

Article

Circular Business Model Challenges and Lessons Learned—An Industrial Perspective

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Received: 8 January 2018; Accepted: 27 February 2018; Published: 8 March 2018

Abstract: Both practitioners and researchers are concerned about resource deficiencies on the planet earth and agree that circular business models (CBMs) represent solutions to move towards zero waste, improving environmental impacts and increasing economic profit. Despite all of the benefits of CBMs, the implications are not widely available, and failure rates are high. Thus, there is a need to identify the obstacles that stand in the way of CBM transition. This paper aims to identify the primary challenges of CBMs. Multiple case studies are employed, incorporating six companies and data gleaned from 17 in-depth interviews. Theoretical and managerial implications are described at the end of the study.

Keywords: circular business models; circular economy; barriers; challenges; empirical study

1. Introduction

Current linear business models, which are often described as “take-make-waste” approaches, have led the world into an enormous cycle of waste production and extreme shortages of resources [1]. These trends are in contrast to nature, where there is no waste and everything is an input for other processes [2]. Urbanization and population growth demand more and more resources, despite the fact that there are currently shortages in critical supplies such as water [3], and some materials will be exhausted within five to 10 years, including indium, which is used to produce Smartphone touch screens, and erbium, which is used in fiber optics [3]. Thus, radical changes are necessary to alter the current economy. Circular business models (CBM) have been introduced to move businesses toward decreases in waste, as well as the reuse, recycling, and retention of materials [4].

Although the concept of circular business models has existed for many years, the precise term has only recently been employed in academic research [5,6]. The research of Mostaghel et al. (2017) demonstrates an increase in the number of mentions of the term in academic publications from 1 article in 2013 to 19 in 2016. Both practitioners and scholars have come to understand the benefits of adopting CBM, which are not limited to environmental impact [2,7].

Various studies related to this field have different lists of barriers for CBM adoption. The literature review by Mostaghel et al. (2017) reveals a more comprehensive categorization of antecedents and barriers of CBM adoption from the perspective of focal firms, their customers and suppliers, government, and technology. Other studies have also emphasized the importance of the network as well as the entire supply chain in the adoption of CBMs [1,8,9]. The goals of reusing, recycling, and reducing materials and products are not achievable without internal and external collaboration [1]. The study of Gorissen et al. (2016) empirically illustrates the important role of co-creative collaboration in transition to business model innovation. There are limited empirical studies that incorporate a holistic overview, from suppliers to end consumers. Bocken et al. (2016) call for studies that focus on the supply chain and infrastructure to develop case studies.

Sustainability and its environmental, social, and economic aspects are highly prioritized within the European Union policy landscape [10]. Sweden and other Nordic countries have actively worked on the subject and arranged conferences and public seminars to disseminate information on circular economics to individuals and organizations (e.g., [11,12]). Sweden is one of leading countries actively invested in research and solutions for Circular Economy (CE) and it has adopted supportive environmental policies, including goals for waste management [13]. Global Swedish large firms have very clear insight and aims toward sustainability, particularly with regard to environmental issues. The purpose of this study is to identify challenges in the adoption of CBMs through the development of multiple case studies. We propose that overcoming these primary challenges will improve CBM performance.

The rest of the paper is structured as follows. Section 2 presents the extant literature on barriers and challenges to CBM adoption. Section 3 then describes the methodology and data gathering processes. Following this, Section 4 explains the data analysis and results. Finally, Section 5 includes a discussion and delineates theoretical and managerial implications and directions for future studies.

2. Literature Review

2.1. Circular Economy

A circular economy (CE) is defined as a system that strives to be regenerative and restorative [14] while reducing the speed of waste generation [15]. Economic development can be also realized in conjunction with environmental sustainability [16]. A CE aims to provide a framework and possibilities for economic growth in a way that reduces environmental impacts and the use of finite resource consumption [17,18] by improving the quality and maintaining the value of materials, components, and products [17] or reusing them over and over again [16].

The implementation of a CE should be from the top down through policies and legislation or from the bottom up through firm competitiveness and profitability [15]. Three vital aspects for the implementation of CE are as follows: (1) environmental impact through the minimization of solid waste, landfill expansion, and emissions; (2) economic benefits through the redesign of products, supply chains, and choice of materials; and (3) resource scarcity through reductions in the use of materials, as well as reuse and recycling [15]. Implementation of CE requires all actors to be aligned and active. The entire cycle degenerates if even one actor is not sustainable [17].

2.2. Business Model (BM)

Richardson (2008, p. 136) describes business model (BM) as “the conceptual and architectural implementation of a business strategy and the foundation for the implementation of business processes.” In terms of strategy execution, Richardson (2008) proposed an integrative framework for a business model centered on the concept of value. The framework has been widely employed by researchers, and its dimensions are value proposition, value creation, and value capture. Value proposition concerns the offering and customer segmentation [19]. Value creation deals with resources, value chain, structures and processes [20]. Value capture describes the cost structure and revenue model [20].

2.3. Business Model Innovation (BMI)

Practitioners and scholars have devoted substantial attention to innovative business models as a key to business success and movement toward a circular economy (e.g., [6,21,22]) as current linear business models are cradle-to-grave and resources invariably end up as waste [23]. Such Business Model Innovations (BMIs) include circular BMs, sustainable BMs, and closed-loop BMs [24].

A circular business model (CBM) is cradle-to-cradle and has the same goals as sustainable and closed-loop BMs, which are environmental sustainability and reductions in the use of finite resources [24]. While sustainable BMs strive to bring (1) businesses, (2) stakeholders, and (3) environmental entities to the table, CBMs work to preserve materials, components and products

by reusing, repairing, and remarketing [25]. Closed-loop BMs have similar aims; however, they focus mainly on eliminating waste by recycling and re-manufacturing. It can be concluded that both CBMs and closed-loop BMs are subcategories of sustainable BMs; however, more research is required to distinguish between innovative business models [6].

