli, 2008). Chamberlin (1953) raised the question: 'What governs durability of different products, under different conditions of competition and monopoly; and how does the optimum defined by profit maximization compare with standards defined by the public interest or welfare criterion?'. Bullock (1986) examined durability choice under the presence of monopoly and found that firms that sell choose lower durability than those that rent goods. Swan (1972) showed that monopolists tend to produce goods with less durability than a competitive industry, pointing to the cost minimization issue: 'for any given flow of services the monopolist chooses to produce, profit maximization implies that these services will be produced as cheaply as possible'. However, Goering (1993) demonstrated that because of learning curve effect production costs tend to decrease, which has a direct positive effect on product durability. Goering et al. (1993) reformulated Bullock's model (1986) in terms of R&D choice rather than durability choice and explain that sales firms have higher levels of R&D than rental firms do. In addition, Goering (1993) demonstrates that existing levels of demand uncertainty in the market will influence product durability. On the other hand, Goering (2010) finds that stressing strategic use of CSR and producing goods that last, the monopolist signals of not having an intention to flood the market in the future, thus increasing the value of the present supply of goods. In addition, Goering (2010)

also shows that distribution channel's characteristics (when distribution channel consists of up-stream durable-goods manufacturer and down-stream retailer) will induce manufacturer to offer higher product durability. Therefore, only when the manufacturer can credibly commit to both potential buyers and retailers, profit-maximizing durability choice will be socially efficient.

On the other hand, durability relates to quality concept. Stone-Romero et al. (1997) bring up four general dimensions of quality, i.e., flawlesseness, durability, appearance, and distinctiveness. Longer lasting products tend to be always better serving consumers. Wicksell (1934) illustrates this idea: "a farmer has to choose between two ploughs, one that lasts ten years, and the other lasting eleven. If he chooses the more durable and dearer plough, he has the benefit of an extra year's service".

2.1.3 Product Obsolescence: Consumer's and Producer's Perspectives

Since the middle of the twentieth century, products with shorter lifetimes have become a trend in consumer durables industry mainly driven by the need for cost reductions in order to meet "price points," convenience of disposability, and fashion appeal. The immense rates of consumption led to disposing products at ever increasing rates and emergence of the so-called 'throwaway society' that is seen to flourish product obsolesce (Cooper, 2010).

Many widely used goods such as cars, electrical appliances and computers nowadays boast the utilization rate of only 10-20% of their potential. For instance, while the average useful lifespan of cars during the 1960s and 1970s was 15–16 years, by the 1990s it had dropped dramatically to 5–6 years (Barbiroli, 2006). Greenpeace study (2011) has reported that 90% of all products are thrown away within 6 weeks of purchase, and many products that used to be designed to repair are no longer repairable. In addition, a study conducted by P&G revealed that life cycles of consumer products declined by 50% between 1992 and 2002 (cited by Niinimaki and Hassi, 2011).

BOX 1.

In many developed countries, a car has become a fashion product, rather than a durable good. In Japan, cars older than 5 or 7 years are mostly exported. According to Nieuwenhuis (2008), this is a result of remarkably high numbers of new cars because of high consumer spending power (which leads to low residual value of older cars) in combination with high labour cost, required for a vehicle repair. Similar trends have been noted in the usage patterns of washing machines, dishwashers, gas cookers, personal computers and other consumer durables., 2011; Wilhelm, 2012).

Consumers demand relentless growth and flexibility, whilst "all the material possessions remain frozen in time", incapable to sustain a durable relationship with users (Chapman, 2005). Obsolescence can be intuitively understood as the value loss of a good because of the development of better ways to provide the same function, or because the function itself is no longer desirable, or needed (Saleh, 2008). Obsolescence occurs when products become "out of use" or "out of date", or other words, when a product is no longer "wanted," even though it might be in working condition,

and fulfilling its intended function for which it was designed (Rai and Terpenney, 2008). Lemer (1996) suggests that: “an obsolete item is not necessarily broken, worn-out, or otherwise dysfunctional, although these conditions may underscore its obsolescence. Rather, the item simply does not measure up to current needs or expectations”.

The concept of planned obsolescence summarizes typical elements of the classical market economy, such as maximization of industrial outputs, economies of scale, average quality and manufacturing of short-lived products, the cycle of depreciation and fast replacement of goods and the consequent ever-growing demand of consumers for new products and services (Mont, 2008). Bernard London first presented the term ‘planned obsolescence’ in 1932, suggesting that government-imposed maximum life spans of the products could become a solution to recession and unemployment. Bulow (1986) further defined planned obsolescence as “the production of goods with uneconomically short useful lives so that customers will have to make repeat purchases”. The term ‘planned obsolescence’ is well defined Brooks Steven’s (an American industrial designer): “Instilling a buyer the desire to own something a little newer, a little better, a little sooner than is necessary”(Cooper, 2010). Goering et al. (1993) view planned obsolescence as closely related to the firms R&D policy and suggest that planned obsolescence is define by the amount of resources a firm is willing to spend on R&D to make an existing version of a product obsolete.

Packard (1963) and Cooper (2010) distinguish following types of planned obsolescence:

- *Functional obsolescence*, or obsolescence of technology, occurs when products become obsolete due to technological advancements; 2) obsolescence of quality (products are designed for short life);
- *Psychological obsolescence*, or obsolescence of desire, is a result of advertising-based strategy to convince a consumer that a certain product is old, out-of-date, or unfashionable.
- *Economic obsolescence* is a consequence of product usage becoming economically inefficient, especially when repair and maintenance cost more than a product replacement) (Cooper, 2010).

Planned obsolescence is a controversial issue; while some scholars perceive it negatively because of ever-increasing amounts of waste and environmental impact, the other camp argues that planned obsolescence may drive technological progress and fast innovation fostering economic growth (London, 1932; Mont, 2008).

Packard (1963) exemplifies the manufacturer’s choice for planned obsolescence: “ If you are producer and most families already own your product, you are left with three possibilities for making further sales. You sell replacements; you sell more than one item to each family; or you dream up a new and improved product - or one that at least seems new or improved – that will

enchant families that already own an ‘old’ model of your product.’’ Guiltinan (2009) shows that firms aim to increase the rate of replacement through obsolescence as it enables to stimulate revenues, reduce competition, and by making used goods less competitive, increase prices for the replacement products. Bulow (1986) further demonstrates that 'planned obsolescence' (reduced durability) results from firms' incapability to know future prices and demand in terms of on-going product innovations, business cycles and other external factors. Marketing managers and strategic planners may favour planned obsolescence with a belief that multiple repeat purchases will serve to retain customers (Guiltinan, 2009). Firms therefore will facilitate migration of their customers to their own version of the next technological advance rather than risk losing them. Guiltinan (2009) illustrates this idea with an example of mobile phone industry in which free phone upgrades are offered every 2 years as incentives to consumers to renew cellular service contracts.

On the other hand, Rosen (1995) shows that the mature market often develops into different segments as consumers become more sophisticated. Manufacturers desperately seek to develop new products for these particular segments, incurring high fixed costs. As the firm's capacity is higher than demand, the firm will be working under optimum capacity. Therefore, it will attempt to squeeze out even more and reduce costs, which often undermines the product's durability (Rosen, 1995).

2.2 Strategizing for Product Lifetime Extension

2.2.1 Strategy and Business Model

Strategy generally compounds the goal formulation and achievement of results within the system (including sub-systems) in which it is applied (Smeels, 2003). Strategic goals are formulated in order to give a motivation for future-oriented activities and an orientation in which fields (markets, technologies, competences etc) opportunities should be explored and exploited, and also to align on various activities (Porter, 1980). Strategy then is materialized as the chosen feasible option (Macmillan and Tampoe, 2001). Thus, strategic choice refers to the process of selecting a single option for implementation based on criteria deriving from intent and assessment.

Business unit strategic managers design organization as systems for sustainable value creation and distribution by deciding what resources a firm will use to carry out its business concept, determine organization design to coordinate resources, as well as required controls and incentives to monitor and motivate the resources (Sanchez, 2006). The company's strategies are highly dependent on its environment that, according to Porter, comprises five forces: 1) competition among competitors; 2) entrance of new producers; 3) substitute products; 4) bargaining power of buyers; 5) bargaining power of suppliers (cited by Smeels 2003). In the rational mode of strategy formulation, strategic managers determine strategy based on the environment analysis, strengths and weaknesses of the

organization and etc (Bowman and Kakabadse, 2007; Macmillan and Tampoe, 2001). Rosen (1995) therefore suggests the following criteria as a filter in strategic choice making:

1. How well does it contribute to meeting corporate objectives?
1. Is the project consistent with the organization's policies/culture?
2. Does the strategy overcome strategic weaknesses and threats?
3. What would be the consequences of strategy failing, or of its only partial success?
4. Is the strategy based on sustainable competitive advantage?
5. Is the strategy viable with regards to resources required for its implementation?
6. How will the stakeholders' react?
7. What are potential rewards?

At the same time, Reed (1987) finds that product decisions largely rely on managerial experience. Aurich et al. (2006) results show that most managers still predominantly apply intuitive approaches in industrial practice.

According to Wikstrom et.al (2009), business models describe or prescribe more specifically how resources are combined and transformed in order to generate value for customers and other stakeholders, and how a value generating company will be rewarded by its exchange partners that receive value from it. Business models have been considered to concern firm-level descriptions of business. Business models could be grouped into two main categories — novelty centred and efficiency-centred business models. A company's business model is a source of competitive advantage; therefore, a business model can be integrated into or separate from the company's selected product market strategy. As stated above, business models build upon the theoretical traditions of within the field of business strategy. The ultimate goal is to combine the different views on strategy and the relationship of a firm's strategy and performance. Whereas strategy emphasizes competition, business models build more on the creation of value for customers. In that respect, business models are typically developed from a more narrow perspective than a strategy. Still, business models have to be properly aligned with the specific strategy, structures, culture, and industrial logics of the focal firm.

2.2.2 Competitive Advantage

To sustain themselves in highly competitive marketplaces companies need to possess competitive advantages. Competitive advantages are most commonly distinguished as either (1) cost advantage or price advantage and (2) differentiation advantage or benefits advantage (Porter, 1980). Prajogo (2007) also defines the reaction advantage that enables firms to quickly respond to changing customer needs. Accordingly, the pressure of time-based competition and shortening product lifecycles require companies to recognize the need for effective and efficient the new product

development process. NPD process dynamics takes a strategic role for gaining a competitive advantage (Caridi et. al., 2008).

Rosen (1995) further emphasizes the importance of long-term thinking with regards to competitive advantage which should be “the one that the firm can maintain, which will continue to be valued for some time, and, most importantly, will be difficult for competitors to adopt or leap frog – thus allowing the advantage to be lost before a satisfactory return has been achieved”. Rosen (1995) further suggests that although the competitive advantage may reside in a wide range of features of the product or service, however, these features must be of value in the marketplace. According to Roozenburg and Eekels (1995), product planning should include a constant review of the company’s product policy (goals and strategies) and search for novel or modified product or business ideas. Grant (1991) posits a model of Resources-Capabilities-Competitive advantage-Strategy-Resources Design-Related creative product developments in which product design is an important source of competitive advantage. As design and manufacturing processes are closely interrelated, the sources of competitive advantage could be exploited through purposeful strategizing (Ma, 1999).

