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A FRAMEWORK FOR THE DEVELOPMENT OF SUSTAINABLE MASS CUSTOMIZATION BUSINESS MODELS

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Abstract: *In the last decade, the idea of mass customization (MC) has been discussed broadly in management literature as a business model for companies that offer goods to customers with heterogeneous needs. At the same time, the discussion on business models that deal with the increasing customer demand for more sustainable products has gained importance. However, there is a lack of research in the discipline of MC that integrates the new affordances of sustainability into MC based business models. With our study, we contribute to this research gap by developing a set of generic sustainable MC business model patterns. For this purpose, we first describe the requirements for MC on the one hand and for environmental sustainability on the other hand separately. In a second step, we combine both perspectives and propose a set of seven generic patterns that serve as guidance for integrating sustainable MC on a business model level.*

Key Words: ***Mass Customization, Sustainability, Business Models, Framework Proposal***

1. INTRODUCTION

Mass customization (MC) has been regarded by the European Commission as one of the main value drivers of a sustainable European economy [1]. Still, in sharp contrast to other consumer industries, manufacturers of consumer electronics and TVs in particular have not yet followed this business paradigm. The ECO-INNOVERA project "SMC Excel" (Enhancing Sustainability by Mass Customization for European Consumer Electronics) involves developing and evaluating a system innovation in the field of consumer electronics (CE) that enhances ecological sustainability through the integration of new business models. The aim is to shift from the current mass production of products with short technology cycles towards an MC of TV sets meeting individual users' demands while at the same time increasing environmental sustainability. This is done by developing and implementing a business model that incorporates both these elements (MC and sustainability). This article focuses on one aspect of this larger project, i.e. the development of a generic framework for the systematic implementation of a Sustainable Mass Customization (SMC) business model for the CE industry.

While standard approaches for developing business models solely incorporate economic considerations [2–4], research in the context of sustainable business models has recently acknowledged the importance of incorporating sustainability in a company's business model [5,6]. In the research field of MC, however, there is a lack of research that integrates sustainability considerations into MC based business models. Research in the specific field of SMC business models is limited to very few publications. Hence, this article aims to strengthen the knowledge in this area through the implementation of SMC within the consumer electronics (CE) industry, and to develop a framework that makes the implementation of SMC in this sector more systematic.

Following a qualitative approach, this paper proposes generic business model blueprints that can be used when integrating SMC on a business model level. Building on the insights gained by reviewing literature in the distinct domains of SMC business models, a set of business model innovation (BMI) workshops have been conducted by an expert panel in collaboration with the Turkey based TV producer Vestel Electronics.

This article has been structured into five main parts. First, the theoretical background is outlined including an introduction to Business Model Innovation (BMI) and SMC. This is followed by a methodology section. Third, the results are presented and discussed. This includes (1) a short overview on previous results to build upon regarding SMC business models, MC business models, and sustainable business models, (2) a discussion on the requirements for integrating MC and sustainability in business models, and (3) a framework that combines both perspectives into a single business model. The discussion is followed by an outlook of applying this

framework in the manufacturing of TVs. Finally, the article concludes with a short summary and a discussion of limitations and opportunities for further research.

2. THEORETICAL BACKGROUND

2.1. Business Model Innovation

Over the recent years, the term Business Model Innovation (BMI) has become en vogue. After all, the object of interest is the progression and redevelopment of all entrepreneurial action: the business model. Among other definitions, a business model is the hypothesis of the management how, at what time and by exploiting which resources a company may create value for its customers and, in return, be rewarded for doing so [4]. Consequently, working on a business model represents one of the core activities of the management.