The research on sustainable BM actually is the development and extension of industrial servitization research [26] and there is a well-studied body of literature on product-service systems [27]. Product-service systems (PSS) have many features in line with resource reduction; however, they do not discuss closing the loop. The recent study of Prendeville and Bocken (2017) illustrates how service design can support sustainable BMI [28,29].

The study of Koen et al. (2011) explains that BMI represents both opportunities and challenges for firms; however, sometimes ignoring the BMI opportunities might lead to failures despite current huge financial investments. Such examples are Kodak that failed to dominate the digital photography market and Microsoft's failure in gaming market [30]. Considering the whole European Union attempts toward sustainability, companies who do not invest and move towards sustainability might not have the opportunity to be active in European market in near future. Demands could come from both regulations and customers. Rest of the world such as US and China are also very active in pursuing sustainable perspectives. Thus, in the long term the industry does not have other choice but to transit towards CE in order to survive.

2.4. Circular Business Model (CBM)

The most commonly used definition of a CBM is the definition created by Mentink (2014, p. 24): "A circular business model is the rationale of how an organization creates, delivers and captures value with and within closed material loops" [24]. Based on this definition, Linder and Williander (2015) contend: "The conceptual logic for value creation is based on utilizing economic value retained in products after use in the production of new offerings" [31]. However, the most comprehensive definition is: "The rationale of how an organization creates, delivers, and captures value with slowing, closing, or narrowing flows of the resource loops".

Traditionally, a business strategy strove to create superior value for customers and capture a greater portion of that value in comparison to competitors. In CBMs, in addition to economic gains, business should be conducted in a sustainable manner that provides measureable environmental and/or social value [32,33]. Thus, the results of CBMs can be categorized as economic, social, and environmental factors [32]. Economic factors can save costs for customers and the firm by reusing, recycling, and using less materials/components/products. Social factors involve sharing and reusing resources among members of society, and primarily among businesses, which in turn enhances interactions. Environmental impacts minimize both waste production and the use of resources [32].

Special characteristics of CBMs could derive from collaborative ties, as firms do not create value autonomously [34]. This requires close collaboration with partners. On the other hand, increasing complementary services/products also yields increased interactions with customers.

Figure 1 depicts specific characteristics of CBMs, which were adapted from a study by Bocken et al. (2017) [30]. The ultimate aim of CBMs is to improve the quality of human life by including the environment and society as stakeholders and by considering their interests as equal to other stakeholders [35]. This changes the design of the offer, which in turn influences the cost structure. A new design might decrease costs if residuals from products or waste could be used as a major resource. Reducing the levels materials/components used would also result in cost reductions. However, special designs for reparability, durability, and upgradability might increase the initial costs of product/service development [36].

Another primary difference with CBMs is the close collaboration with suppliers, partners, and customers, which requires clear agreements and mutual trust [36]. There is greater customer interaction in CBMs, as customers may not own the product and may need to use different services [32].

The firm needs to educate customers and inform them about the originality of the products [37]. Finally, the revenue model will be totally unique, since the offering will be more service-based [31].

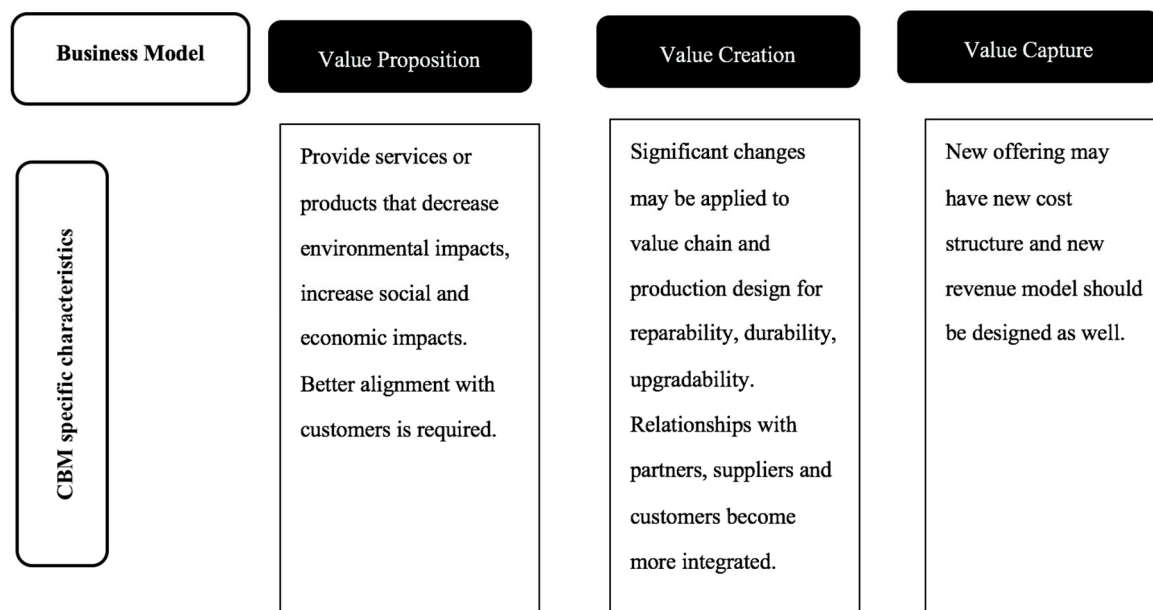


Figure 1. Special characteristics of Circular Business Model Framework (adapted from [32]).

2.5. CBM Transition

Transformation to a CBM requires multiple strategies, approaches, methods and tools that go hand in hand [32]. Essential elements in this transition are product design, supply chain design, enabling technologies, and infrastructure [32]. This transition includes internal activities and changes in logistics, the offerings provided, services, and the manufacturing process [38], and it is affected by many constraints, including technological, economic, political and cultural limitations [16]. Risk management is necessary at each step in this complex organizational restructuring [39].