Product Quality as Competitive Advantage

Some scholars hold a strong view that quality must be adopted as a strategic goal in organizations (Prajogo, 2007). Makinen (2005) distinguishes two types of quality advantages: (1) advantages based on concrete quality, i.e., technical quality and visual features of products, and (2) advantages based on the perceived quality image of products.

Quality in general is regarded as a rather relative concept. Perceived quality is what influences consumers’ buying decisions. Moreover, it is noted that the way manufacturers and consumers perceive the quality of a product might vary significantly. Manufacturers’ assess quality according to the degree product conforms with engineering standards, while the consumer’s perception of product quality may be its shape, elegance, or size. Also, perceived quality criteria will differ depending on a product (Nepal et al., 2006).

Concrete quality categories on which a company could compete include principle and function, order and complexity, form and size, manufacture and construction, materials, colour and surface, signs and ornamentation as well as style, fashion, and “look”. Branca and Lopes (2011) note that quality is central for customer value in contributing to customer loyalty, profitability and differentiation. Similarly, Philips et al. (1983) suggest that quality approach most often characterizes a differentiation strategy.

The decision the company needs to take is which level of quality to offer (Philips et al., 1983). Branca and Lopes (2007) uttered that the important issue, from the current management

perspective, is to analyse and model quality economics. They posit that the decision on the quality level will depend on the maximum profit, rather than on cost minimization approach. Philips et. al. (1983) find that incompatibility between high quality products and low cost occurs because quality requires more costly materials and processes that cannot be supported under the cost leadership regime. At the same time, the link between high quality and low cost is not totally negated, rather it is suggested that high quality products will eventually bring lower costs after the attainment of benefits on economies of scale via higher market share. In addition, according to Deming (1982), organizations enhance their competitiveness by improving quality which would decrease costs through eliminating scrap and rework (failure costs).

Product designer's objective is to design products of high quality that offer durability, ease of operation, aesthetic appeal and features that are desirable. Quality is inherent in the product design rather than being an afterthought (Hallstedt, 2008). However, designers work under certain pricing constraints that allow products to be sold at certain price points. Thus, designs are tailored to meet the required level of quality for every price point at which company chooses to compete. Accordingly, product design strategy consists of assessing the price points for consumers the company has decided to target and then designing high-quality products that can be produce in terms of pricing constraints (Lopez, 2005).

2.2.5 Environmental management as a competitive advantage

Recent literature on sustainability has shown that sustainability strategies can be a source of competitive advantage with regards to product image, sales, market share, and new market opportunities (Mariadoss et. al., 2011). Effective environmental management confers a competitive advantage in four different ways:

- Cost savings
- Product differentiation
- Technological innovation
- Company reputation
- Strategic planning (Lawrence et al., 2004).

The company geared towards responsible production and sustainability needs to position itself in relation to sustainability agenda based on its preparedness to integrate environmental sustainability into business management and product development (Norris, 2004).

Business sustainability involves the firm's capability of sustaining and expanding economic growth, shareholder value, corporate reputation, customer relationships, and the quality of products and services (Eweje, 2011). Moreover, nowadays the supplies of various natural resources are defined by high price volatility, thus representing increasing costs and risks for manufacturers'.

Mohr et al. (2012) provide evidence that firms are more and more inclined to increase their resource productivity as a result of increasing manufacturing variable costs due to resource scarcity. Accordingly, they find that in the period 2000 – 2010 the variable costs of one Western steel company augmented from 50 to 70 per cent, and, for a manufacturer of LCD televisions, energy accounts for 45 per cent of the total cost of production. It is therefore suggested that companies need to prioritize four areas regarding resource productivity: production, product design, value recovery, and supply-circle management.

2.2.3 Product Lifetime Extension

Attempts to lengthen product life spans, whether by improving intrinsic durability, influencing user behaviour or promoting socio-cultural change, are defined as product life extension (Cooper, 2010; OECD, 1982; Heiskanen, 1996). Product lifetime extension is possible taking a dual perspective and requires strategic management preparedness; longer lasting product feasibility is not only about changing the product characteristics, but it is consumer behaviour that needs to be changed through the product design (Nes and Cramer, 2005). Product lifetime extension refers to the economy in which “do not repair what is not broken, do not remanufacture something that can be repaired, do not recycle product that can be remanufactured” (Stahel, 2006).

According to Niinimäki and Hassi (2011), products for long-term use should be of high quality. They suggest that classic and timeless design, good fit and high quality could offer opportunities for longer product utilization. In addition, Chapman (2005) proposes a framework of strategies and approaches for extending the product-user relationship, and outlines the importance of product characteristics, such as high quality, aging with dignity’ and (or) retaining aesthetic appeal, overall aesthetics. Moreover, Barbiroli (2008) proposes a definition of ‘long-term quality’ (or enduring quality over long periods). It is defined as “the aptitude of goods to carry out their functions in effective and stable manner for a very long time, without downgrading, therefore having great capacity to keep unaltered the original properties during all life-span, also by easily and cheaply reinstating the original quality level in case of downgrading.”

Product lifetime extension is one of the eco-innovations forms. Thus, factors that influence the company’s strategic intent for eco-innovation will be related to product lifetime extension to some extent. Montalvo et. al. (2011) show main drivers for eco-innovations and foresee that community, regulatory and market pressures will increasingly push companies towards eco-innovations. In addition, the company capabilities (organizational learning, technological capabilities, strategic alliances, networks of collaboration) will facilitate the developments of eco-innovations. It is also forecasted that economic risk and environmental risk will play a less important role. This implies that eco-innovation will become more strategically embedded into companies, rather than pursued to address the aforementioned risks.

The OECD report (1982) proposes that limitations the design team has to face when developing a new product are threefold:

- technological constraints that arise from specified performance criteria, available materials, limits of the current production technology;
- market and economic constraints that include tastes and consumer preferences, costs and competitive conditions;
- other constraints (mainly revolving around legal requirements).

Changes in product lifetime may infringe existing supply and demand relationships. Whether they occur ultimately depends on expected profits and, therefore, on the degree of competition among sellers. In competitive markets the firm is constrained by the actions of other producers. Being slow to introduce an innovation may force a firm to leave the industry as consumers turn to the improved products of competitors (Avinger, 1981). The overall perception of businesses is that if products have too long life span, there may not be enough incentives to invest in the development of a new technology and as a result the economic growth may stagnate. Thus, producers' choice concerning how much durability to build initially into the product goes hand in hand with the decision on how often new models of products should be introduced to the market (Mont, 2008).

The level of compatibility between old and new models also poses the question of product reparability and availability of spare parts. Some products are becoming impossible to repair because businesses do not find economic rationale in repairs and in spare parts, while for some products, such as cars, after-sales support and repairs may bring higher profits than selling new cars (Mont, 2008). OECD (1982) report states that the ease of maintenance and presence of second-hand markets will have a direct influence on product's durability. The ease of maintenance of a product could be measured in terms of the time needed to perform the necessary maintenance operations. It is obviously closely linked to the cost of maintenance operations, which in turn needs to be evaluated in terms of two separate factors: the cost of the part that may have to be replaced, and the respective cost of labour (Barbiroli, 2008).

Barbiroli (2008) suggests that firms need to determine which products are best suited for product lifetime extension. It is therefore proposed that besides any individual analyses or considerations for each product activity, the main criteria for the design and manufacturing of new products capable of satisfying the overall requirements of sustainable development are timeless design, long life guarantee, robust, reliable wear-resistant design, design for easy repair and maintenance, high opportunity for repeated use and etc. (see Barbiroli, 2008). One consideration raised is that the design criteria are not always fully specified, especially for radically new products.

Benefits of product lifetime extension

From the manufacturer's perspective, there are three main implications associated with the benefits of an increased system design lifetime. First, systems with long design lifetimes offer manufacturers possibility to generate additional revenues and higher profits from service contracts. Notably, there is a limited potential for additional revenues from services with a short design lifetime system. The second observation is that an increased design lifetime acts as a signal of a system's 'reliability as a competitive advantage'. The reliability will be of increasingly more value for customers as products lifetime increases. Therefore, manufacturers with core competencies to produce highly reliable systems have some incentives to increase their systems design lifetime and augment the quality gap compared with manufacturers of less reliable systems. Manufacturers of less reliable systems who want to engage in 'design lifetime extension will face the risk if they do not have a track record in designing distinctively reliable systems'. Thus, the third implication in choosing an extended durability is that manufacturers facing threats of future entry may choose increased durability as a barrier to entry, or a strategy to deter entry of potential competitors (Saleh, 2008).

From the environmental standpoint, the longer and more intensively a product is used, the less new production of products and waste the same service entails. Therefore, the aims to extend product lifetime are seen as environmental contributions. For example, the Morris Minor Centre, a firm based in Bath, England, received a National Green Apple Award for its environmental impact, helping the owners of historical cars to maintain their use. This clearly indicates that car durability is an officially recognized environmental issue by the UK government (Nieuwenhuis, 2008).

2.2.4 Modular Product Design: Benefits and Applications

As some consumers discard products before the end of physical lifetime, it is generally agreed that products with longer life should have functional upgradability besides reliability. In industrial markets, there is an emerging trend of sequentially improving products designed to be upgraded in a modular fashion (Krishnan, 2008). Upgradeability can be considered to the degree of improvement in a product's properties/performances achieved without any significant change being made in its original structure. The design and production of a modular structure would enable making improvements in performance (Barbiroli, 2008). Upgrade design has not been broadly practised. This issue mainly comes from two reasons: one is future uncertainty, and the other is current business strategy. These issues require development of business strategies, including upgrade planning, for upgrade design as an important future work. At least there should be some product categories suitable for upgrade design. Conditions of such suitable products include the following:

- Products with short value lifetimes;

- Products of which functions and their performance in some generations specified with some certainty;
- Preferably, the company can control trends of products according to their upgrade plans.

As modular design allows achieving upgradability, this section attempts to further explain modular design and examine how modular product design enables upgradable products (Arnheiter and Harren, 2005).

Modular product could be defined as ‘a function-oriented design that can be integrated into different systems for the same functional purpose without (or with minor) modifications’ (Gershenson et. al, 2003). Similarly, it is emphasized that every component in a modular product is supposed to support one or more function.

Today, a broad range of industries use modularity, including vehicle manufacturing, personal computers, machine tools, bicycles and etc. Modules could be distinguished to be either hard or soft. At the same time, many products consist of a mixture of soft and hard modules. Furthermore, as modularity can be applied to business in different areas, Arnheiter and Harren (2005) suggest four types of modularity:

(1) *manufacturing modularity* is a technique to produce fully finished products by using only a handful of pre-manufactured subassemblies (the “modules”) and is commonly practiced by many industries. It facilitates mass customization by quickly producing alternative configurations of products and allows the use of the same modules on several product derivatives.

(2) *product use modularity* implies the use of modules to facilitate product customization by the user. Examples of product-use modules include computer drives, colored faceplates for cell phones, and aftermarket bicycle components. Installed modules become part of the larger system, and durability, ergonomics, and appearance of the modules are often important design considerations.