BMI is based upon an understanding similar to that of the modern strategy process [4]: Both, BMI and the modern strategy process, periodically boost the upcoming strategy with great involvement of the entire organization. This requires a suitable toolset which empowers every member of the organization to participate in this core process. The goal is to provide participative and interactive methods which permit a creative and simultaneously systematic derivation of new business models following the idea of Design Thinking. This user-oriented approach is based upon the following core steps: understanding, observing, point-of-view, idea generation, prototyping and refinement [7,8]. Usually, all of these core steps are conducted by an interdisciplinary project group and multiple iterations are applied.

Several modern approaches to business model innovation have been established in recent years with the most widely known approach being the Business Model Canvas (Figure 1) developed by Swiss business theorist Alexander Osterwalder [3]. By applying this model, companies can visualize existing and potential new business models structured alongside factors of importance, such as product creation, distribution channels, customer relationship or cost and revenue composition. Consequently, this model was chosen as the basis of this project's approach for developing a new business model for SMC. However, the Osterwalder business model canvas only functions as an intermediate step between two other essential elements of BMI: the generation of potentially exploitable ideas; and their examination with respect to their suitability as the foundation of a new business model.

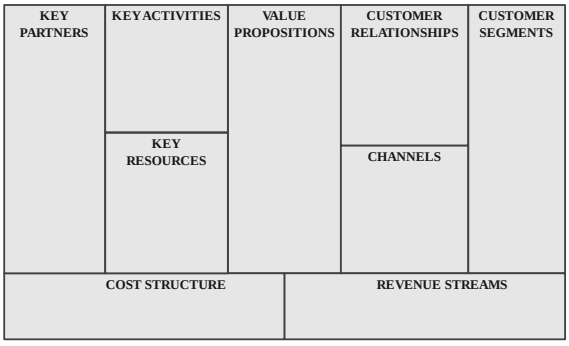

Fig. 1. Osterwalder's *Business Model Canvas*

2.2. Sustainable Mass Customization

The synergies between MC and sustainability have been cited frequently in research [1,9–14]. However, less evidence is available at the practitioner level [13,15]. The lack of practical results is mainly due to the relative novelty of the SMC concept on the one hand, and the high complexity of the sustainability improvement assessment and the subsequent identification of the importance of the various enablers including those related to MC on the other hand. Nevertheless, some common principles emerge from the literature review. The achievement of SMC implies a strong involvement of customers and the undertaking of the product re-design following a life cycle approach. For these reasons, specific guidelines for the Design for Sustainable Mass Customization (DFSMC) have to be developed. These guidelines stem from the integration of the existing Design for eXcellence (DFX) approaches developed on the basis of the mapping of MC and sustainability requirements and constraints. The analysis of the correlations between product design requirements related to sustainability and MC, described using a QFD roof, shows a great majority of positive correlations and only four negative correlations out of 378. Negative correlations call for a tradeoff between two attributes, which either means to identify the most important attribute, and/or to reduce the negative impact of the correlation by developing innovative design solutions [10]. Congruent with this, Medini et al. also stress the commonalities among MC and sustainability enablers [13].

The most cited benefit of MC on environmental sustainability is waste reduction. It is achieved by the replacement of the forecast based mass production system by a "zero storage" system where finished products are produced at the exact moment and in the exact quantity the customer requires [10,11,13,15–17]. A longer product lifespan can also be achieved due to the fact that MC products are designed for satisfying specific customer needs and because they often make use of durable classic designs [10,11]. The increased product lifespan results in a reduction of resource and material consumption because the products are replaced at a slower pace. On the contrary, the high level of customization can decrease the positive effects of product reuse put forward by the circular economy concept, unless one assumes that product modularity eases product modification [11]. Another driver of SMC is the establishment of closed loop supply chains supporting product reuse, refurbishment and recycle, facilitated by the adoption of modularity and DFX guidelines [11,13]. The impact of the adoption of MC in the establishment of a closed loop supply chain and the management of the product extended life appear to be less explored subjects in previous literature. Both aspects call for significant BMI because they redefine the relationships between customers and producers, with a stronger accent on the notion of Product Service Systems [11,12]. More generally, they affect various elements of the Business Model Canvas, such as for instance value proposition, key partners, or revenue streams.