Product design is one of the major elements, as products need to be adapted for multiple lifecycles and upgradability [40]. The study by Bocken et al. (2016) clearly discusses product design for CBM strategies. The three suggested fundamental strategies for product design are slowing resource loops by extending the life of products through reuse, repair and remanufacture; closing the loop by recycling; and narrowing resource flows by reducing the amounts of materials and components in the production system.

2.6. CBM Archetypes

Bocken et al. (2016) suggested circular business model archetypes based on product design. For slowing loops, they recommended (1) an access and performance model, where customers use products or services without owning them; (2) extension of product value, where the residual value of products is exploited by the customer and is then returned to the manufacturer; (3) classic long-life model, where the firm offers high quality, a long product life, and a design that will withstand the test of time; (4) sufficiency incentives, where the firm offers solutions to reduce customers' consumption. For closing loops, Bocken et al. (2016) suggested two additional business model archetypes; (5) extending resource value, where the firm employs the residual value of resources by recycling to turn waste materials into new forms of value; and, finally, (6) industrial symbiosis, where the firm provides a process-oriented solution by feeding one process with the residual outputs of another process.

2.7. CBM Challenges

An extensive review of the extant literature revealed barriers to CBMs. The study by Liu and Bai (2013) emphasizes that cultural and institutional barriers are more important than skills and resource constraints in CBMs [41]. Table 1 illustrates all of the identified barriers in the literature among the empirical and conceptual studies reviewed.

Table 1. Challenges of circular business model (CBM).

Challenges of CBM	Description
Lack of Supporting Regulation	Lack of supporting regulations, complexity and inconsistency of regulations [1,8,31,42–44].
Organizational barriers	Change is difficult for organizations and individuals [1]. Restructuring is costly and risky, resistance among managers benefiting the current structure might rule out the expected benefits for the firm and the environment [45].
Cultural barriers	Fear of the unknown is a barrier for organizations [45].
Financial and economic barriers	Major up-front investment costs, recycled materials are often still more expensive in CBM rather than in linear business models [36]. Different skills and resources can be more expensive [37].
Technological barriers	Lack of methods for handling life cycle of products data [36]. Limited availability and quality of recycling materials [36]. Technological limitations for recycling, product design, and other processes have been identified as major barriers for CBM adoption [1].
Customer Type Restrictions	Customers want to have ownership, particularly in B2C area [37]. Customer is careless when leasing [31,37]. Lack of customers' knowledge on origins of products [37].
Product Category Restrictions	Product category restrictions would be a barrier [31]. Lack of resources for designing products adopted for reuse, repair and remanufacture [44].
Fashion Vulnerability	Since CBM strives to slow down or close the life cycle of materials and products ([32]), fashion could be a barrier for high quality products [31,46,47].
Risk of Cannibalization	Risk of cannibalization similar to fashion vulnerability hinders production of long-lasting high quality products [31].
Return Flow Challenges	Exchange of materials is limited by capacity of reverse logistics [36]. Return flow challenges are barriers to CBM adoption [31].
Lack of channel control	Lack of channel control and conflict of interest within firms are barriers to CBM adoption [8,31].
Confidentiality for individual firms	Information exchange between all actors in CE can conflict with confidentiality and related competitive position of an individual firm [24,36].
Trust among partners	CBM is based on collaboration, and that requires trust between parties [48].
Mutual benefits for all partners	Mutual benefits among all stakeholders are necessary for collaboration [24]. Misaligned profit sharing along supply chain would hinder CBM adoption [8].
Increase of dependency to partners	Partners work closely and increase dependency on each other which is considered a risk that must be controlled [24].
Higher risks for CBM	Validation is not achievable without later sales and that risk of resource exposure grows during the validation [31].

From a macro perspective, rules and regulations may unintentionally hinder CBM transition [1,8,31,43]. For instance, tax systems, where the price of new materials is much cheaper in relation to repaired and reused materials, decrease customer demand for CBMs based on reuse, repair and remanufacture. A study by Kalmykova et al. (2016) demonstrates that despite the milestone set to reuse or recycle 60% of household waste by 2020 in Sweden, no policies have been introduced to motivate reuse and repair or decrease the demand for new products [49].

Several studies (e.g., [1,9]) pointed to organizational and cultural barriers; however, they have been among lower rankings in comparison with other challenges for transition to CBM. They refer to individual resistance within the company due to the risk associated with changes of current beneficial structure.

Financial and economic barriers have been discussed in both empirical and conceptual papers (e.g., [9,31,36]). Due to special structure of CBM, the evaluation measures are very complicated and up-front investment costs are more expensive than linear BM. In addition, the return on investment is not very simple to calculate as the maintenance and repairing costs are highly related to the type of use and care by customers. The empirical study of Rizos et al. (2016) ranked lack of capital as number two in the list of challenges.

Besides organizational, cultural and economic barriers, technology know-how is another challenge for practitioners [36]. Lack of expertise related to product design for recycling materials, handling data about life cycle of products, and other processes is a vital barrier. The study of De Los Rios and Charnley (2016) investigates the role of design [50]. In the challenges list of Rizos et al. (2016), lack of technical know-how is ranked as number five. The design of revenue models for CBM are complicated due to its nature and aims. The empirical study of Linder and Williander (2015) clearly demonstrates the challenges of CBM revenue model. This is associated with return flow and limited capacity of reverse logistics is another barrier [36].

From marketing perspective, several challenges have been identified for CBM such as customer type restrictions, product category restrictions, fashion vulnerability and risk of cannibalization [31,32].

The other consideration is that circularity is not achievable without collaboration from all parties [9,42]. In the global world, where partners are spread over several countries, inconsistency in regulations may interrupt or terminate circularity [8]. Several challenges have been identified in the literature related to network which are lack of channel control, confidentiality for individual firms, trust among partners, mutual benefits for all partners, and increase of dependency on partners [8,24,36].