(3) *limited life modularity* refers to a situation when parts of a product need to be replaced during the product lifetime (e.g. a car battery). It thus implies the use of easily replaceable disposable modules having distinct characteristics. To some extent, limited life modules can also be product-use modules. A simple example of a module that can be both a limited life module as well as a product-use module is the incandescent light bulb. The end customer might decide to replace a worn out 60W bulb with a brighter 100W bulb or install a less expensive bulb. Limited life modules are extremely sensitive to cost because they must be replaced numerous times during the life cycle of the product. High profits from spare part sales often allow manufacturers to sell end items at prices that are below product cost. In order to make products environmentally acceptable, designers have to give limited life modules careful attention. Because of the short lifespan and high

turnover of limited life components, recycling and the responsible use of natural resources have to be considered during product development.

(4) *data access modularity* provide data storage, separately from the system in which they are used is widely used and include CDs, DVDs, storage cards, USB memory sticks, as well as less standardized forms.

Benefits of modularity

Assemblers can reduce cost of production and increase productivity by reducing direct labor, capital equipment requirements, and engineering design costs. Another key advantage is that modules can be assembled in a variety of configurations, allowing firms to quickly produce a wide range of products. Because of this advantage, modularity is seen as one of the keys to economical mass customization. The flexibility to leverage new products by configuring new combinations of components within a modular architecture makes possible a number of new product strategy initiatives. Modular architectures can be used to explore customer preferences for different combinations of functions, features and performance levels through real-time market research.

BOX 1. Modularity and user based innovation

Sony, a skilled user of modular architectures, leverages many variations of its products to discover “in real time” the most desired models in each of its markets. In developing the US market for its Walkman products, Sony introduced more than 160 product models in a ten-year period to discover the combinations of functions, features, performance levels, and price most preferred by US consumers. This strategy has helped Sony maintain a dominant global market share in Walkman-type products.

Modular product variations may be leveraged to saturate the most profitable regions of product space and leave no uncontested product space to invite entry by competitors. To maintain market leadership, interfaces in modular architecture may be specified to accommodate new or improved components expected to become available during the commercial lifetime of the architecture. Improved products can then be configured and brought to market as soon as improved components are developed. Suppliers might be rewarded with long term contracts, and even without such contracts, long lasting partnerships will result from market consolidation and raise barriers of entry for other suppliers (Arnheiter and Harren, 2005). Furthermore, by modular design companies can increase product lead time to the market (Foss, 2008).

Ramachandran and Krishnan (2008) show that modular upgradability can reduce the need for slowing the pace of innovation or forgoing upgrade pricing. This additional flexibility in pricing and timing makes the modular approach preferable to an integrated architecture. Lastly, modular design is seen as a means to enable recyclability of the product as it allows grouping product into easily detachable modules (Gupta and Okudan, 2007).

One of the primary risks of modularity is that it can lower barriers to entry for competitors. Secondly, component suppliers deciding to start subassembly production often must commit additional resources and capital in order to develop the required capabilities.

- A potential drawback for suppliers is that when an existing system is broken into modules, like in the case of the personal computer, modules can quickly become commodities. When this happens, suppliers may experience volatile profitability due to intense pressure to decrease prices (e.g. cirrus logic and western digital come to mind).

3 Thesis Research

The further research revolves around two studies: 1) expert interviews – to complement findings from the theory; 2) case study research – to explore research propositions conveyed from the literature and expert interviews.

3.1 Conceptual Model

In this thesis, the conceptual model (Figure 1) represents a set of related concepts summarized by the literature review, their properties and associated relationships to provide guidance for the further research and interview questions design.

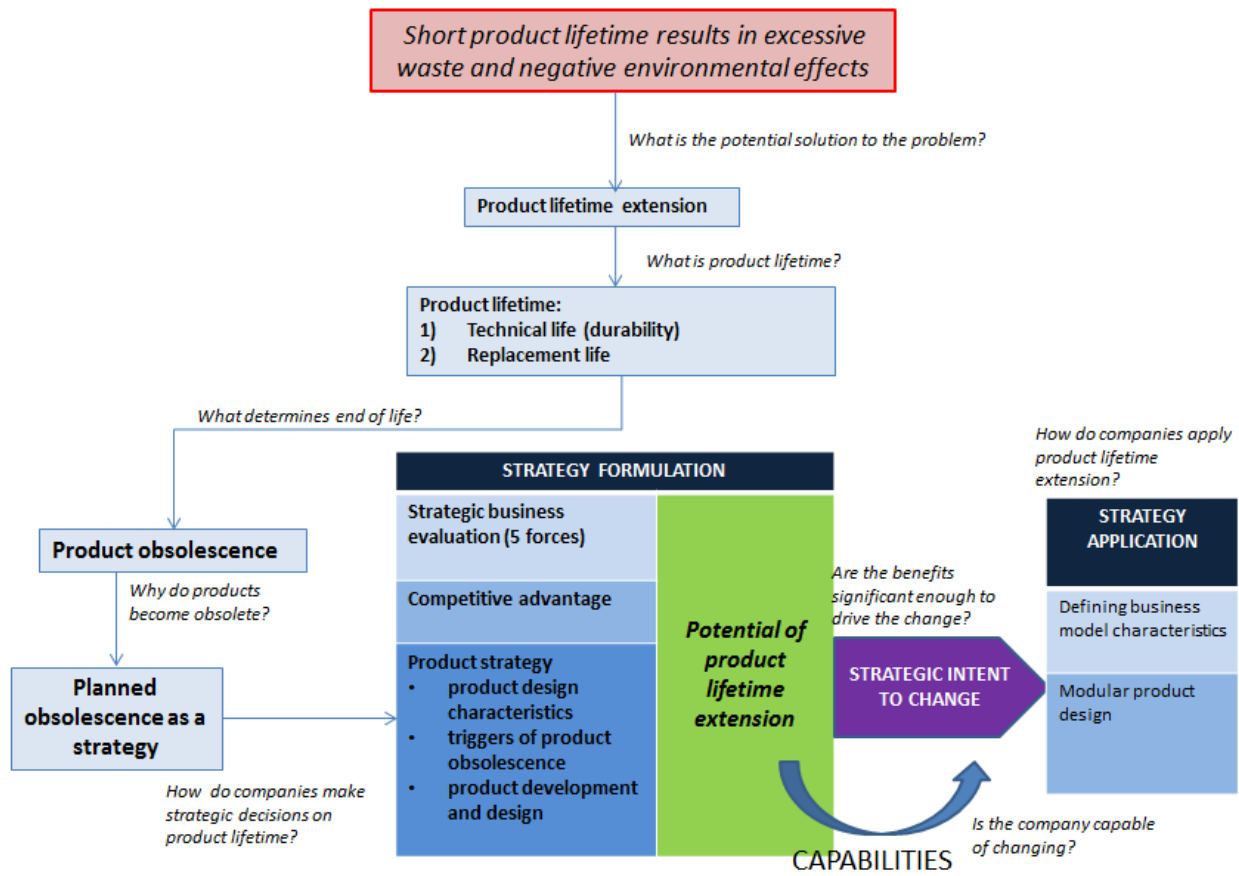


Figure 1: Conceptual model

The conceptual model has been developed based on the below study propositions derived from the literature review. This model largely replicates the model of Resources-Capabilities-Competitive advantage-Strategy-Resources Design-Related creative product developments proposed by Grant (1991).

Proposition 1: Product lifetime is a multifaceted concept and a variable in the company’s strategies that should be considered from consumers and producers’ standpoints.

Proposition 2: Strategic assessment of product lifetime extension includes monetary and non-monetary costs and benefits in terms of the company's competitive environment (5 Porter's forces) and capabilities.

Proposition 3: Managers' perception of consumer needs, market environment, competition, and predicted future trends will influence managers' strategic choices. Feasibility of product lifetime extension depends upon a number of factors, such as existing business model, firm's structure and management capabilities, product characteristics, product design and manufacturing, after-sales service capabilities.

Proposition 4: Theoretical discussion shows that competitive advantage through product lifetime extension can be attained by enhanced product differentiation that includes product quality and environmental management dimensions.

Proposition 4a: Longer lasting product design links to environmental sustainability approach that addresses one of the major environmental concerns – excessive volume of waste. Growing environmental concerns might drive product lifetime extension;

Proposition 4b: Longer product lifetime maximizes the utilization rates of products. Resource scarcity threat might induce companies to plan their resources more cautiously, thus create new business models for product lifetime extension.

Proposition 5: In order to pursue a new strategy (product lifetime extension), the company that has assessed the benefits of product lifetime extension should have a strategic intent to change. Top-down communication, internal alignment is needed to apply product lifetime extension in business models

Product lifetime is a grounding concept in this thesis. Short product lifetime causes excessive amounts of waste, whilst longer product lifetime (product lifetime extension) presents a solution to these environmental problems. Therefore, it is critical to understand what defines product lifetime. According to the literature, two main concepts of product lifetime should be discerned – technical life (durability) and replacement life. Further, the thesis identifies that obsolescence determines the actual end of product life. The literature analysis shows that product obsolescence can be a result of planned obsolescence (which underpins functional, psychological and economical types of obsolescence). It is noted that planned obsolescence by its definition is a business strategy. Therefore, in order to conceive the drivers for product lifetime extension, the research should further focus on understanding strategy formulation across its main dimensions (as derived from the literature review): strategic business assessment, competitive advantage choice, product development and design. Finally, after assessing benefits and possible difficulties for product

lifetime extension, the company should be inclined to transform its business model (e.g., shift towards modular product design).

3.2 Methodology

As mentioned before, the further research is comprised of two parts: the first set of qualitative data presents experts views, whilst the second study compounds case studies of the three selected companies.

Given that product development process requires combining expertise from different disciplines, the interviews with experts are conducted to gain multidisciplinary insights and cross-industrial observations. The further case studies allow obtaining specific examples of managerial practices related to product lifetime extension.

The study deploys the conceptual model derived from the literature review to design the specific research questions that guide study research. Next, using the case research method, the thesis examines three companies to identify the potential of product lifetime extension, and its practices within these certain companies/industries. Both case studies and expert interviews are based on the semi-structured interview research approach that allows investigating what the respondents think is important about the topic, their beliefs and experiences. Open conversation form enables to obtain insights that are out of the scope of the reviewed literature.

Expert Views: Methodology

Selected experts represent diverse fields of science: industrial design, sustainability and eco-innovation, sustainable business development. The objectives of this study are: 1) to obtain more contextual knowledge; 2) attain additional insights that might have not been captured in the theoretical part of this thesis.

At the first stage, industrial design experts were interviewed, aiming: 1) to investigate the decision making with regards to product design; 2) trends in design for durability and product lifetime extension; 3) discuss important product characteristics that might impose constraints on product lifetime extension strategies. Furthermore, experts in eco-innovation and sustainable development have been inquired: 1) to gain some insights into how new product developments reinforce eco-innovative business approach; 2) possible product lifetime extension drivers in the context of environmental sustainability

Case studies: Methodology

Three companies were selected for the case study research based upon the following criteria: 1) manufacturers' of durable goods; 2) willing to participate in the research. The representative cases include: InterfaceFLOR, Auping and Philips (see appendix for a detailed more summary of each

company). Notably, Philips case is twofold: the first part presents the design project in Philips Interactive Design research centre in Eindhoven, while the second part focuses on Philips Consumer Lifestyle – Personal Care – Male Grooming – Shaving case. Case study data consists of corporate company communications and semi-structured interviews (around 1 hour) with company representatives.

