THESIS

Tackling the Circular Economy

Aiding firms in the design and implementation of circular business models

Master Thesis

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Alexander Ceha

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Author
Alexander Ceha S1565613

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Faculty: Engineering Technology
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Educational Institute
University of Twente
Drienerlolaan 5
7500AE Enschede

Examination Board
Chair of Product Market Relations

Project Supervisor:	Dr. C.V. Gelhard	
Examination Committee:	Prof. Dr. Ir. J. Henseler	*Chairman (PMR)*
	Prof. Ir. M. E. Toxopeus	*External Member*

1. Abstract

The global economy is under increasing strain due to the continual consumption of finite resources to provide firms, organizations, and governments with necessary raw materials and to meet their growing energy demands. In order to slow and close resource loops in today's marketplace a regenerative economic model is required, a circular economy. This paper sets out to aid in overcoming the challenges that businesses are facing prior to, during, and after their transition to a circular economy. The main barrier to entry for many firms is uncertainty, this is the leading reason for a firms distrust in the circular economy. To overcome this source of uncertainty the in-depth analysis of six, tangible, circular business models was carried out with the goal of identifying key, overarching, building blocks (from the business model canvas), and opportunities for sustainable product design principles. This research revealed that there are three key building blocks [Partnerships, Value Proposition, and Revenue Stream] that are not limited to a singular circular business model archetype and should be a strong focal point for any business looking to transition to a circular economy. This study also reveals that certain sustainable product design principles align with specific circular business model archetypes. This information can be utilized by businesses to form their product design strategies in line with their circular business model, under the umbrella of a, single or combination of, sustainable design principles. The results found in this paper should be used by firms who are looking to transition to a circular economy. The identification of the three key building blocks allows for a better focus on areas of disruption within the business model canvas, giving firms the ability to make more informed decisions during the early phases of their transition. The firm should select design strategies based on the sustainable product design principle associated with their specific circular business model archetype. The combination of these results provides a firm with a less uncertain and more validated business model canvas, allowing the firm to exploit a more informed approach to circular business model innovation.

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3. Introduction

Imagine a global economy in which today's products can become tomorrow's resources. This is the vision which is driving global businesses, organizations, and governments to change their perspective on traditional linear consumption patterns ('take-make-dispose') (MacArthur, 2013). These traditional models are increasingly leading to resource scarcity, marketplace volatility, and goods pricing levels that are straining our global economies. Governments have been a leading stakeholder in regulations towards effective resource management and recycling systems, however increasing consumer pressures, rising levels of resource scarcity, and volatile raw material prices are pressuring businesses to adapt. The economy is forcing sustainability to become an integral factor in the decision making processes for businesses. The success of a circular economy boils down to the ability for firms and organizations to adopt and profitably develop relevant, new, 'circular' business models (MacArthur, 2013).

Traditional linear business models have created a series of fundamental challenges for the world's social, economic and environmental climates. With increasing global population growth, finite resources are becoming scarce, increasing their value, and causing many firms to rethink their material and energy usage strategies (Geissdoerfer, Savaget, Bocken, & Hultink, 2017). A few firms are choosing the routes of least resistance, such as sourcing cheaper materials and compromising the quality of their products, while others are investigating the opportunities present in more closed loop systems. These closed loops refer to the recapturing of value from firms products, often extending the lifecycle or recovering value from already sold products (Tukker, 2015), (Ellen-MacArthur-Foundation, 2015), (Stahel & Reday-Mulvey, 1981). This generates a circular economy, where a firm recovers the material and processed value from products it has previously brought to market. This method has led to the restructuring of business models to enhance a firm's 'circularity', and in so doing decrease the global impact of a firms products and/or services.

With firms and organizations trending away from the linear economy and towards the circular economy, the importance of such a transition lies on the circular business model that will be implemented. The fundamentals for all firms lie on the goal of the profitable delivery of a product, service, and/or value proposition. This paper will examine the real world implementation of four distinct business model archetypes taken primarily from (Nancy M. P. Bocken et al., 2016). These four archetypes are: service oriented, extended value, design for durability, and industrial symbiosis. Each of these circular business model archetypes focuses on a unique facet of the circular economy, providing a product as a service, extending the intrinsic value of a product, extending the usable lifetime of a product, and using waste outputs from proximal industries.