2.8. CBM Performance

Performance has been a major concern of practitioners since the beginning of business and trade. Researchers have tried to conceptualize and measure it; however, there are many different assumptions about, and interpretations of, performance [51]. The literature review by Writz et al. (2016) reveals that among 149 academic studies on BMI only 14 (9.4%) focused on performance and controlling BM. Business model performance can be divided into static performance and dynamic performance [19]. Static performance focuses on value creation and value capture with indicators such as net income and return on sales [51]. Dynamic performance includes the element of long-term firm survival and focuses on firms' economic sustainability [51]. In practice, both perspectives are necessary.

For CBMs to succeed, in addition to traditional performance, other aspects of sustainability (i.e., environmental and social) should be considered as well. For instance, a study by Bakker et al. (2014) measured the improvement of refrigerators' productive life in terms of years through the CBM [52]. Lee et al. (2012) depict the environmental, economic, and social dimensions of CBM performance at both the macro and micro level for several cases [53].

3. Methodology

In order to identify the challenges of CBM transition, two major steps were taken. First, an extensive literature review was done to identify the barriers to CBM transition. The literature was not limited to CBMs and also included innovative business models such as sustainable BMs, closed-loop BMs, and PSS. Second, we moved back and forth between literature, secondary data and interview transcripts in order to identify the definitions of CBM archetypes and challenges. Thus, Maxwell's model for qualitative research design [54] was employed for an interactive and reflexive process.

Since the research on CBM transition is in the early stages, the nature of the study is more explorative. Thus, the case study approach appears adequate and even advantageous, since the phenomenon can be studied in its natural setting [55,56]. In this study we used multiple case study, as it augments the external validity and diminishes observer bias [55]. In addition, we confirmed the gathered data, from interviews and observations, by official annual reports, and archival and history information of each case. We present the context of study first and then detail methodological process.

3.1. Context of Study

As mentioned earlier, Sweden is among leading countries in CE and we chose 6 firms in Sweden to include in our case study. These companies have business scopes in processing industries, heavy

trucks, customer support agreements, luxury car sharing services, services for hospitals, and paper cable packaging. Brief description of each case is followed here.

Firm 1 is a global company with headquarter in Finland, founded in 1999 and operates in 50 countries. The company has more than 11,000 employees and turnover of more than Euro 2 billion in 2016. The firm provides services and technology for recycling, pulp and paper, oil and gas, mining, and aggregates. The focus of this study is on upgrading of pressure filter systems in processing industry. They are well aware of their aims for sustainability and act accordingly.

Firm 2 is a multinational company with headquarter in Sweden. It has more than 40,000 employees around the world and founded in 1891. The company is a major automotive industry manufacturer, specifically in heavy trucks and buses with clear aims and activities for sustainability. They clearly emphasize on all aspects of sustainability. In this study we focused on a service package comprising trucks, sensors, connectivity, and software for use by truck fleet operators. The package monitors usage and offers driver training, route planning, and advice regarding truck loading and use of gears and brakes.

Firm 3 is a multinational company with more than 3600 employees that was founded in 1832 in Sweden. It develops, manufactures and markets equipment for construction. They have clear aims and activities for all aspects of sustainability. This study focused on customer support agreements (CSA) which are tailored to include tools and services to unique customer needs and generate value. Focusing on end customers, these packages strength customer relationship.

Firm 4 is a Swedish vehicle manufacturer that was founded in 1927 and has more than 18,000 employees around the world. It has explicit aims for all aspects of sustainability and acts accordingly. This study focused on providing access (without ownership) to an array of premium cars to residents of specific apartments.

Firm 5 is a Swedish manufacturer that develops and markets medical devices. The firm was established in 2003 and has 10 employees. Sustainability is considered in all aspects of the work. This study focused on a bundled package consisting of a pump and disposables that together increase visibility during endoscopic surgery.

Firm 6 is a global company that is based in Sweden and is active in 40 countries, in 5 continents. The company has 26,000 employee and generated sales of 5.8 billion Euros in 2016. The company emphasizes on all three aspects of sustainability and ranked as number 50 innovative company (according to their website). In the cable industry, they ranked number one in research and development. Only in 2013, they registered 80 new patent requests. In total, the company has 650 patents in its portfolio and has invested 83 million Euro in research. They recycle 95% of manufacturing waste and have allocated 3.5 million Euro to improve energy consumption efficiency. The company has many offerings and solutions for four key markets that are power and data infrastructure, energy resources, transport and buildings. All their activities are toward renewable energy sources and sustainable world. This company provided 570,000 people in Asia and Africa with electricity through hydroelectric, solar, and wind power since 2013.

3.2. Case Selection

Single or multiple case studies could be conducted; however, there are many limitations in employing a single case study, such as the generalizability of the conclusions and the possible exaggeration of available data [55]. The major benefit with a single case study is that it can examine the phenomenon at a more in-depth level in comparison to any other method [55]. However, we decided to use multiple case study to study several cases and be able to generalize the findings. In this study, two main criteria were applied in the case selection process: manufacturer size (more than 10 employees) and the establishment of a CBM (in at least one business unit). The size limitation was established because medium to large companies are usually better structured and have more in-house expertise to provide in-depth information (cf. [57]).

3.3. Data Collection

Both primary and secondary data were gathered. The principal method of data collection was face-to-face onsite interviews, complemented with onsite observations and other secondary data to contrast with the interview data. To generally understand the CBM transition process and industry development, secondary data were first collected through publicly available information, annual company reports, and existing reports from DI (Dagens Industri).

After the research agreement was reached with firms, the right person with in-depth insights into CBM in the organization was identified. Overall, 17 key informants were identified in these firms, including the CEO/General Director and the Vice President/Director, either in the product development or sales division, or in new technology and services.

In the next phase, an interview protocol was developed. The interview protocol commenced with the introduction of the research project and involved parties. Interview themes were then outlined, and following this, semi-structured questions were identified. The themes of interview included general description about a specific circular business model within the firm, advantages of CBM in their case, differences of CBM and previous business model, challenges for current CBM, and finally lessons learned from transition to CBM. The protocol ended with contact-follow-up requests. The interviews were conducted by a senior research with knowledge about the subject, project and research aims. These on-site interviews were open-ended, lasting from one to two hours, and they were tape-recorded and then transcribed. The data was complemented with firms' annual reports and archival records. Feedback was provided for all respondents after the interviews to give them a chance to go through the interview and update any eventual answers.