A case study research method has been chosen because of several following considerations. First of all, the literature analysis has shown that product lifetime is often influenced by both external and internal factors underlying boundaries being unclear. Therefore, in order to understand the existing links within a specific business context, a holistic study approach is required. Yin (1984) defines the case study research method “as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used”, suggesting a case study approach to be a suitable method for the thesis research. The data collected through the case study method is richer and more in-depth that compared to other methods (e.g., experiments). Moreover, case study method is most commonly used when large samples of similar participants are unavailable, which is the case in this thesis. At the same time, a collective case study approach deployed in this thesis allows comparisons between different cases to take place, thus enlarging an explanatory capacity. Such multiple-case design enhances the robustness of the analysis and supports the previous results (Zainal, 2007).

At the same time, some shortcomings of the case study research should be taken into account when drawing conclusions. The most frequent objection to the use of case studies is the issue of representativeness. Notably, the data collected through case studies cannot be generalized to the wider populations, which often makes the results inapplicable to the further development of a certain science field. Thus, it is suggested that to avoid this criticism case studies could be used to test theoretical propositions based on the literature review. A clear conceptual framework is needed to construct the case study report which is easy to read and follows the predictable structure. In addition, given the traditional concern with case studies that they provide little basis for scientific generalisation, Yin (1984) suggests that case studies could be generaliseable to theoretical propositions and not to populations. Another drawback is that case studies are rather subjective as they rely on a person who collects the data. Finally, as case studies mainly focus on a certain actor with specific complexities that characterize it, it is very difficult to draw definite cause/effect from case studies.

To avoid possible shortcomings and structure case studies in a comparable manner, the following case study framework has been constructed (Table 1).

Table 1: Case study framework

| DOMAIN | GENERAL QUESTION | OPERATIONAL QUESTION |
|---|--|--|
| Product lifetime and product obsolescence | <p>How important is durability in the company's value propositions?</p> <p>What are your target consumers' attitudes in terms of product lifetime and product lifetime extension?</p> | <p>Is product durability a product differentiator?</p> <p>What are main reasons for discarding a product?</p> <p>Do your customer tastes evolve fast? How do you consider 'psychological obsolescence' problem?</p> <p>Products with extended product lifetime usage: How likely your consumer is likely to accept them?</p> |
| Strategy and competitive advantage | <p>How does your company realize its competitive advantage?</p> <p>Describe what makes your company superior compared to the competition.</p> <p>How does the company approach environmental sustainability?</p> | <p>What is the market the company operates? B2B and B2C?</p> <p>Do you see product lifetime as an important factor to your industry?</p> <p>How durable are the competitor's products?</p> <p>Do you see lifetime as your product differentiator?</p> <p>Resource scarcity is a threat for multiple industries. Discuss its relevance to your company.</p> <p>Do you perceive product lifetime extension as a way to mitigate the effects of resource scarcity (e.g. material price vulnerabilities, limited access to resources in the future)?</p> |

| | | |
|---|--|---|
| <p>Product lifetime extension and business models</p> | <p>How can making products that last generate benefits to your business?</p> <p>How does the company perceive the opportunity given by PLE?</p> <p>What are the applications of PLE business models?</p> | <p>How does the company perceive the opportunity given by PLE?</p> <p>Explain pros and cons.</p> <p>What are the benefits of PLE, discuss the further dimensions:</p> <ul style="list-style-type: none"> - Competitive edge - Company operations(efficiency) - Environmental sustainability <p>How does the company design its products for PLE?</p> |
|---|--|---|

All data is further summarized under the individual case study report. Each case essentially represents a company activities and strategy from a perspective of product lifetime extension. During the case study interviews, respondents described the company, its products and business model. Interviewees were further asked to define how the company sees the opportunities for product lifetime extension in terms of costs/benefits and competitive environment. Thirdly, respondents characterised the company’s approach to environmental sustainability. The cases were examined according to:

- Company’s overall and product strategies;
- Drivers for product lifetime extension (Benefits)
- Applications of environmental sustainability and product lifetime extension
- Possible challenges and barriers to product lifetime extension

The data is analysed under the study propositions in conceptual model and later related back to the theory from which they were drawn. Finally, conclusions from an interpretation of the data as compared to the theory obtained in the literature review.

3.3 Expert Views

3.3.1 Results

Product characteristics

According to industrial designers, the feasibility and implementation of product lifetime extension will largely vary depending on product characteristics (technical, physical, etc.). Because of these differences, companies will develop diverse business models. On the other hand, product usage patterns (e.g., purpose, fashion evolvments) will determine the utility of longer product lifetime.

Before designing products, companies also need to evaluate how certain innovation will diffuse the market; it is where consumers' acceptance will play an important role in product decision making.

Durability as product differentiator

Product durability could possibly help differentiate products. However, unique selling propositions rarely use product durability as product differentiator. Miele, a well-known washing machine manufacturer, represents a good example of product durability communication. Its advertising message states: "Statistically, people change their partner before they change their Miele washing machine". The main consideration for a company that wants to embed product durability in its key marketing message is the extent to which consumers would value product durability.

Changing consumer preferences

The number of environmentally conscious consumers is growing. Although product 'green' is not a primary product characteristic to be considered in the product purchasing process, consumers tend to prefer products that are sustainable to those that are not.

Economic recession reinforces consumers to consider purchasing decisions more cautiously. Consumers are increasingly recognizing that throwaway consumption does not lead to the accumulation of wealth. It is observed that more and more people are favouring second-hand markets. Thus, societal movements with a goal to repair products and prevent throwaway consumption are emerging. For example, so-called voluntary simplifiers (people who choose to limit expenditures on consumer goods to promote non-materialistic sources of satisfaction and meaning) take control over technology being able to repair it by themselves. In addition, the dynamic lifestyles imply that consumers do not want products (especially, home appliances) that break down and need to be changed frequently.

In general, designing for product lifetime extension implies building sustainable business models. Marketing which, by definition, revolves around creating and selling the value is redefined with a greater focus on the value created. Thus, it implies the shift from the value in traditional business models to the sustainable value in sustainable business models, defined in terms of triple bottom line – social, ecological and economic benefits.

Product lifetime extension - drivers

Industrial designers do not see any technological obstacles to produce products that are more durable. However, the main concern is whether product lifetime extension fits to the company's business model. Accordingly, product lifetime extension is often in lesser favour compared to alternative solutions to environmental damage (e.g., recycling and reduced energy consumption) that are more compatible with conventional (sales volume driven) business models.

Experts indicate that a choice for product lifetime extension, or other sustainable production strategies, will depend upon possessed firms' capabilities, which are of dynamic nature - over time product strategies will be adjusted according to the market trends. Environmental sustainability and product lifetime extension is commonly agreed to be a top-down driven managerial decision. Thus, the company's management systems (for example, TQM), management's entrepreneurship and experience might have determining power on the company's strategic choices.

Experts evidence the importance of regulatory mechanisms in the company's strategy formulation. Companies forced to comply with new production standards would opt for durable product design even when it requires transformation in existing business model. In addition, as the extent of regulations varies across different countries, international companies that offer standardized products will be more inclined to comply with regulations (including voluntary). Moreover, experts confirm that resource scarcity is becoming a recognized problem across industries. It is known that even economically healthiest companies are going to face the resource scarcity in the future. In general, it was found that eco-design can mitigate these risks. Therefore, it is expected that such risks as resource scarcity and stricter regulations in the future will induce companies to use resources more efficiently.

Sectorial characteristics

Competition in the industry has significant implications on production patterns. During product design process, designers analyse competition products aiming to design superior propositions. At the same time, industry characteristics (rapid or slow innovative developments) will affect product lifecycle management. This links to the innovation theory which states that obsolescence is an indirect result of competition between firms that seek to establish their dominant designs. Through a so-called 'creative destruction' process companies make existing products (including their own) obsolete in the market. Accordingly, product lifecycle will affect the decision on product lifetime that needs to be embedded in product design.

Furthermore, large companies are better positioned to increase product lifetime and set directions for industrial innovation. Large industry players possess resources that enable them to cope with the shortage of revenues on a short term. For example, Philips with significant market power and resources to transform the entire production cycle has successfully established the new standard for light bulbs (LED). At the same time, smaller players were forced to leave the marketplace.

Four sustainable business cases

Prof. dr. Rob van Tulden distinguished four types of sustainable business cases to explain what drives companies to become more environmentally sustainable.

The first business case is called 'inactive'. In this business case, sustainable product design is pursued because of a perceived opportunity to acquire market share as green product characteristics are desired by consumers (e.g., Body Shop). However, the number of consumers for whom green product characteristics is the key purchase driver is low, thus this business case is common among smaller niche players.

The second business case –'re-active' – refers to the situation when a firm is not sustainable or environmentally friendly by its essence (e.g., petrol/tobacco producers). Because of unsustainable performance (i.e., due to reputational damage, higher wages to attract and retain employees) these firms might incur large additional costs. In order to minimize their financial losses for being unsustainable, these companies intend to improve their environmental performance.

In the third business case ('active'), the company sees sustainable production as a balance between environment and business. This is often embedded into the company's vision, so that environmental sustainability is of a rather strategic and entrepreneurial nature. In this case, the company considers all the variables in its triple bottom line to create value propositions. By contrast to 'in-active' business case, the goal to reduce environmental footprint is pursued not because of consumer preferences, but to improve the overall business performance.

The fourth case (a so-called 'pro-active' or 'new economy') might be a result of the third business case. In this case, the company not only aims to minimize its own environmental impact but also strives to change the thinking of its stakeholders and the industry, i.e., create standards. For example, it might intend to change consumers' consumption patterns. Therefore, instead of adjusting to customer needs, the company aims at evoking different needs oriented towards more environmentally friendly product use. To do so, the company needs to have significant market power that is difficult to gain in highly fragmented markets. Therefore, strategic alliances play a pivotal role.

Carlos Montalvo has explored the strategic intent for eco-innovations. He finds a number of drivers for eco-innovations which, however, differ depending on the type of eco-innovation. For example, recycling and reduced energy consumption are generally more acceptable by businesses. Despite of differences, it is suggested that to pursue sustainable strategies, the company should be inclined to change and engage in innovative activities. This behaviour therefore has to be contemplated by decision makers as a strategy.

Pioneering the strategic choice for sustainable production is not always beneficial

Environmental sustainability is becoming widespread. In many cases, companies follow sustainability wave as they perceive it as 'something that sells'. Prof. Rob van Tulden suggested

that pioneering sustainable initiatives in the industry often leads to less advantageous position compared with those who choose to follow. Under the shade of large pioneering companies, some other companies might decide to use the newly created industry's image to produce products under same labels selling them at lower prices.

3.3.2 Discussion

Expert views demonstrate that design for product lifetime extension encompasses different perspectives from strategy, design, sustainability and marketing fields.

| Questions | Findings |
|---|--|
| Benefits of products that last longer | <ul style="list-style-type: none"> - Reduced environmental footprint; - Competitive advantage (as a result of meeting customer needs better); - More efficient use of resources; - Improving innovation capabilities; |
| Barriers for making products that last longer | <ul style="list-style-type: none"> - Reduced sales - Need to redesign the business model – change the organization’s culture, newly establish customer acceptance |
| Product development and design | <ul style="list-style-type: none"> - Top-down decision – the overall company’s strategy will affect requirements for the product design - Design goal: design better value propositions than competitors; - Sustainable design is often pursued because of ‘fashion’(something that sells now in the market); |
| Sectorial factors that affect design for product lifetime extension | <ul style="list-style-type: none"> - Product usage patterns and purpose (level of attachment to a product, fashion, diffusion rates) - Market fragmentation and competitors’ offers; - Being a pioneer in eco-innovation might have adverse effects if competition starts to imitate under the image of the pioneering company; |

Product design for product lifetime extension should be considered as every innovation in terms of consumer acceptance and market structure factors.