As stated above, research indicates that a number of environmental benefits along all phases of the product life cycle can be achieved by shifting from a forecast based mass production system to an on-demand MC based system. Environmental benefits include the reduction of inventory (e.g. raw material consumption) and waste production, a longer product lifespan, the adoption of eco-innovations at feature level, the establishment of closed loop material flows, etc. The methods applied for achieving these objectives and ensuring a well-balanced SMC require a stronger integration of the main drivers of MC and sustainability. Moreover, these methods have to be assessed and tailored according to the specific demands of the application context because the product nature and the availability of innovative technologies are both crucial for exploiting all potential benefits of SMC.

3. METHODOLOGY

The results of this paper are based on a four-step procedure. The first step was to review the existing literature on the underlying idea of Business Model Innovation (BMI) with the goal to identify how business model patterns are created and used as generic blueprints for new business models (see section 2.1.). In a second step, two additional literature reviews were conducted separately for MC and sustainability due to the lack of information that combines the fields of BMI and SMC.

Based on the outcomes of the literature reviews, a set of business model innovation (BMI) workshops were conducted as a third step, in which experts from the fields of BMI, MC, and sustainability assessment collaborated with practitioners from the TV manufacturing industry. In the course of these BMI workshops, business model elements were collected considering the required transformations proposed by MC literature and MC practice examples [18]. The business model elements were then structured and distributed to four different MC design element clusters. Analogously, environmental business model elements were selected if they outlined how different customization options offer opportunities for enhancing the sustainability along all stages of the product life cycle. This was followed by the distribution of all sustainability business model design elements to a set of six sustainability clusters.

The final step involved the development of generic SMC business model blueprints by combining the MC and sustainability design element clusters identified. Seven SMC blueprint patterns were designed by creating a business model canvas for each cluster and by describing each section of the canvas.

4. RESULTS AND DISCUSSION

4.1. Identified Previous Results to Build Upon

4.1.1 Sustainable Mass Customization Business Models

The literature analysis showed that SMC business models still need to be well established and well explained. The previous work of Boër et al. on SMC touched the context of business model development only briefly focusing mainly on the general requirements for a successful implementation of SMC from an operational point of view [1]. The development of business models, however, also requires a strategic dimension, which has not been addressed in detail so far. A study conducted by Pourabdollahian et al. [15] aimed at understanding how the integration of MC into a company's business model affects sustainability. Despite providing important insights regarding the environmental relevance of MC integration into business models, this study coincides with the aims of this article only to some extent. This is because it does not consider MC and sustainability simultaneously. In contrast to this, the main goal of the SMC Excel project is to develop business model patterns based on SMC elements. Consequently, both MC and sustainability elements should already play a prominent role in the company's business model. Overall, the results to build upon in the specific context of SMC business models are limited and require an individual review of MC and sustainability business models.

4.1.2 Mass Customization Business Models

Gassmann et al. discovered that just 55 business models are responsible for 90% of the world's most successful businesses. Therefore, they came up with the so-called “Business Model Navigator” that comprises 55 blueprints of the business models they identified [4]. One of these business model blueprints is MC. Hence, for Gassmann et al., MC comprises a stand-alone business model blueprint.

Gassmann et al. consider MC a hybrid strategy between “mass production” and “customization”. As a concept in BMI, it describes the attempt to combine the advantages of both concepts [4]. In simpler terms, the goal is to provide an individualized product at the low cost of mass production [16]. This is often achieved through the application of a modular product architecture. In the production process, the modules are very homogenous products. Production thus exploits economies of scale and specialization effects well. The limited number of modules directly translates into a much larger number of final products offered to all customers whose needs are completely satisfied, but not over-satisfied as is often the case with standard products. In addition, customers do not need to pay a notable surcharge for the customization of their product because production only engages with standard modules [4]. The co-creation process between a company and its customers results in an intensified company customer relationship caused by the “I designed it myself” effect [19]. This effect refers to the emotional attachment the customer develops towards the product and company during the customization process.