These innovative circular business models come with a set of challenges that businesses face in order to successfully transition from linear to circular business models (Ghisellini, Cialani, & Ulgiati, 2016). Firm's often associate change and disruption with risk, and in so doing they require a validation, of types, that a new business model is successful before they are more inclined adopt it. This creates the initial challenge of validating a business model before a business is more inclined to transition. It is not rare for firms to look to competitors, or start-ups operating under a new business model, for a disruptive business models validation. In so doing firms and organisations limit their own factors of risk by incorporating successful strategies being

employed by others. Often validating a business model is a costly endeavour, requiring heavy investment and time before validation of a model is completed. For this reason it is important to examine existing cases of success for firms utilizing circular business model strategies. In order to reduce the challenge of business model validation, this paper seeks to identify, analyze and evaluate the common key building blocks that drive success in a circular economy.

The challenge businesses face is not limited to their choice of business model, but inherently in the designs of the products and services they offer. The traditional linear business models have created their own set of design principles, focusing heavily on production efficiencies, mass production, and the functionality of products. The growing appeal of the circular economy has brought with it a new set of principles for sustainable product designs. These principles allow firms to enhance the value they offer to consumers, while aiding in the effectiveness and efficiency of the circular business model the firm may transition to. In order to aid in a firms transition to a circular economy, this paper will attempt to analyse the opportunities created for firms to incorporate sustainable design principles during a products development phase.

This paper is structured to provide a clear overview of previous research on the topics of sustainability, circular economy, closed loop supply chains, business models, and product oriented design strategies for sustainability. These chapters seek to inform the reader on the previous research taken on these subjects and the concise formulation of the results of this research. With a solid theoretical framework, the paper will move forward with a conceptual framework, to provide the context via which an investigation into the identification of the key building blocks and opportunities for sustainable product design during a transition to the circular economy can be made. This is achieved using six distinct case-studies which outline concrete examples of circular business models. Cross-case analysis, in the discussion chapter, allows the reader to have a structured overview of the results of each individual case study analysis, outlining the differences and similarities identified for each case. Further discussion will be done to identify the underlying product design principles that each case employs, concluding with the strategies to implement and design under the guidelines of these principles, as well as, an overview of key building blocks for firms to focus on during the conceptualization of their circular business models.

4. The Challenges Facing Firms

With the rising costs and scarcity of natural resources, organizations which employ a linear business model need to adapt very soon. Linear business models that utilize the take-make-dispose concept are becoming out-dated and unsustainable, with unattractive levels of waste and process inefficiency. The nature of a disruptive business model innovation dictates the creation of a new market and value network (Bower & Christensen, 1995) for firms who adapt to a circular business model. The disruptiveness of a circular economy can be estimated by examining the extent to which the existing linear model being employed needs to be altered, and the 'new market and value' associated with this transformation.

The circular economy transforms the linear system to a model which closes the loop, eliminating waste, in favour of recycling, re-use, repair, or refurbishment. This transformation disrupts existing linear

business models, during this disruption the creation of new markets and value networks is possible. This is possible by the creation of value (by design) during the end of life cycle of current products. Where materials can be repurposed to add value, or value is attained by the purchasing of another organizations end of life products to be used during the production process, eliminating both the waste and/or input requirements for a business. The extent of this disruptiveness is determined by how dissimilar linear and circular business models are. This dissimilarity could create the need for major firm re-organization, both on the production floor and management level to achieve the operational needs of closed-loop supply chains or the establishment of a product end of life management system.

Due to this process of disruption, it is difficult for a firm to situate itself within a new marketplace. Businesses increasingly see the challenge of where to focus their new circular business model, should a firm focus on its value proposition, or its key resources, perhaps the channels it uses to reach its customers should be a focal point during the design of the business model. This subject of uncertainty for firms is a source of risk, and is acting as a barrier for many firms to transition to the circular economy. In order to overcome this barrier, this paper will investigate a framework designed to identify the key building blocks that are most common for a circular business model. These key building blocks are part of the business model canvas, and will aid in a validation of the success of a business model, while also allowing a business to pinpoint which building blocks should be a focal point during the transition to a circular economy.