Data collection was achieved through multiple case study with 17 semi-structured in-depth interviews among six firms. Table 2 summarizes the profiles of the studied firms. All firms are large-sized with minimum of 490 employees except Firm 5 with 10 employees, the turnover of the companies in 2016 starts from Euro 3 million. The names of alliance partners are listed in Table 2 along with title of interviewees. Among the interviewees we have general manager, CEO, executive vice president, production manager, procurement manager, and engineers. This verity of interviewees gives a clearer picture about different aspects of CBM, especially the challenges from different perspectives.

Table 2. Profiles of the studied firms.

	Firm 1	Firm 2	Firm 3	Firm 4	Firm 5	Firm 6
Turnover 2016	2586 M€	11,072 M€	2550 M€	13,461 M€	3 M€	191 M€
Employee number	11220	40286	3690	18046	10	490
Business scope	Processing industries	Heavy trucks	Customer support agreements	Luxury car-sharing services	Services for hospitals	Paper cable packaging
Alliance partners	Boliden, LKAB, ABB, Remard Industry, Pöyry Group, Bosch Rexroth	Ziegler group, Vendelbo Spedition A/S, M&M Militzer & Munch and Asta Logistik Grupo	Swecon, FAMCO, SMT, Kuiken, CJD	Sunfleet, and Tobin Properties	Smith & Nephew, non-disclosed service delivery company	Ahlsell, Borealis, Elektrokoppar, Spitze, and Stora Enso
Interviewee	(1) Engineer, spares process equipment (2) Process equipment (3) Project service support	(1) Head of service (2) Head of commercial management (3) Director business development	(1) General director (2) New technology and services director (3) Product development director	(1) New technology and services director (2) Product development director	(1) Executive vice president, sales and marketing (2) CEO (3) International service engineer	(1) Production manager (2) Procurement manager (3) Plant manager

3.4. Data Analysis Procedure

Data-driven thematic analysis [58] was adopted to uncover detailed elements of barriers to CBM. Two experienced researchers jointly conducted the data analysis. First, they independently analyzed transcription text. A unit of analysis was a paragraph in the text. Following this, they thoroughly discussed the results with each other, and discrepancies were debated. Please see Figure 2 for the data analysis procedure.

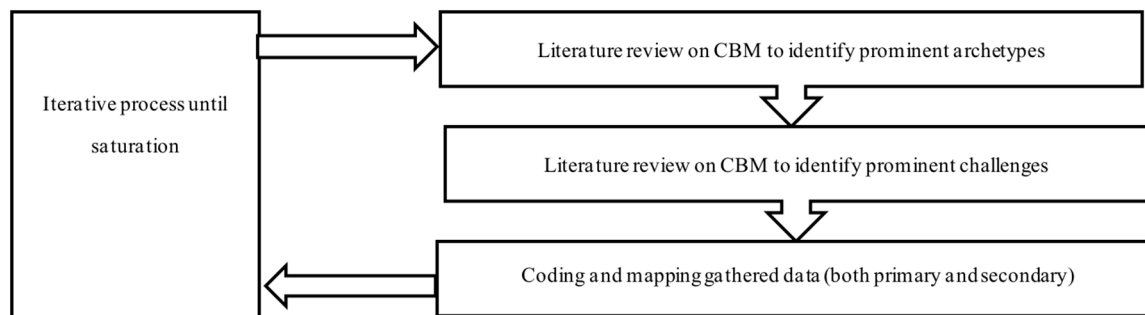


Figure 2. Data analysis procedure.

3.5. Quality Criteria

To secure the quality criteria, recommendations from Yin (1994) were implemented and each one explained in the following. These recommendations focus on construct validity, internal validity, external validity, and reliability. For construct validity, several sources of evidence were employed in this study, as explained earlier these sources were on-site interviews, public information, annual reports, and archival information. In addition, each key informant reviewed the interview transcriptions and confirmed the text. Internal validity was assured by pattern matching conducted by two researchers. The different sources of data were coded in a similar way (as suggested by Corbin and Strauss, 1990) [59]. With replication logic in this multiple case study, external validity was secured. Finally, case study protocol reliability was ensured.

4. Data Analysis and Results

Before presenting the results of multiple case studies, we focus on each case and describe them. After that the results of the analysis of all six firms are presented in Table 3, which illustrates the cases' CBM archetypes, primary CBM challenges, and main sustainability benefits, along with exemplary quotes. Thereafter, the analysis across six studied cases are presented followed by propositions.

In Firm 1 we focused on pressure filters that perform dewatering of minerals, as critical component of final products in process industries. CBM for Firm 1 improved total system utilization, raw materials flows, and processing capacity, it also reduced energy costs significantly, decreased maintenance needs and production costs. Major challenges for CBM was explained as establishing win-win scenarios between all involved parties, design of revenue model based on new offerings of functional sales instead of product sales and resolving customer procurement routines. The key lesson learned was importance of redesigning of value capture, as there would be misalignments if the offering changed to functional sales, while the revenue model remains based on product sales.

The service package offered by Firm 2 optimizes the truck use by monitoring the use and advice for route planning, truck loading, and use of gears and breakings. CBM significantly reduced the fuel consumption of trucks and CO₂ emission. Major challenges were expressed as establishing win-win scenarios between provider, driver, and transportation firm, redesigning of value capture for functional sales instead of product sales, and customers' inability to incentivize change of drivers' behavior. Major lesson learned was the importance of establishing interesting scenarios between provider, the customer, and the user.

Table 3. Cases' CBM archetypes, primary CBM challenges, and main sustainability benefits, along with exemplary quotes.