Gassmann et al. state that, for a long time, MC was regarded as a very theory-based concept that was close to impossible to put in practice because of its inherent antagonism (mass production vs. customization). Today, practical applications of MC have shown that MC in fact is a feasible business model that was rendered possible by computer-based production technologies in the 1990s. During this time, MC also profited from the trend of market segmentation [4].

4.1.2 Sustainability Business Models

Most literature on the development of sustainability business models was found to be more conceptual. The majority of existing publications deal with the adaption or supplement of generic approaches on the description of business models scrutinizing specific business model types for the "Green Economy". Based on the work of Osterwalder, Lüdeke-Freund constructs a general business model for a sustainable economy. This study extends the idea of Osterwalder by adding the two aspects of accentuation and expansion. Accentuation describes the orientation of the business model elements related to a sustainable economy. Expansion refers to the aspects which are not market related, such as air, water and ground. These aspects especially reflect the value of the business model [20]. Bocken et al. develop eight archetypes for sustainable business models, which are subdivided into generic principles. They include (1) the use of waste products as a valuable input for additional production processes, (2) the change from ownership to use, and (3) the demand for a consequent reduction of energy consumption [21]. Boons and Lüdeke-Freund provide a concise overview of the current state of research regarding business models for sustainable innovation [6].

Unlike the studies mentioned previously, the contribution of Joyce et al. is entirely of methodological nature, i.e. the development of a framework for assessing business models from an economic, social and environmental point of view [22]. This tool, called the *triple layered business model canvas*, adds two new layers (an environmental life cycle layer and a stakeholder social layer) to the original canvas [22]. This framework, however, was found to serve primarily as an assessment tool for existing business models or for refinements rather than for the development of completely new sustainable business models (and for completely new generic business model patterns as in the case of this project,).

4.2. Requirements for Mass Customization Integration

The shift towards MC requires a profound system innovation along the entire knowledge and supply chain. First, designers have to adopt a new way of thinking about product architectures towards modularity [23,24]. Second, the manufacturing facility has to be organized differently with robust but, at the same time, adaptive processes centered on single customer orders [25–28]. Third, customers have to change their habits when making a purchase and MC companies have to develop and implement new kinds of customer interaction systems [26,29]. Considering the required transformations proposed by MC literature and MC practice examples [18], the following main MC elements have been identified as most relevant for the CE industry:

- **Key partners**: Customer as co-designer, assembling partner or/and retailer.
- **Key activities**: Flexible production and distribution, marketing (segmented market), product and process (re)design.
- **Value proposition**: Upgradability, customization experience, specific performance & usability, "Don't pay for what you don't need", and easy-to-use promise.
- **Customer relationships**: Direct interaction with the customers (=co-creators), provision of an assisted process (e.g. through a web-based interface), goal to establish continuous relationships.
- **Channels**: The consumer choice navigation system (e.g. product configurator) as a main channel to address customers via the internet, in-store customization as a complementary strategy for retailers.
- **Customer segments**: Several niche markets targeted at the same time, high segmentation (long tail) instead of homogeneous mass market.
- **Key resources**: Choice navigation system, robust processes and flexible production system, customer (behavior) data.
- **Cost structure**: Shift from a cost driven to a value driven business model. Cost drivers: fast (single) distribution, flexible production, long tail marketing, increase in complexity.
- **Revenue streams**: Customer experience driven revenues, additional service revenues, personal media selling, upgrade revenues.