4.1. Research Questions

This leads to the first research question:

'*In order to overcome the barriers of uncertainty that businesses face during their transition to the circular economy, are there any identifiable key building blocks that remain common between different circular business model archetypes operating in various industries?*'

The second research question that this paper seeks to address is:

'During the implementation of a circular business model, are there any opportunities for firms to incorporate desirable sustainable product design principles to more holistically create value in a circular economy?'

The answers behind these research questions should culminate in an overview of the key building blocks for firms to incorporate during a move to a circular economy, and the outlining of distinct principles to design sustainable products. This paper hopes to aid firms during the design and decision making processes when developing a suitable circular business model. Allowing for a reduction in associated risk during the transition while providing a point from which a firm can redesign their products and services while utilizing principles for sustainable design.

5. Literature Review

5.1. Sustainability

With roots in the forestry industry, the term sustainability originated from the principle that the amount of wood harvested should not exceed the volume that grows again. Today sustainability has become a term fashionable to use, but under defined for the majority of people. One may wonder how such an ambiguous term "has become a critical perspective in managing firms … by considering economic, environmental and social dimensions"(Chang et al., 2017). The concepts uptake can be traced back to the increasing evidence behind the environmental risks of climate change, ozone depletions, and bio-diversity loss (1960s) (Geissdoerfer, Savaget, Bocken, & Hultink, 2017). These risks began raising questions asking whether these current trends of prosperity can be maintained in the future.

Recently (Brockhaus, Fawcett, Knemeyer, & Fawcett, 2017) stipulated that an enhanced purchasing power made sustainability economically viable. The 'luxury value' proposition made it appealing to many, with the consumption of sustainable products long conveying a positive esteem-laden reputational effect (Nia & Lynne Zaichkowsky, 2000). In this era of abundance (Brockhaus et al., 2017) research by (Janssen, Vanhamme, Lindgreen, & Lefebvre, 2014) strongly suggested that sustainability and luxury notions show strong interaction in the mind of consumers. This feeling of 'moral rightness' along with the conceived belief that sustainable products can be more easily consumed has led many businesses to promote sustainability's social value. This trend in consumer mindsets can be seen as a leading factor in an organization's push towards sustainable products, packaging, and processes (Watkins, Aitken, & Mather, 2016) (Carvalho, Silvestre, & Cunningham).

In order to clearly define the term 'circular economy', a solidification of the term sustainability should be done. A recent European literature review study defines sustainability *"as the balanced integration of economic performance, social inclusiveness, and environmental resilience, to the benefit of current and future generations." (*Geissdoerfer et al., 2017*)*. This definition for sustainability reveals the full extent of the term, encompassing economic, social and environmental factors in order to benefit future generations. The key to sustainability is a balance, e.g. to balance the raw material input and output of a business, or to create situations where value is cycled as a balanced operation, conserving value for firms. The circular economy ideology strives to help businesses create an overview of techniques, routes, and strategies to achieve this balance. Businesses and organizations often implement circular business models to create their own circular economy.

5.2. Circular Economy

Nearing the end of the European industrial revolution scientists and forward thinkers began realizing how the linear production process depletes finite reserves and stockpiles landfills and incinerators. With this realization, Walter R. Stahel, founding father of 'industrial sustainability', and Genevieve Reday conceptualized their vision of an economy in loops. Outlining a loop (circular) economy's impact on job creation, economic competitiveness, resource savings, and waste prevention, in the book (published 1981) 'Jobs for Tomorrow: The Potential for Substituting Manpower for Energy.' The main goals behind this idea are, product-life

extension, reconditioning activities, waste prevention and long-life goods. Insisting upon the importance of selling 'services' as opposed to products, an idea referred to as the "functional service economy" (Stahel & Reday-Mulvey, 1981). This model emphasises the selling of utilisation instead of the ownership of goods as a relevant sustainable business model for a 'loop' economy (Geissdoerfer et al., 2017). This in turn allows industries to profit without the externalisation of risks and costs associated with waste.