Companies should recognize benefits that derive from product lifetime extension:

- reduced environmental footprint
- higher consumer preference
- improved company image
- differentiated products.

Longer lasting product design might also present a solution to resource scarcity, which is becoming one of the most severe threats to business sustainability. These individually recognized benefits will drive companies to design products for lifetime extension. At the same time, there are significant barriers to product lifetime extension. The major impediment to the implementation of product lifetime extension implies significant changes needed in business models (e.g., shift towards services), KPIs (i.e., changes in measuring the employee's performance). Therefore, product lifetime extension being a top-down decision is critical to drive these changes.

On the other hand, some external factors such as new government regulations could foster companies to adopt business models based on product lifetime extension.

3.4 Case Studies

3.4.1 Philips Consumer

Philips is the most comprehensive case in this research which summarizes twofold views the company has towards product lifetime extension. In the first part, research focuses on the research project in Philips Interactive Design aimed at exploring emotional product design that could address psychological obsolescence problem. The second case represents a conventional business model based on recurrent repurchase goal(a contradictory business model to product lifetime extension at Philips Consumer Lifestyle – Personal Care – Male Grooming – Shaving.

Philips – Interactive Design Case

Being a consumer-driven company, Philips devotes great efforts to understanding consumers' needs and behaviour. As industrial design experts evidenced during the interviews, there are no real obstacles to making products with longer technical lifetimes. However, the question that Philips raises is “whether a consumer seeks for longer lived product?”. Researchers in the interactive design centre in Eindhoven focus on understanding the psychological factors would encourage consumers to use products longer. More specifically, their project revolves around

developing product design for longer use with a focus on emotional consumer's attachment to a product.

However, the project is at its early stage and does not have strategic focus (e.g., assessing business models that would enable the shift of entire business towards product lifetime extension). Managers do not perceive that increasing product lifetime by incentivizing consumers use their products longer could set directions to transform existing business models. Given the company's size, Philips is somewhat inflexible in changing the ways business is run. Also, there is no strong evidence that it makes economic sense to shift from current business models to product lifetime extension.

Furthermore, the decision making in the company depends on its priorities. Prioritization on sustainable development (environmental perspective) is highly determined by the regulatory environment. As there are no high level initiatives towards product lifetime extension, it is not a strategic priority within the company. The Philips case discloses the existing gap between the strategic choice for sustainability and product lifetime extension. Even though Philips strongly positions itself as the 'green' brand, product lifetime extension is not pursued as a part of this approach. The main reason is the facts that it requires some major modifications in its business models.

The main benefit of interactive design for the company is an ability to create products that are more appealing and differentiated against the competition, and thus attaining more sales. In addition, emotional design could have highly positive effects on word-of-mouth, again making products more desirable to other potential consumers. However, the success of product lifetime extension through emotional design will depend upon product characteristics, especially the usage purpose, and attitudes towards that product. Not all the products enabled with emotional design could make consumers attached to them.

Philips – Personal Care – Male Grooming - SHAVING case

Product

Philips has been present in electric shaving business since 1957. Today it has long traditions with a home based factory in the Netherlands. Superior technology, reliability, consumer-driven innovation best describe shavers produced in Drachten (see Appendix for Philips Shaving business model canvas).

Philips shavers are designed with long inbuilt lifetime. The studies have shown that on average consumer uses its shaver for 5 years. However, some consumers claim using their Philips shavers for up to 15, or even 40 years (Amazon). The reasons why consumers discard their products vary among different segments. In general, an electric shaver is seen as a functional good discarded only

when it breaks down. In high-end segments, though, consumers tend to replace their products before the end of the technical product lifetime.

Attitudes towards product lifetime extension

In general, Philips Male Grooming – Shaving presents a traditional business model of the B2C company. It operates in incremental innovations-driven consumer electronics industry defined by short product life cycles of 2-4 years. Even though managers admit that innovating in technology (especially, shaving heads) becomes more and more difficult, they perceive there are still untapped opportunities and solutions that could lead to break-through innovations. Thus, the current strategy is aimed at driving the superior cutting edge innovation and leveraging recurrent revenue opportunities to increase customer lifetime value.

The following managers' views could be outlined:

Electric shavers are defined by longevity with low levels of psychological obsolescence in the usage of electric shavers

- Shavers are defined by the functional use (most consumers replace products at the end of technical lifetime). Philips products are defined by long lifetimes (average – 5 years)
- Longer in-built product lifetime is more valued by low-end shaver consumers. Shaving performance remains the primary purchase driver across all the segments.

Constant innovations based on consumer insights, shorter product repurchase cycles, consumer loyalty are the pillars of Philips Male Grooming (Shaving) strategy to drive sustainable profitable growth.

- The company's strategists perceive product replacement lifetime (avg. 5 years) as too long. By offering product news every year, Philips seeks to shorten product replacement lifetime and increase customer lifetime value
- Electric shaving technology is becoming mature (especially, shaving blades). However, as consumers are more and more attracted by technology innovations (e.g., Apple concepts) and exploring personal care options, there are still opportunities for 'creative destruction'.
- Despite gradually increasing market fragmentation, Philips and Braun compound a duopoly in most of markets. Strongly recognized brand maintains loyal consumer base.

Philips enables consumers to extend shaver's lifetime through accessories platform (shaving heads & cleaning solutions).

The communication on shaver's cleaning solutions is based on possibility to extend shaver's lifetime. However, extended product lifetime it is not the strategy, but the way to generate

additional sale, and more importantly, by attracting consumers to come stores more frequently, incite them to shorten shaver's replacement life.

Extended product lifetime does not provide substantial revenue sources in terms of the current business model

- No strategic intent to change the current business model:
 - Perceived benefits would not compensate required investments
 - Such a change is not a strategic priority
- Philips has limited capabilities to change a current business model
 - Main Philips customers are retailers. Thus, product lifetime extension should be executed via retailers (Philips has not strong market power to drive change in retail channels)
 - Product lifetime extension requires significant modifications in operations. Large scale and complexity in value chains poses a challenge in implementation of product lifetime extension.

Benefits of product modularity are conceived through several dimensions with multiple applications at the product level (see Figure 3).

Even though shaving accessories (e.g. shaving heads, cleaning station) can extend physical lifetime of the products, Philips is more interested in:

- Recurrent revenue opportunities in the post-purchase phase (additional revenues with high profit margins)
- CRM opportunities: frequent interactions with consumers would allow communicating news in shaving and incentivizing them to upgrade earlier (thus, shorter replacement life). Shaving is a part of everyday men's routine. Men who decide to pursue a certain shaving method are most likely to continue using it throughout their lives. Customer lifetime value, therefore, is the central concept in the shaving marketing. Philips strives to attract young users to electric shaving as well as retain and upgrade the current ones.
- Driving shaving accessories sales would also have a positive impact on consumer retention levels. However, this rise would not be significant as Philips consumers are already highly loyal to the brand.

Although Philips is highly sustainability oriented, product lifetime extension is not perceived as one of sustainability initiative compatible with a current business model.

In shaving it is generally noted that male consumers are less concerned about environmental impacts. At the corporate level, Philips invests heavily in improving its manufacturing methods towards recycling and energy efficiency. This is applicable to shaving products as well (Green Star).

These attitudes could be summarized by the following graph (Figure 2):

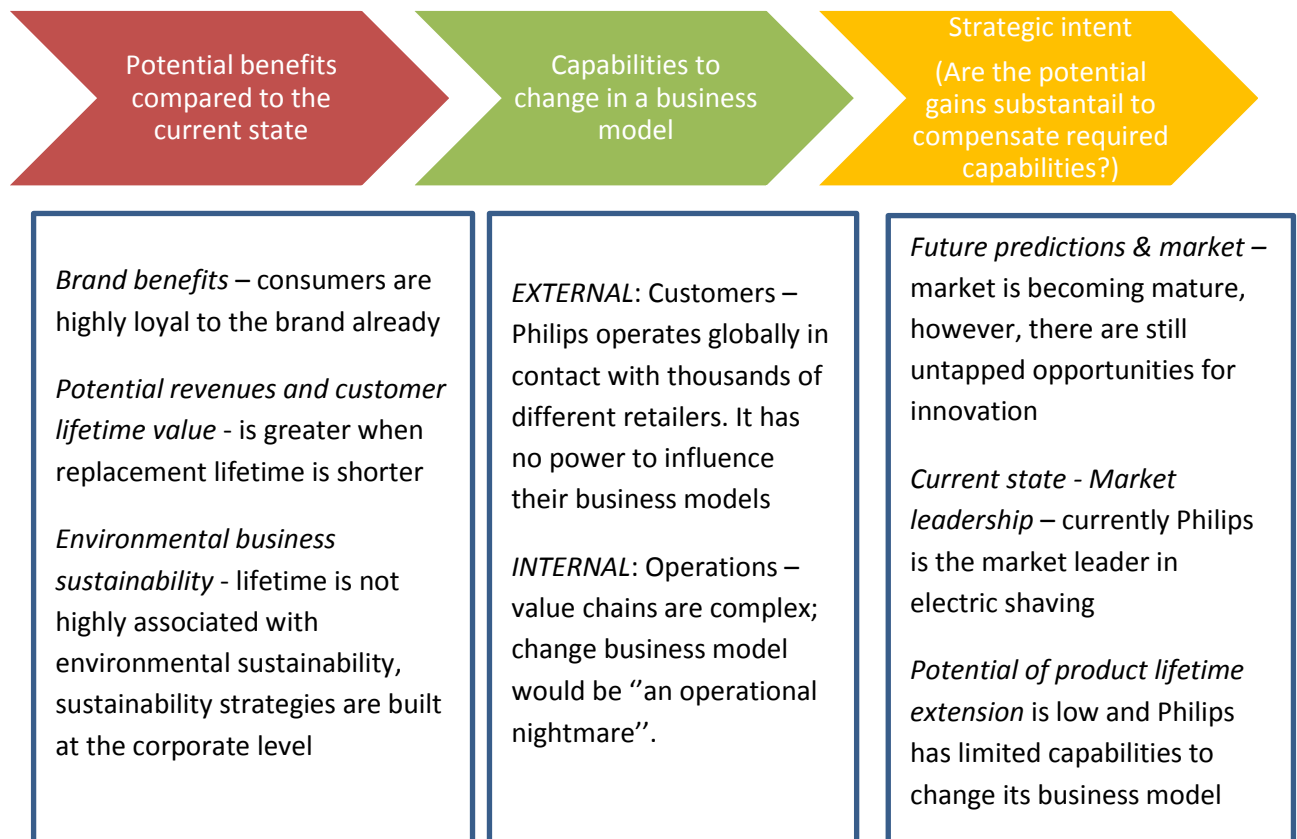


Figure 2: Potential of product lifetime extension

Applications for product lifetime extension

The platform is largely based on product modularity and can be grouped into several categories (Figure 3):

- Shaving heads (limited life – replacement)
- Click-on accessories (product use – upgrade)
- Cleaning solutions (product use – maintenance)’

To reach consumers after the purchase, Philips leverages its shaving accessories platform:



Shaving heads recommended replacing every 2 years



Click-on function enables compatibility with Philips shaving accessories(styler, trimmer)



Cleaning solutions used together with cleaning station (longer shaver's lifetime & servicing approach)

Figure 3: Modularity - generating value after the purchase

In addition, modularity has been broadly embedded in manufacturing (Figure 4). Manufacturing modularity allows Philips to manage its product lifecycle by frequently introducing refreshed design products. Also, as a global player, Philips is better positioned to adapt its products to local requirements and meet pricing constraints.