	Firm 1	Firm 2	Firm 3	Firm 4	Firm 5	Firm 6
Business scope	Processing industries	Heavy trucks	Customer support agreements	Luxury car-sharing services	Services for hospitals	Paper cable packaging
CBM archetype	Encourage sufficiency	Encourage sufficiency	Encourage sufficiency	Access and performance model	Encourage sufficiency	Encourage sufficiency and Extending resources value
Primary CBM challenge	(1) Value creation—partners (2) Value capture—revenue model	(1) Value proposition—complementary products (2) Value capture—revenue model (3) Value creation—customers	(1) Value chain—partners (2) Value creation—customers (3) Value proposition—complementary	(1) Value capture—revenue model (2) Value proposition—complementary	(1) Value capture—revenue model (2) Value proposition—complementary (3) Value creation—partners	(1) Value creation—partners (2) Value capture—revenue model (3) Value creation—customers
Main sustainability benefit	Environmental and economic	Environmental and economic	Environmental and economic	Social, environmental and economic	Social, environmental and economic	Social, environmental and long-term economic
Exemplary quote	"We offer a Life Cycle Solution."	Primary challenge of CBM is "lack of alignment of incentives between the involved actors and units."	Partnership "was based on a gentlemen's agreement and trust."	"We start seeing the needs" of customers.	"... we have to train the trainer. And maybe the information is lost on the way."	"Not all customers value the sustainable offerings"

Firm 3 offers tailor made packages for its customers need. The firm sells the equipment along with maintenance services in this package. Transforming to CBM enhanced the life of the equipment through better maintenance and service contracts. Major challenges for CBM expressed as alignment of incentives between the firm and global service delivery partners, establishing win-win scenarios between the firm, customers and service delivery partners, and finally delivering promised function to customers. Key lessons learned were importance of network and capability development within that, plus identifying diverse incentive models for each partner.

Firm 4's CBM was based on the service of luxury car sharing for residents of specific apartments in Stockholm. The CBM improved the utilization of cars with more effective maintenance, enhanced brand equity, and market share. Major challenges of CBM were designing of new revenue model, establishing superior after-sale service and maintaining the quality of services and cars, for instance clean interiors. Key lessons learned were importance of identifying new partners that are interested in the offering and differentiate revenue model for additional functions.

Firm 5 has an offering that improves the vision of surgeons during endoscopic surgery. The package includes a pump, that is too expensive for hospitals to purchase and disposables which hospitals charge the patients for them. The solution decreases the use of saline water, which decreases the operating costs. With focus on maintenance and calibration of equipment the after-sale service costs are also reduced. The CBM has improved the life of the pumps by three years. Key challenges for CBM were designing and delivering the new services to hospitals and revised the revenue model to pay-per use logic for disposables. Major lessons learned were importance of identifying new partners to create specialized arthroscopy and redesigning of revenue model for after-sale services.

Firm 6's vision and mission are aligned with sustainability aims. They strive to optimize energy consumption and ensure that the installations and equipment are energy efficient. This improves and develops economics for both themselves and their clients. The firm's activities are toward limiting the environmental impact and encouraging development of renewable energy. Finally, from social aspects the company's offerings improve the quality of life and meet the security requirements. Thus, there are no internal barriers to CBM transition, as the whole idea and aims of the company are based on sustainability.

The focus of this study is on production, packaging and transportation of cables in Firm 6. In order to consider all aspects of sustainability and have complete CBM, all materials and components for production are selected and designed carefully with respect to the life cycle of the cable. Quality certified according to ISO 9001, IRIS, ISO/TS 16949 and ISO 14001. Each product has a certificate with complete list of components and if each one is recyclable. On the external surface of the cable all components are embossed as well. It prepares the cable for future recycling. Even for packaging an alternative to PVC, and other type of plastic traditionally used, paper packaging is employed. This innovative packaging preserves the cable by sturdy corrugated cardboard made to withstand humid conditions and rough handling. It is made of recycled biodegradable materials. The company provides total solution from production to packaging, transportation, installation, maintenance, and recycling (see Figure 3).

Major barriers are identified in relations with customers, lead users, and third parties. Not all customers value the innovative sustainable solutions. Recyclable packaging and components need to be returned for recycling and if customers do not return them after their productive life the cycle will not be closed. Literature has also identified customers' type restriction as a barrier [31,37]. Despite all the information and certifications that the company provides still some customers do not have sufficient information about origins of products.

Lead users are creative customers whose current needs are still unknown to public and they benefit greatly if they achieve solutions to these needs. This group is so focused on their needs that sometimes they do not close the circular loops of the products.

Third parties' involvement are necessary for the success of the company. By increasing the responsibility and involvement of the third parties the challenges and conflict with them arises as well.

The study of Mentink (2014) emphasizes on increase of dependency on third parties that increase risks in CBM transition.

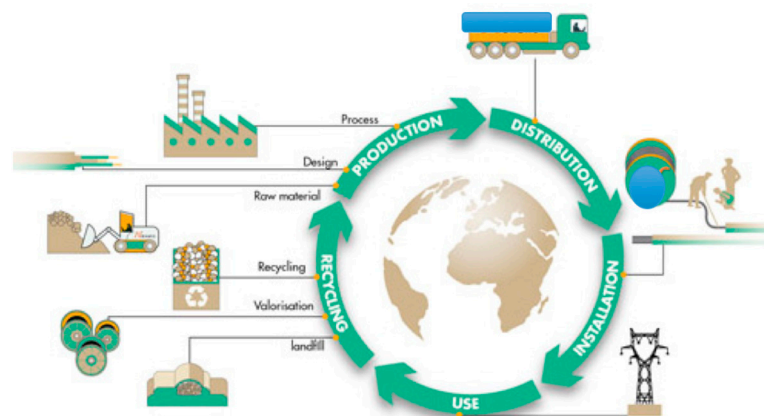


Figure 3. Life cycle of cables (Firm 6's website).