To integrate sustainability into the MC business model, all interactions between MC options on a product hardware, software and service level (i.e. along the entire product life cycle) and associated environmental impacts were evaluated. The outcome of this evaluation served as the basis for defining the environmental objectives for the new SMC business model. During the workshop, the project consortium also collected sustainability design elements for TV producers and wholesalers. A summary of the main sustainability elements identified for the business model include:

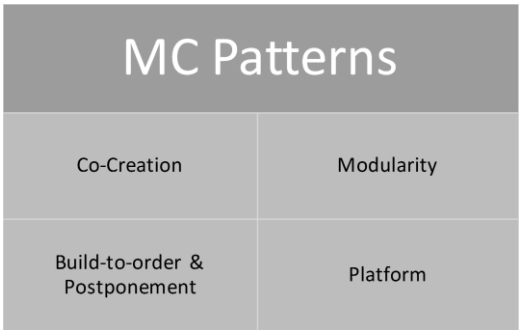

Fig. 2. *Mass Customization Design Cluster*

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of the main sustainability elements identified for the business model include:

- **Key partners**: mainly stakeholder groups related to sustainability and corporate social responsibility (e.g. NGOs, certification bodies, policy, customers), reverse logistic partners.
- **Key activities**: Certification processes for the product, eco-design implementation and closed-loop production within the supply chain.
- **Value proposition**: Sustainability certificates, longevity of products, availability of environmentally friendly materials, conscious consumption.
- **Customer relationships**: Taking into account communities with sustainable behavior and encouraging participation, exchange and provision of information, forming long lasting customer relationships.
- **Channels**: The product configurator presents a main channel to address sustainable product features, followed by social media and respective consumer groups, and an elaborated reverse logistic channel.
- **Customer segments**: Need to take into account which consumer group might be receptive to additional value, cross marketing concepts to address specific needs of target groups that correspond to apparently common product features.
- **Key resources**: Acquisition of new environmental data about the organization, supply chain, value chain and product itself, implementation of internal and external knowhow on sustainability and life cycle thinking, internal and external sustainability communication.
- **Cost structure**: To develop sustainable systems and offers, sustainable management costs are to be expected unless the organization is equipped with a certain degree of organizational elements.
- **Revenue streams**: Sustainable offers, options to include or add additional sustainable services (renewable energy, etc.), closed loop systems (e.g. use or selling of recycled materials, reuse parts and products.

These design elements were then adapted to each environmental objective identified for the product, known as sustainability clusters. The six sustainability clusters identified include: longevity, eco-design, efficiency, awareness, circular economy and dematerialization.

Fig. 3. *Sustainability Design Cluster*

4.4. Framework for Sustainable Mass Customization based Business Models

The framework for the SMC business model involved combining the elements of the MC clusters and sustainability clusters. The initial merging of the clusters resulted in seven different SMC patterns (orientated towards the CE market):

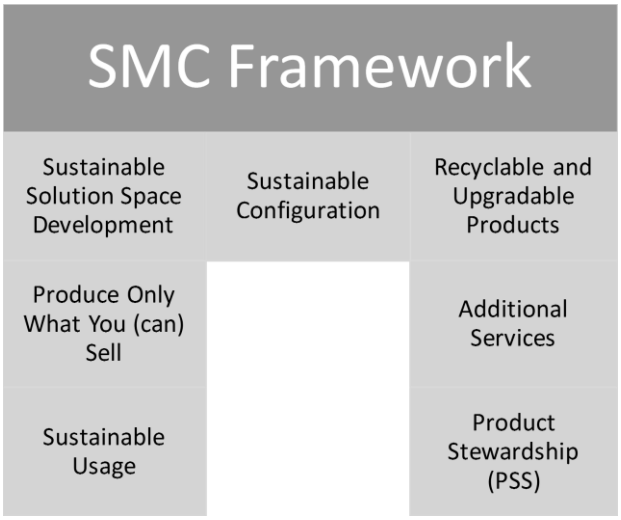

Fig. 4. *SMC Business Model Framework*

Sustainable solution space development: This is one of the three critical capabilities to successfully offer individualized products. Here, the company defines the limited space customers can choose from when individualizing their products. As such, the business model has to tackle the integration of sustainability into the solution space development. Three clusters of relevance to be included in the business model canvas are co-creation, modularity and eco-design.