Different shaving systems to drive user trade-up within the range



Different user interface for a better user trade-up



Front panel colours vary to offer more product variety to a consumer

Figure 4: Manufacturing modularity in Philips

Challenge

The full potential of modularity *has* yet to be tapped. Only small number of consumers replaces their shaving heads regularly. The same is true for cleaning solutions. Philips has aimed to address low shaving heads replacement rate by embedding replacement reminders on shavers. However, further enhancement in communications, go-to-market strategies and ensuring shaving accessories availability in stores are crucial to success. At the same time, consumption patterns need to change. It is noticed that consumers purchase shavers and accessories at the same time and they do not

come back to electronic shops to upgrade. This implies the need for understanding consumer decision journey and innovations in current business models.

3.4.2 InterfaceFLOR

Company

InterfaceFLOR is a well-known carpet tiles manufacturer, serving clients across the globe. The company operates in B2B markets, its main customers being companies with office spaces (see Appendix for InterfaceFLOR business model canvas). InterfaceFLOR has been implementing product lifetime extension since 1994 (the beginning of sustainability initiatives in the company). At that time pro-active CEO strategic guidance largely shifted the company towards service-based business models. Although to create engaging culture product lifetime extension strategy initially was a rather radical top-down decision that needed strong internal communication (e.g., explaining changes in sales KPIs to sales people), currently InterfaceFLOR is focused on driving bottom-up initiatives to enhance its business models.

Attitudes towards product lifetime extension

The implementation of product lifetime extension is based on innovations in existing business models: modular carpet design, leasing, repair and maintenance, shared-use models. All these business models revolve around pro-active customer relationship management.

Contractual arrangements, full-time service availability are the groundings of InterfaceFLOR value propositions. Nevertheless, product durability and environmental sustainability are not explicitly emphasized as the main attributes in product value propositions. Meantime, the company strives to offer superior product design and performance to its customers.

At the strategic level, dematerialization is regarded the best way to solve the problem of finite resources and secure sustainable business performance on the long term.

In the beginning, InterfaceFLOR mainly acknowledged environmental benefits stemming from product lifetime extension. Over the time, the management recognized that extending product lifetime can 1) enhance the brand's innovativeness; 2) help to control volatile raw material prices; 3) create attractive product value propositions for environmentally conscious customers; 4) improve business performance resulting from effective resource absorption capabilities.

Pioneering in product lifetime extension is perceived to be highly advantageous because of 1) increasing customers' interest; 2) limited competitors' capabilities to copy the company's business model because of required high initial investments and strategic preparedness. InterfaceFLOR

currently engages in discussions with policy makers and complies with sustainable production standards (WEEE, ISO).

Applications of product lifetime extension

InterfaceFLOR offers modular carpet tiles. The modular carpet concept is simple, but it enables multiple applications and brings different business benefits (Figure 5).



Figure 5: Modular product design at InterfaceFLOR

With modular product characteristics, besides great product customization possibilities, InterfaceFLOR is capable of offering various services to its customers:

- a programme by which customers could lease carpet tile rather than purchase;
- InterfaceFLOR technicians would replace just the worn units only at high traffic areas

Challenge

In addition, more active stakeholder's engagement across the entire value chain and suppliers' selection based upon sustainability criteria could be the ways to achieve the company's sustainability goal to reduce its environmental footprint by 100% by 2020. Limited consumer acceptance (due to conservative attitudes towards carpet tile purchase and usage), psychological obsolescence have been identified as barriers to the implementation of product lifetime extension.

3.4.3 Auping

Company

Auping is a Dutch bedding company with strong traditions. Auping's products have been traditionally characterized by high quality and longevity (see Appendix for Auping business model canvas). Auping is proud to call itself "Royal" as the royal Dutch family is among its clients.

However, product durability is not the unique selling point of Auping's products as consumers choose bedding based on design and comfort (performance) criteria.

Attitudes towards product lifetime extension

Auping recognises product lifetime extension as an opportunity to strengthen the brand. The bedding market is saturated with rather similar product characteristics, thus brand recognition can play an important role in driving sales.

According to the brand manager, the company's brand is an important product differentiator at the point of purchase. Brand building is based on trust, in which product durability and reliability are prerequisites. For example, Auping provides product maintenance guidelines to its customers to diminish complaints and ensure that customers use their bedding products for a long time. Although the company's environmental footprint is a relatively insignificant factor to the consumer's purchase decision, consumers become increasingly critical towards strong brands. That is why Auping is aiming for a sustainable company image.

As product lifetime extension would increase the number of interactions with a consumer, the manager views it as an opportunity to increase customer loyalty and enhance brand's perception (i.e., get rid of the 'dusty' brand image). From an economic standpoint, the shift towards a service-based business model would enable Auping to generate constant cash flows and increase customer lifetime value. In addition, it is noted that recycling is a relatively expensive technique, which often does not even cover the required investments. By implementing service models, the company could reduce recycling costs.

Thus, having a product that lasts (10-15 years), the company does not opt to extend technical product lifetime, but rather: 1) find ways to attain closer relationships with its consumers to increase loyalty; 2) by offering additional services to address inefficient replacement behaviour (e.g., bedding is discarded because old bed does not fit the new space or interior).

According to the brand manager, resource scarcity, environmental and regulatory pressures are not today's issues for the company.

Material scarcity is not perceived as a severe threat so far, although resource recovery and product lifetime extension could help reduce dependence on suppliers.

Implementation of product lifetime extension

Aesthetics is one of the most common triggers for replacement behaviour. Therefore, product upgradability is the most feasible option for product lifetime extension. Increasing consumer acceptance through changing their views towards bedding is seen the major issue in product lifetime extension through servicing. Thus, enhancing brand communications (which are often

problematic given sales through the dealers) and establishing closer customer contacts are foundations for the creation of new service-based business model in Auping.

3.5 Discussion

Case study research has determined that regardless of differences between the companies and approach taken, product lifetime extension exhibits a number of common principles of a modular approach. Table 2 summarizes the main study findings:

Table 2: Comparison: Philips, InterfaceFLOR and Auping

| | PHILIPS –SHAVING & INTERACTIVE DESIGN | INTERFACEFLOR | AUPING |
|---|--|---|--|
| B2B/B2C | B2C | B2B | B2C |
| Product | Consumer electronics (men’s shavers) | Modular carpet tiles | Bedding (e.g., mattresses) |
| Application of product lifetime extension | Limited: Modular design and replaceable shaving accessories | Modular design/Service models | Early exploration: modular design, possibly services |
| Types of modularity | Manufacturing (various product designs) Product use (click-on function) Limited life (shaving heads) | Manufacturing (recycling/assortment) Product use/ Limited Life (renew the parts of the tile) | Manufacturing (assembly) Product use (upgrade according to the new needs) |
| Potential benefits of product lifetime extension | Ability to create more appealing, thus superior over competition designs (Interactive design) Possibility to extend shaver’s lifetime is appealing to the consumers. (Cleaning station sold with a shaver) Retaining consumers Higher consumer satisfaction about the brand and loyalty | Offering cost efficient solutions to a customer’s needs (e.g., replacing only parts of the carpet) Recurrent revenues Stronger customer relationship through service approach Long term contract Sustainable brand image – recognition and preference by sustainability oriented customers Efficiencies in production provided by easy recyclability Business more resistant to material price volatilities and resource scarcity | <ul style="list-style-type: none"> - Recurrent revenues after purchase - Closer customer contacts - Ability to strengthen the brand through direct interaction with consumers - Strong brand that will eventually allow better product differentiation |

| | | | |
|------------------|---|--|--|
| Challenge | <p>Incentivizing consumers to upgrade their products (e.g., shaving heads are only replace by 1% of consumers)</p> <p>Ensuring availability and winning shelf space in stores</p> <p>Need to influence multiple stakeholders in the chain. Given the scale, Philips has limited capabilities</p> <p>Product lifetime extension does not generate benefits that would encourage the shift from the current state (current business is perceived more beneficial)</p> | <p>More related to Zero Footprint programme: collaborating with other stakeholders to ensure higher sustainability levels of its products</p> <p>Motivating customers to pursue new unconventional services (e.g., shared use – switching tiles between offices)</p> | <p>-Consumers tend to see bedding as traditional buy-own-discard process. Offering products/services aimed at product lifetime requires to transform consumers attitudes towards bedding</p> <p>-No direct customer contact (sales via retailers)</p> <p>-Because of product characteristics, Auping finds it difficult to come up PLE solutions (e.g. How to renew a bed when most consumers need it every day)</p> |
|------------------|---|--|--|

As experts already emphasized, companies admit that improving technical product lifetime (durability) is not of any issue; however, they do not see consumers demanding for more durable products. When analysing consumer motivations to discard products, companies notice that a product becoming functionally out of date is often discarded before the end of its technical lifetime. Hence, psychological obsolescence is a common reason for replacement behaviour.

All inquired companies aim to understand what drives upgradability of their products. In InterfaceFLOR’s case, a common situation is that customers replace their carpets when changing their interior design. In Philips shaving case, most consumers do not replace their shaving heads at all, while some segments discard current products to purchase the latest technological innovation in the market. Similarly, as in InterfaceFLOR’s case, Auping sees a trend that changes in lifestyle (e.g., moving to a new place where bedding might need adaptations) often becomes a reason to discard a product that could still be used longer. In Philips, InterfaceFLOR’s and Auping’s cases, product durability is not a central feature in their value propositions. However, Auping’s case exhibits that having a durable and reliable product helps establish the brand image in different ways. First, it creates trust and reduces consumer complaints. In addition, as products that are intended for product lifetime extension require constant customer contacts, it increases customer retention and loyalty. Finally, by providing services additionally to products, companies increase their innovativeness. The brand building goal has laid a strong foundation for the Auping’s choice.

All these companies operate in the rather mature industries characterised by small incremental innovations. However, InterfaceFLOR case shows that implementation of product lifetime extension might be less complex in B2B, than in B2C context because of several reasons. First of all, B2B customers are more used to purchasing services via contractual arrangements. Also, for them more sustainable and cost-efficient product offerings tend to be highly appealing nowadays. Although a problem of emotional obsolescence might exist in B2B, it is not as dominant as in B2C markets

Meanwhile, Philips does not see service approach to be feasible business model for personal care electronic products. Both Auping and Philips admit that being a producer of durable goods in a mature industry often does not provide enough revenue sources required for the sustainable business growth. These companies are geared towards product lifetime extension as it generates recurrent revenues. Neither Philips, neither Auping perceive their consumers seeking for green product characteristics at the purchase phase. Sustainability for consumers is more ‘nice to have’, but not required. Thus, differently to InterfaceFLOR, consumer preferences for more sustainable products do not impact significantly a strategic choice for product lifetime extension. Philips shaving case shows that the company’s product strategy can be twofold: e.g., while communicating possibility to extend the lifetime of its products, the company actually aims at generating recurrent revenues and even shortening replacement cycles through more frequent interactions with a consumer.