During the CBM transition and after that it became clearer that involving customers in the design of products result a “win-win perspective” For the company and customers. This consequences in higher popularity and higher margins. This is aligned with findings of the study by Gorissen et al. (2016) as well. The company has also learned that selection of expert suppliers is very important especially raw producers of paper and machine suppliers and manufacturing partners. Even small mistakes from these suppliers could have magnitude consequences in the supply chain. The final lesson was preparing clear defined responsibilities for third parties to minimize misunderstandings, conflicts and risks in close collaboration with them. Such a third party is service provider that tie together process machinery equipment from a larger network.

4.1. Data Analysis and Results of Multiple Case Studies

All of the six studied firms had production methods in place with complete consideration for the environment and followed all recommended quality certificates. The following sections we describe the CBM archetypes of the cases and their challenges in details. Table 3 illustrates results of all six studied firms.

CBM Archetypes

Five firms identified “encourage sufficiency” as a CBM archetype. These firms offered solutions to reduce customers’ consumption by offering high quality products and complementary services such as repairs, maintenance, and training and education of staff. Firm 4 had an “access and performance model”, as its customers used the product without owning it. Finally, Firm 6 identified both “encourage sufficiency” and “extending resources value”, not only offering complementary services for extending the life of the products, but also offering recycling and closing the loop.

4.2. Challenges of CBM

Figure 4 depicts the causal loop diagram of the circular business model pattern, with an emphasis on challenges. As learned from the literature and case studies, the major challenge for CBM generally commences with the design of a new offering.

A new sustainable offering requires changes in customer segmentation. Palmatier and Sridhar (2017) suggest that detailed needs, demographics, and the value of target customer segment should be identified. Based on target segment(s), their needs and benefits, and identification of the reasons why to the target segment(s) will use the firm’s offering, the positioning statement will be developed [60]. Brand development is influenced by the positioning statement, and it also

impacts customer dependency [61]. Firm 6 invests considerably in the development and securing of patents, as well as R&D capabilities. This has a direct influence on brand development and customer dependency.

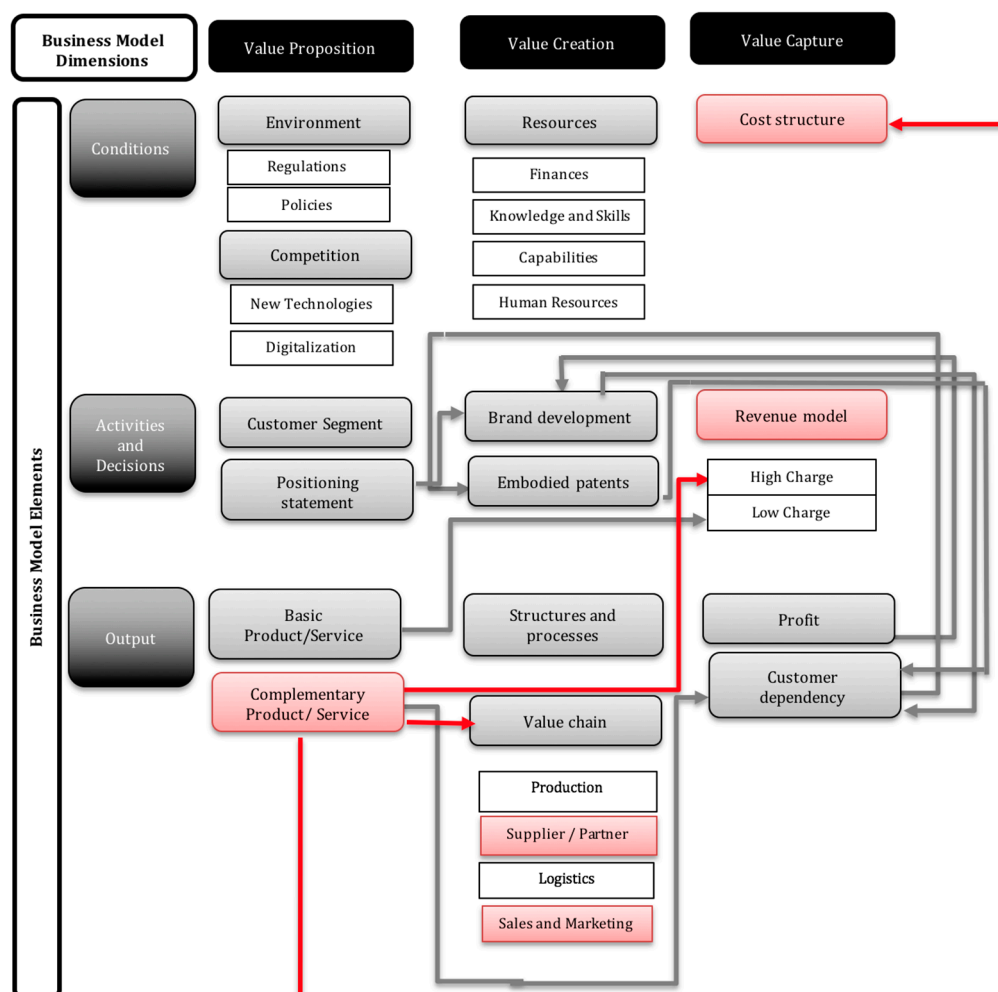


Figure 4. Casual Loop Diagram of the Circular Business Model Pattern, highlighting challenges (adapted from [62]).