Sustainable configuration: This pattern involves combining the Co-Creation pattern (MC) with Awareness and Eco-Design (sustainability). The basic idea of the so-called sustainable configuration is to incorporate environmentally or socially conscious choices in the user-interface [30]. This involves informing consumers about the environmental impact of their choice. Badurdeen & Lyanage propose that product configurators should facilitate an evaluation of any desired configuration with respect to environmental and social performance [30]. Analogue to the changes in price usually displayed, alterations in the sustainable performance resulting from the selection of certain materials could be communicated to the customer. This pattern also involves the transfer of authority from the company to the consumers enabling customers to decide what is customized and to dictate what is actually produced.

Recyclable and upgradable products: Modularity is a key enabler, particularly within certain industry sectors, for offering a wide variety of finished products while still benefiting from near mass production efficiency. If the product design is undertaken from the beginning, thinking about the whole life cycle, modularity can also facilitate product upgradability and recyclability, promoting the adoption of the sustainability clusters such as Circular Economy and Longevity.

Production process modification, for instance concerning disassembly, might be required to enable the application of this SMC pattern.

Produce only what you (can) sell: Instead of in-stock production, MC is usually based on the principle of build-to-order. Thus, the final manufacturing of the individual product does not start until the customer order is received. This also avoids overproduction and the need for storage facilities. In the specific context of SMC, this pattern combines the build-to-order and postponement pattern with design elements from the eco-design cluster.

Sustainable usage: The Sustainable usage pattern reflects the assumption that MC concepts are suitable for improving the environmental impact during the use phase. Sustainable usage results in longevity, upgrade options, and the efficient use of energy and materials. This pattern involves a combination of the MC cluster Co-Creation and the sustainability clusters Awareness, Eco-design and Efficiency.

Additional services: A shift to a pay-per-use business model reduces customer risks and investments, and it provides customers with a dynamic offer, continuously integrating the new services proposed by the value chain network. For manufacturers and retailers wishing to develop a sustainable strategy and to benefit from a closed-loop supply chain, the adoption of the pay-per-use business model is also an advantage because keeping the ownership of the physical products allows them to better manage all the decisions concerning the different phases of the product life cycle. The strong and long lasting relationships built with the customers through the process enables the promotion of conscious consumption and it helps widen the services offered to meet targeted sustainability objectives.

Product stewardship: The core idea of this concept is that the company remains the owner of the product and the service related systems, and it provides a value-oriented solution for the customer instead of an item to purchase. Furthermore, this approach offers the possibility to really tackle product and consumer systems in a very comprehensive way. Not only does it consider the whole life cycle but it also aims at improvements for the whole value chain by combining services, logistics, products and information/ communication to create a sustainable product service system (PSS). Mass Customization itself is often labelled as a PSS, however, in order to be sustainable, additional features and elements are necessary. Therefore, they require the development of a new business model rather than the modification of an existing one.

5. OUTLOOK: APPLYING THE SMC FRAMEWORK IN THE TV INDUSTRY

In the course of the SMC-Excel project, the framework for SMC based business models is the subject of several piloting activites. The SMC patterns generated and described above are used as building blocks for SMC scenarios in the TV industry. Until now, two preparatory workshops have been conducted to plan the application. Brainstorming sessions based on a collaborative approach by Vestel's staff from different company departments generated several scenarios for further elaboration by project members, and they will be used for the final pilot business model.

In the following, initial SMC scenarios developed for piloting are presented. At the end of each scenario, the link between the seven SMC patterns and the piloting ideas is described briefly. Each piloting idea relates to either a single or multiple patterns. Ideas do not need to be in line with all aspects of a pattern but they should be consistent with at least one integral component.