As mentioned in the literature review, product modularity is grouped into several categories. In Philips and InterfaceFLOR examples, both companies implement several types of modularity approaches, each of them providing different business benefits.

- ✓ Limited life modularity (e.g, Philips shaving heads, InterfaceFLOR partial carpet replacement) extends technical product lifetime and allows producers to attain recurrent revenues.
- ✓ Product use modularity can be seen as solution to psychological obsolescence problem and it is more related to the product’s replacement life. For example, even though personal care products are for rather functional use; the insight shows that consumers tend to change their facial style and there is a trend of men spending more money and attention to their looks. In this way, Philips aims to increase consumer lifetime value by including additional offerings after the purchase is done. Moreover, in the industry which is defined by mature design, innovating by modularity (without high technological investments required) can be seen as a more efficient way to innovate.
- ✓ Manufacturing modularity is mostly related to benefits stemming from operational efficiency and effectiveness. At the same time, manufacturing modularity facilitates product customization and personalization, thus allowing expansion of product ranges. For Philips, it is a way to maintain its broad product offerings globally to meet different customers’ requirements. InterfaceFLOR clients can choose their individual designs. For InterfaceFLOR, it implies better differentiated products versus competition and closer customer relationships resulting in long term contracts. In addition, ease of recyclability enabled by modularity is of paramount importance in InterfaceFLOR. By recycling, the company achieves cost savings and thus is able to optimize production efficiency.

Accordingly, different approaches to modularity and goals assigned to it require developing different business models. To do so, companies should recognize all potential benefits of modularity. As InterfaceFLOR example shows, by embedding several modularity approaches into one business models, company achieves benefits across several dimensions:

- value proposition (externally) - multimodal structure allows customers to choose customized designs;
- economic efficiency (internally) -eliminating the waste, recovering the costs by take-back recycling.

Product lifetime extension strategy should be seen as dynamic business approach through which the company is capable of capturing new opportunities. As InterfaceFLOR case shows, the company can move to a so-called active sustainable business case gradually. In the beginning, sustainable business models in InterfaceFLOR were pursued as a possibility to enhance product offerings and brand image. Over the time, the company realized that product lifetime extension bring more benefits with regards to its business effectiveness. In the future, InterfaceFLOR wants to collaborate with its suppliers and set the sustainability standard in the industry (thus, move to the 4th business case).

Changing usage patterns and shifting consumers from ‘throw away’ to ‘servicing’ culture has been seen a major challenge by the interviewees. Strategic decision making towards product lifetime extension is a part of the holistic sustainability approach the company might aim to take. Other identified constraints in adapting product lifetime extension were technological, economic (cost efficiency).

In InterfaceFLOR decision making for PLE is more based on assessing environmental footprint (with regards to its Mission Zero programme), while for Auping economic benefits are major considerations. The B2B carpet industry experiences greater pressures to shift towards sustainability, mainly because of its customers that are strongly oriented towards sustainability. Both InterfaceFLOR and Auping are the sustainability pioneers in their industries. Their strategic choices could be seen as largely based on future predictions (InterfaceFLOR: ‘sustainability is becoming mainstream, solution to the resource scarcity problem requires dematerialization’, Auping: ‘consumers will become more and more critical about the brands’, Philips ‘industry is becoming less innovative, however, flexibility in value added offerings is crucial’’).

Lastly, the case study results confirm the importance of entrepreneurship. Top-down entrepreneurship helps convince all the members within the organization of the choice validity. Thus, organizational culture inside the company is rather important in the adoption of new business models. In addition, as it is clear from the Auping’s case, strong corporate culture, based on

traditional high-quality product view, plays an important role in sustaining the brand's positioning when facing cost cutting initiatives in the industry.

4 Conclusions

4.1 Main Findings

The aim of case study research and expert interviews was to evaluate and validate the benefits of product lifetime extension through modular product design and determine the potential drivers.

The results of this study show that implementation of product lifetime extension can be less difficult in B2B context mostly because service-based products are more common and widely accepted by customers. Meanwhile, B2C companies seem to be struggling in finding revenue sources for product lifetime extension given their existing business models.

Philips case study shows that the potential of product lifetime extension is low given the current business model. Moreover, as the change requires significant capabilities in change management, the company does not have a strategic intent to change. Philips Shaving case study exhibits that the company's strategy and marketing communications might have significant differences. While offering a possibility to extend product lifetime, Philips expects that consumers will become more tempted to market novelties in shaving and thus it will lead to the faster repurchase. Accordingly, it can be argued whether products design in upgradable fashion are more environmentally friendly as it is likely that the overall amount of waste incentives will increase even more.

This study confirms that even though the drivers for product lifetime extension may vary according to the requirements of individual firms, the main benefits of product lifetime extension are the following:

- Recurrent revenues,
- Increased customer lifetime value,
- Closer customer/consumer and company relationships.

These results further support the idea that product lifetime extension revolves around stakeholder relationship management:

- 1) Consumer relationship management is crucial in enabling product lifetime extension strategies
- 2) The potential of product lifetime extension is assessed in terms of benefits, capabilities and intent of each stakeholder in the value chain.

In addition, the study findings show that product lifetime and durability are generally incorporated into overall product design, product performance and design being major purchase drivers. Consumer's demand for product longevity varies across different product categories. Producers of longer lasting products might gain competitive advantage in different ways that depend on the market characteristics and environment in which they operate. Strategies to achieve competitive

advantage are dynamic (i.e., they need to evolve corresponding to the changes in the environment). Therefore, more mature industries that can better identify future market evolvments and plan product evolvment through upgradable design are in a better position for product lifetime extension.

According to case studies, existing consumption patterns are regarded as a common barrier to product lifetime extension. Consumers are not always in favour of upgradable design, or shifting towards more service-based product consumption (Auping).

At the same, more and more consumers are becoming increasingly concerned about the impact of their consumption on the environment. The extent to which consumers demand more environmentally sustainable products differs across the industries. Some clear differences are observed in terms of how product durability is embedded in value propositions and communicated to consumers. In B2B context, customers are provided with assessments of reduced environmental footprint, while in B2C markets product lifetime is perceived as a part of quality that constitutes to the brand image. B2B customers are exerting higher pressures on firms by demanding more sustainable products.

4.2 Managerial Implications

Based on the thesis research, some of managerial implication might be drawn to help mangers strategize for product lifetime extension. These recommendations mainly fall in two categories: strategy development and consumer marketing.

Strategy development

- Product lifetime extension should be implemented according to the objectives and goals of individual firms based on their customer requirements, production complexities and volumes.
- As mentioned in the literature review, the study confirms that product lifetime is a multifaceted concept that has implications in the strategy formulation. Therefore, psychological product obsolescence and replacement lifetime should be taken into account when considering the implementation of product lifetime extension. Companies should first investigate what drives replacement behaviour and when consumers tend to replace products (technical vs. replacement lifetime).
- Essentially, product lifetime extension implies a shift from customer transactions to relationships. This change will result in companies focusing on customers, rather than products, retaining existing customers, rather than constantly acquiring new ones. The following elements will become crucial in building viable business models:
 - Customer relationship driven corporate strategy

- Increased customer lifetime value as the key business goal
- Shifting from traditional customer acquisition marketing funnel to understanding consumer decision journey
- In order to manage its complexity and broad-ranging links and interactions, modularity should be supported by a system-level framework. A strategic product lifetime extension should be based on the rigid analysis of existing value chains and roadmap development aimed at holistic integration of business models across the organization.
- In the similar vein, an economic incentive to design products for durability and upgrading requires that sales operations and R&D to be closely linked within an organization.
- Designing for upgradability requires to determine a long-term plan - *upgrade plan* of upgrading among several generations. The upgrade plan should compound a *platform*, a common structure of the product that does not change throughout all generations. Determining size of the platform is another central issue of the upgrade design. Similarly, Customer Lifetime Value should be used as KPI to determine business performance aimed at product lifetime extension.

Consumer marketing

- Given that consumers are becoming increasingly aware of waste problem, brands will more exposed towards critical consumers' views. Thus, product lifetime extension aimed at responsible resource use can be a strategy to strengthen the brand and create trust.
- Customer relationship management plays a dual role in product lifetime extension. On one hand, strong customer relations are necessary to provide services when extending product lifetime and addressing changing customer needs; on the other hand, longer product lifetime will lead to long-term customer relations and increased brand loyalty because of multiple interactions with a customer.
- Companies that pursue upgradable design strategy should ensure that consumers have strong incentives upgrade product later. The common problem with upgradable design is that it might be as an additional feature of the product for a consumer at the point of purchase. However, consumers do not tend to upgrade later (e.g., computers).

4.3 Limitations

This thesis research has several limitations that should be taken into account while applying its main findings to the business theory.

Firstly, it should be noted that in general strategic decision-making process involves multiple actors. Therefore, because of the case study research has been limited to interviewing only a few representatives per company, the study insights might lack completeness.

In addition, interviewees represent different functional areas which increases the level of subjectivity (i.e., some matters might have been assigned more importance compared to the others). Furthermore, due to a limited number of companies investigated, a comprehensive cross-sectorial comparative analysis is not possible. Accordingly, as highlighted in the case study methodology part, the study results cannot be generalised and are not necessarily applicable to other companies. Finally, product lifetime extension through modular design might not always be less waste generating, thus environmental efficiency of the models presented should be reassessed.

4.4 Future Research

This research opens up opportunities for further study.

- ✓ To make this strategic analysis of product lifetime extension complete, the further studies could focus assessing the potential of product lifetime extension across the entire value chain (e.g., *what are its benefits to each of stakeholders?*) and focus on implications across business model building blocks.
- ✓ The first concerns that a strategic choice for other product lifetime should be examined with regards to other available eco-design alternatives. The future research on the company's strategic choice for product lifetime extension could be based upon usage of quantitative methods to extrapolate relative importance of each strategic factor and predict the strategic intention for product lifetime extension in the future. The strategic product lifetime extension choice could be assessed using game theory method.
- ✓ Secondly, case studies show that the company's management characteristics play a somewhat important role in decision making. The ownership structure, company's management and organizational culture - are those important characteristics that might condition the decisions made. Thus, the future research could focus on investigating certain firms' characteristics and their importance for a product lifetime extension strategic choice.
- ✓ Last issue concerns the fact that product modularity has not been widely explored among consumers. The question for the future research should concern how consumers evaluate modularly upgradable and techniques to drives upgradability. In addition, go-to-market strategies (4Ps) could be of particular interests to marketers that aim to implement product lifetime extension through modularity.

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APPENDIX

List of Experts

1. Ir. Marcel Den Hollander, senior researcher of ‘Products that Last’
2. Dr. ir. Conny Bakker, ‘Product that Last’ project coordinator
3. Dr. Fernando Diaz Lopez, Senior Researcher TNO, expert in the field of eco-innovations and sustainability.
4. prof. dr. Rob van Tulder, Professor of International Business-Society Management, Department of Business Society Management, Rotterdam School of Management (RSM) (Centres of Expertise: SCOPE Sustainable Business, Emerging Markets)
5. Dr. Carlos Montalvo, Senior Researcher, TNO – Strategy and Policy.