Improving the durability, reparability, and/or upgradability allows customers to use the offer for a longer period of time, which increases switching costs and enhances customer dependency [62]. The firm needs to expand its complementary offerings to provide after-sales services for upgrading, repairing, and/or recycling, and this escalates customer interactions, which in turn requires more resources to address them. On the other hand, greater education and informational exchanges between the firm and its customers are necessary in CBMs. The cases of Firms 2, 3, and 4 found the design and configuration of new sustainable offerings challenging. Challenges in relationship with customers were expressed by Firms 2, 3, and 6. Turning this challenge into an opportunity, managers can improve CBM performance by reconfiguring customer engagement. The role of customer engagement in business model performance has been discussed in the extant literature [51]. Thus, the first proposition is as follows:

Proposition 1. *Rethinking customer engagement positively influences CBM performance.*

Several managers from Firms 1, 3, 5, and 6 in the case studies expressed challenges in collaborating with third parties. These challenges were specifically expressed by Firms 1, 3, 5 and 6. Since closer collaboration is required in CBMs, the confidentiality of the individual firm may become challenging [24,36]. Trust is the prerequisite, and doubts among the parties will likely yield problems [36]. The business model should be designed based on the mutual benefit of all partners [24]. On the other hand, building close, trustworthy relationships increases the dependency of those specific partners, which itself could be an inherent risk of CBMs [24]. Therefore, we propose the following:

Proposition 2. *Reconfiguring external linkages positively influences CBM performance.*

The major challenge is reconfiguring the revenue model for CBMs. All of the case studies with the exception of Firm 3 expressed difficulties with the revenue model. Sustainable offerings are new for the firms and other stakeholders and planning a win-win scenario for all involved parties is not easy. Even if an offering seems attractive for customers at a certain point in time, it is difficult to predict future sales due to fashion trends, technology developments, and cost structures (i.e., [31]). Thus, we pose the third proposition:

Proposition 3. *Reconfiguring the revenue model positively influences CBM performance.*

Based on a case study by Linder and Williander (2015), the risks and cost structure for CBMs is different in comparison with traditional BMs. Time plays a huge role in costs and revenues. Design and production of early products with durability, reparability, and/or upgradability might carry costs that are much higher than subsequent production runs. Additionally, the risks are higher for predicting long-term market demand and costs. Tukker (2013) explains that customers are careless when it comes to leasing particularly in B2C area, and this is another factor that renders the prediction of maintenance costs challenging. Altogether, these factors build unpredictable costs.

In one of the six firms studied cases in the revenue model in which the customer uses the product without owning it, depreciation costs were not considered, and that in and of itself generated a large amount over the years. Thus, the fourth proposition is formulated as follows:

Proposition 4. *Optimizing the cost structure positively influences CBM performance.*

5. Discussion and Conclusions

This paper sought to provide insights into the current challenges of CBMs with an industrial perspective. The extant literature review identified the list of challenges, and multiple case studies helped to identify the most important challenges. The primary challenge as identified by five of the six firms was value capture and, more specifically, the revenue model. Managers expressed concern regarding the design of new revenue models. Examining the sources of this challenge, we explained the unexpected costs and higher risks. The complexity of associated cost structures and risks has also been explained in other studies, including a study conducted by Linder and Williander (2015).

The other challenge expressed by managers involved value creation and, more specifically, relationships with partners. Many studies have explained the importance of collaboration with partners in CBMs, as well as the challenges that can result from these collaborations [24,36]. The third primary challenge was in value proposition and, more specifically, the design of the development of new sustainable offerings, as expressed by three firms. An offering that can survive fashion and technology trends while maintaining durability and customer attraction is not very easy to design and develop. Finally, customer relationships are not the same among CBMs in comparison with traditional business models. Among the case studies, three firms expressed difficulties in their relationships with their customers.

This study identified the primary challenges of CBMs and strove to transform them into opportunities to improve CBM performance, suggesting four propositions. We proposed that

rethinking customer engagement, reconfiguring external linkages, reconfiguring the revenue model, and optimizing cost structure all positively influence CBM performance.

The firms learned many lessons during and after their transitions to CBMs. First, involvement of customers in the early stages of new offering development is highly recommended. In this way, not only will the sustainability factors be considered, but also the needs and desires of customers [51]. Second, several firms in the study suggested the importance of the selection of expert partners and the development of cooperative arrangements with ecosystem actors. It is recommended that the responsibilities of partners be clearly defined before collaboration commences. Third, several firms emphasized that the revenue model should be redesigned according to new offerings, that diverse revenue models for diverse offerings should be incorporated, and that add-on service options should be designed in conjunction with new revenue models.

Each one of the cases, among these six studies, is from different industry; however, there are many similarities between them about CBM archetypes and CBM challenges. Thus, it can be concluded that successful cases that have overcome the challenges of product restrictions and marketing related activities face almost similar barriers mainly in value capturing and value delivery.

In conclusion, these six cases illustrate that despite challenges of CBM transition, it is possible to contribute to different aspects of sustainability. Even though we did not measure the performance of the CBM in the cases, the overall observations and firms' general success could point out that the transition to CBM has been a positive decision and movement. Primary effects of CBM were reduction of negative environmental impacts, improvement of competitive advantage by both lowering costs and/or enhancing revenues. Second order effects were on social and ecological contributions, beyond pure economic impacts. In addition, CBM improved the brand image and made those firms a more attractive employer.

Limitations and Suggestions for Future Studies

Despite the contributions described earlier, the study is not free of limitations. This research highlights the primary challenges of CBMs, but the findings are only valid within the narrowly defined scope of the context, which is large Swedish firms. Thus, to date the generalizability of the findings to small and medium-sized firms is unknown.

Another limitation of this study is that we interviewed focal firm and no other members of the alliance network. Consequently, suppliers' and customers' perceptions and judgements are not included in the study. For future studies, dyadic data, including all members of an alliance, is desirable for incorporation in the results.

This research did not focus on CBM performance, and as a result, we did not compare the success of CBMs in the case studies. CBM performance is a complicated but critical issue in management research [51]. Further studies might identify more antecedents to CBM performance and test them statistically.

Acknowledgments: The authors would like to acknowledge the support given by Sweden's innovation agency (VINNOVA) within the program 2030. Furthermore, the authors would like to thank all other members of the research project.

Author Contributions: Both authors contributed equally in designing and development of the paper. Furthermore, the corresponding author did lead the review response process and resubmission tasks to the journal.

Conflicts of Interest: The authors declare no conflicts of interest.

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