The more modern concept of a Circular Economy has evolved to incorporate further visions of a closed loop system. These concepts attempt to explain more practical applications to economic systems and further refinement of industrial practices. A large influencer to the contemporary model comes from a cradle to cradle philosophy (McDonough & Braungart, 2002) with a focus on eco-effectiveness and eco-efficiency (Toxopeus, de Koeijer, & Meij, 2015). This philosophy, as put forward by William McDonough and Michael Braungart, is a well-known concept to reducing the ecological footprint and minimize the damage inflicted on the world. The other main influencers of the Circular Economy includes the theoretical concepts such as biomimicry (Benyus, 1997), regenerative design (Lyle, 1996) and industrial ecology (Allenby & Graedel, 1995).

A development of the term Circular Economy is needed in order to define a concept that closes the loop, not only for material flows, but the requirements of energy and infrastructure. (Geissdoerfer et al., 2017) Define Circular Economy as "a regenerative system in which resource input and waste, emission and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. … achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing and recycling." This comes from the definition put forward by the Ellen MacArthur Foundation; "an industrial economy that is restorative or regenerative by design". This associates the idea of a circular economy together with biological circular systems. (Geissdoerfer et al., 2017) Take into account the Chinese view of a circular economy with the "realization of closed loop material flow in the whole economic system." (Geng & Doberstein, 2008) and (Webster, 2015) adding that "a circular economy is one that is restorative by design, and which aims to keep products, components, and materials at their highest utility and value at all times." A different perspective is taken by (Nancy M. P. Bocken, de Pauw, Bakker, & van der Grinten, 2016) who examine circular economy in

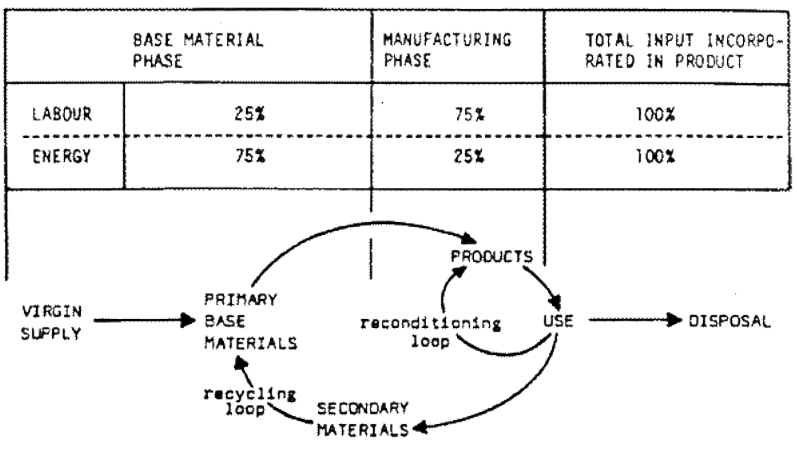


Figure 1. 'Alternative Life-Cycles of an Industrial Product and Intensities of Labour and Energy Inputs in the Production Phases' From: Jobs for Tomorrow: The Potential for Substituting Manpower for Energy

terms of “design and business model strategies {that are} slowing, closing, and narrowing the resource loops.”

5.3. Circular Economy System Diagram

The circular economy (CE) vision seeks to recapture and rebuild value, whether it is financial, human, manufactured, natural or social (Ellen-MacArthur-Foundation, 2015). The CE aims to ensure the enhanced flows of good and services offered by businesses. The Ellen MacArthur Foundation was established in 2010, it exists as a charity with the aim of accelerating the transition to the circular economy. Since its birth the foundation has become a pillar for global sustainability and information about the CE phenomena, becoming a global thought leader for CE. Figure 2 reveals an overview of the circular economy as envisioned by the Ellen MacArthur Foundation, and reveals multiple loops for the rebuilding of value for businesses, organizations, and governments alike.