List of Companies and Interviewees

InterfaceFLOR – Geanne van Arkel (Sustainable Development)

KoninklijkeAuping BV – Jeroen Wijnands (Brand Manager)

Philips – Jon Mason, Dzimity Aliakseyau (Interactive Design Research), CMM BG PC Male Grooming-Shaving Team: Director Consumer Marketing, Manager Shaving Accessories, Manager – 6900 series

Case Studies – About the companies

InterfaceFLOR

InterfaceFLOR®

Company Background

InterfaceFLOR, a subsidiary of Interface, Inc., established in 1973, is the world's largest designer and maker of carpet tile, with 3,566 employees worldwide. As a global company with reputation for high quality, reliability and premium positioning, InterfaceFLOR markets modular carpet in over 110 countries under well-established brand names. For the company, design is 'a mind-set and sustainability is the journey of a lifetime'. InterfaceFLOR characterizes itself by 'Design with Purpose'. The company has been recognised to be among the world leaders in sustainability. By its vision, InterfaceFLOR is aimed 'to be the first company that shows that sustainability is in all its dimensions: People, process, product, place and profits — by 2020'.

Corporate Strategy

In 1994, CEO Ray C. Anderson announced that Interface would seek to become "the first sustainable corporation in the world". To achieve this ambition, the company undertook hundreds of initiatives, for example:

- a program by which customers could lease carpet tile rather than purchase;
- Interface technicians would replace just the worn units only at high traffic areas, reducing waste.
- recycling old tiles.

According to *Nigel Stansfield (InterfaceFLOR)*: "When we started Mission Zero, people thought we'd gone mad. It was the best decision we've taken."¹ Already in 1997, Interface reported a 20 per cent growth in revenue, a 30 per cent growth in profits, with zero increase in physical throughput (Post et al., 2001). According to the company's estimates, reduction of waste to landfill globally is 78 per cent since 1996; energy reduction is down by 44 per cent. These achievements have been made by involving all the stakeholders in the business, shifting bonus schemes from output to material utilisation, or energy reduction.²

In 2011, the company identified corporate strengths on which it could to capitalize its competitive advantage. First strength is its ability to introduce numerous innovative and attractive floorcovering products, allowing serving the needs of multinational corporate customers. Furthermore, the company seeks to create strong ties with its customers through contractual arrangements and higher levels of services. With possession of global manufacturing capabilities, InterfaceFLOR focuses on offering made-to-order modular carpet products, which account for approximately 75-80% of the United States and Asia-Pacific markets (Annual Report, 2011).

The company considers its commitment to be ecologically "sustainable" by 2020 as a strategic initiative brand-enhancing as well as a competitive strength. InterfaceFLOR is paving the development of modular carpet using materials and processes that take less from the environment. Interface's worldwide carpet manufacturing facilities maintain third party registration to the ISO 14001 Environmental Management System, and the company is recognized globally for its commitment to build environmental considerations into its business decisions.³ InterfaceFLOR takes part in LEED certification program, as customers and prospects around the globe are seen to be increasingly making purchase decisions based on "green" factors. Thus, modular carpet products, providing installation and maintenance advantages translated into greater efficiency and waste reduction, are regarded of high importance in serving such customer needs.

Mission Zero:

Through its corporate 'Mission Zero' global branding initiative, which represents a promise to eliminate any negative company's production impact on the environment by the year 2020, the company clearly communicates its striving for sustainable performance. To achieve 2020 sustainability vision, Interface has developed the following initiatives:

¹<http://www.designcouncil.org.uk/Case-studies/DCM-case-studies/InterfaceFLOR/>

²http://www.bradford.gov.uk/bmdc/the_environment/climate_change/for_businesses/case_study_interfaceFLOR

³www.interfaceflor.com.

- Evergreen Carpet Leasing System – for a monthly leasing charge, InterfaceFLOR undertakes to maintain, replace and recycle all its carpets, ensuring sustainability throughout the lifespan of a carpet
- ReEntry® – InterfaceFLOR collects used carpet tiles for refurbishment and re-use
- Cool Carpet® - InterfaceFLOR allows consumers to purchase certified climate neutral products and offset the CO2 emissions for the life-cycle of the products
- Cool Fuel™ - InterfaceFLOR offsets the emissions related to fuel consumed by company cars
- Cool CO2mmute™ – A voluntary employee scheme in the USA to offset the CO2 emissions associated with commuting to and from work
- Trees for Travel™ - a scheme to offset all business related air travel

Challenges

The challenges InterfaceFLOR facing in attaining Mission Zero range from technology barriers to employee engagement. The cost of implementation and highly competitive marketplace are important considerations in decision making. The distinguished challenges include:

1. Sourcing Raw Materials for Closed Loop Products
2. Achieving Zero Footprint
3. Sustaining an Engaged Culture (for more information, visit InterfaceFLOR corporate website)

Thus, Mission Zero 2020 will require to further elaborate on initiatives started in 1994 and increase the effectiveness of business processes. This requires engage the entire supply chain, achieving optimization.



Company Background

Auping was founded in Deventer in 1888 by Johannes Auping. Royal Auping bv is the largest independent Dutch bedding manufacturer, with locations in various European countries, including Belgium, Denmark and Spain. In the beginning, Auping specialised in producing mesh bases. Later, mattresses and box springs were added to the assortment. Thus Auping evolved into 'the sleep specialist' and market leader in the Netherlands. The company states its vision 'to provide consumers with the most comfortable, fresh and hygienic beds that exist'.

Corporate strategy

Auping is focused on building strong brands. According to Marjan Reitsma, communications manager at Auping: "In difficult economic times, consumers particularly want reliable brands. We are delighted that they recognise Auping as a brand which offers consistent Dutch quality at a good price and which listens to what customers want. Furthermore, our 'Royal' predicate gives the consumer even more confidence." In 2010, Royal Auping bv has been voted the most reliable bed brand in the Netherlands.

Auping has been long engaged in corporate social responsibility (CSR). Being aware of the impact that its production has on the environment, Auping strives for a responsible and safe production and use environmentally friendly materials. Durability is seen as one of the strategic pillars of the Auping business. On its corporate website, Auping provides consumers with advices, for example, on how to remove spots from mesh bases and wooden accessories. For minor damages, the company offers special lacquer pens. "Your Auping duvet has a guaranteed long life. If you give it some extra attention once in a while, you will be able to enjoy it even longer". The company's value proposition revolves around the product functionality: 'Essence of sleeping', 'Matches your needs' and classic design. For example, the Auronde bed model has been around for more than 35 years. Another product, the "Royal", also called "The Bed", is characterized as a durable, functional and stylish bed.

Cradle to Cradle®.

C2C® is centralized as a strategic pillar, aimed at an infinite cycle of materials. These materials are fully biodegradable and 100% recyclable in a subsequent equal or greater quality product. Waste will be raw. Or: Waste = Food. Cradle to Cradle® is regarded as an integral process, encompassing production methods, materials as well as work environment. Auping aims to be a C2C® company in every aspect by 2020. To achieve that, the company will tune its operational management to C2C philosophy and designing all the products according to the principles of C2C®. A product example includes the Auping Essential bed, the first bed in the world that has been awarded with a Cradle to Cradle Silver certificate that guarantees that the bed consists for more than 50% of recycled materials or materials that are recyclable.

Challenges

- *Finding profit centres*
- *Changing consumers' attitudes towards bedding consumption*
- *Creating the right brand image whilst selling via dealers*

Company Background

Philips is a global company characterised by several business units with more than 100 business models and thousands of different products. Philips has established a strong position in consumer durables market as the technology, quality and innovation brand. Philips Consumer Lifestyle is a division of electronics company Philips specialized in production of consumer electronics and small appliances. Personal care devices is one of the main Philips Consumer Lifestyle business which comprises Beauty (Female personal care electronics devices) and Male Grooming (men personal care devices, such as shavers, trimmers, body groomers, hair clippers). Traditionally, Philips Consumer Lifestyle has been focussed on the creation of highly innovative products. Even though Philips' positioned itself as a quality brand asking for premium prices, it is becoming increasingly difficult to retain the technological lead over the lower priced competition.

Soon from the late 1940's when the first battery powered shaver appeared, electric razors became part of the cultural landscape, signifying both affluence and modernity. Many popular films from that era used to picture prominent actors shaving with dry razors. By 1969, one-third of men in the U.K. and two-thirds in the U.S. were using electric razors. Philips has been a pioneer in rotary technology in electric shaving. Today, Philips is a market leader in electric shaving, with Braun being its major competitor.

Corporate Strategy

The key pillars in Shaving strategy are retaining and upgrading existing customers and acquiring new ones. Retain & Upgrade focus is upgrading installed consumer base and driving accessory sales. Recruitment team seeks to attract young users to electric shaving. As it is known that converting consumers from blades is hardly possible, this strategic pillar is crucial for the company's growth on longer term. Furthermore, Philips seeks to leverage business opportunities in emerging markets by offering lower priced shavers. In general, electric shaving in Philips is based on constant innovation: product lifecycle is around 5 years, every 2-3 years products are refreshed (incremental change). The competition is based upon product specifications, value for money approach. To bring new innovation to the market, Philips actively collaborates with its retailers (end-to-end) approach. Environmental sustainability in Philips is managed at the corporate level, marketing strategy hardly includes any of its elements.

Challenges

It is becoming increasingly difficult to maintain leading market share due to new players entering the market and aggressive competition. For example, Remington offers lower quality products, but claiming functions that Philips shavers only have at higher price points. In China, electric shaving market is challenged by lower priced local players. As industry becomes more and more mature, the trend is likely to continue. Furthermore, to leverage sales opportunities in shaving accessories Philips lacks distribution coverage (mainly because of low rotation of accessory sales – low purchase intent) .

BUSINESS MODEL CANVAS

Business Model Canvas – 9 Building Blocks – Philips SHAVING

| | | | | |
|---|--|--|--|--|
| <p>Key Partners</p> <p>Suppliers/Retailers</p> | <p>Key Activities</p> <p>Creating and manufacturing men's shavers, selling them through the key retailers in the global markets</p> <p>Key Resources</p> <p>Suppliers, Employees (operations, production, R&D, Marketing and etc.)</p> | <p>Value Proposition</p> <p>Cutting edge technology men's shavers addressing men's need for superior, fast and comfortable shavers. Tailored value propositions for consumers of different age groups and price segments.</p> | <p>Customer relationships</p> <p>High satisfaction leads to high consumer loyalty. Consumers replace their shaver every 5 years. Direct contact with consumers occurs via retailers, online communications and customer support.</p> <p>Channels</p> <p>Retailers (online/offline)</p> | <p>Customer segments</p> <p>Global</p> <p>Different price segment (30-250 eur)</p> <p>Philips user/Competitor consumers/Gifters</p> <p>Different age groups: 16 to >65 years</p> |
| <p>Cost Structure</p> <p>Material, production costs, trade margin and etc.</p> | | <p>Revenue Streams</p> <p>Recurrent sales</p> | | |

CASE STUDIES: BUSINESS MODEL CANVAS

Business Model Canvas – 9 Building Blocks – Auping



Business Model Canvas – 9 Building Blocks – InterfaceFLOR