Hardware customization: Hardware components of the TV (e.g. foot, front frame, wall support) present one of the core customization issues. These components can be customized by granting the customer the opportunity to choose from different types, models, colors and materials. In one particular case, Vestel's Industrial Design Team developed a customizable foot concept for their TVs, which directly addressed the observed conflicting customer needs for high quality sound on the one hand and more narrow frames on the other hand. Among other effects, this customizable foot concept helped decrease the overall packaging size and weight of the TV. Developing TV design strategies that lead to decreasing product package size and transportation volume is thus one of the outputs that fit the SMC Pattern 'Sustainable Solution Space Development'. The idea of presenting more sustainable materials or new design options for the foot originates from the SMC Pattern 'Sustainable Configuration'. By presenting more sustainable options and by informing customers about the sustainability impact of the selected options, the ecological awareness of the customer can be increased.

Software customization: Contemporary televisions are "smarter" than their predecessors of the last decade because of their advanced connectivity features to the internet. Televisions connected to the internet can receive software updates much more easily. This way, software features can be updated and adjusted to changes in customer needs. For instance, the PVR feature is optional to the customer. It is disabled in the products for cost sensitive customers who do not require this feature. However, if they want to upgrade later, they can easily do so without the ecological atrocity of purchasing a new TV. For the above reasons, a company strategy to support post-purchase software customization should be developed for both B2C and B2B customers

This piloting idea that enables the customers to upgrade their product through software updates is based on the SMC pattern 'Recyclable and Updatable Products'. The longevity of the product is significantly increased because the product is safeguarded from changing customer needs that result from the emergence of new technologies or viewing habits.

Elimination of Unneeded Features and Components: In durable product sectors like CE, giving customers the possibility to define the features and components of their choice before purchase may enhance the sustainability of the product. Eliminating unneeded features and components leads to positive sustainability impacts. This elimination option should be provided by the company within the configurator. For instance, the configurator of a TV may include the option of selecting a carton box without printing. This may minimize the use of printing materials and processes, which positively

affects both environmental and economic sustainability. Another example is related to the stand and the wall mounting option of the TV. The configurator may offer the customer the option to exclude either the stand or wall mounting apparatus from their product offer in order to lower the burden to the environment.

This piloting idea of giving the customers a chance to eliminate the features and components of a product that do not correspond to their needs is in line with the SMC Pattern 'Produce Only What You (Can) Sell' (not in its narrow sense of build-to-order but in the wider sense of 'Produce Only What A Customer Really Wants'). The company tries to prompt the customers to buy products only with the components and features they really need. The customers are not charged for unneeded features and components. This is also in accordance with the SMC Pattern 'Sustainable Configuration' because it helps elevate the customers' awareness of sustainability aspects.

Product Rental System: With the emergence of new technologies in the last decades, consumers started to replace their standard TVs with Smart TVs before they stopped working properly. For instance, to be able to watch the latest broadcastings (e.g. Netflix), they depended on the latest technology in their TVs. Developing a rental system for TVs may be a sustainable solution for this need. As part of this rental system, the company could collect used televisions after rental, upgrade them and put them back into the rental system. This piloting idea resembles the SMC Pattern 'Product Stewardship'. The rental system may increase the likelihood of product reuse by returning unwanted products to the company and passing them on to other customers. By adding service activities during the rental period, this business model further corresponds to the SMC Pattern 'Additional Services'.

6. CONCLUSION

In this article, a framework for the development of SMC business models has been developed. The framework contains seven generic SMC patterns that serve as building blocks for entire SMC business models. To develop a concrete and company specific SMC business model, companies can use these generic patterns as a construction kit. Most of the SMC patterns are complementary. The outlook to the application in the TV industry serves as a first reference for practical implementation. Further research for the empirical validation of each distinct pattern, of combinations of patterns as well as of the entire business model is needed.

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