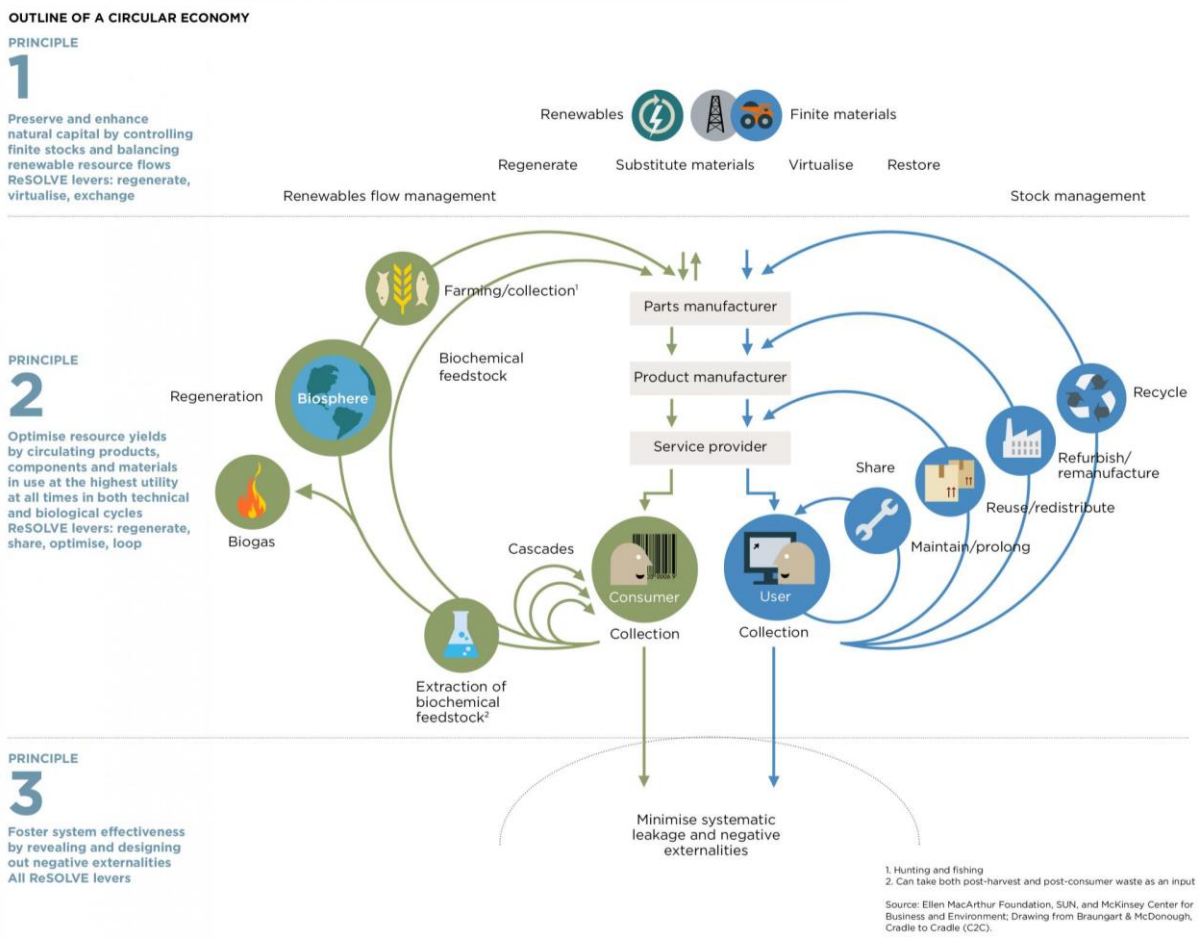


Figure 2. The Circular Economy System Diagram (Ellen-MacArthur-Foundation, 2015)

5.3.1. Principle 1: 'Preserve and Enhance'

The CE system diagram (Figure 2) represents cycles for both, renewables flow management (left-hand side) and stock management (right-hand side). Principle 1 refers to the choice of materials and energy sources being consumed by businesses and organizations. With the aim of preserving and enhancing inherent value by utilizing the control of finite stocks and balancing renewable resource flows. This principle focuses on the sustainable selection of materials that a firm will consume in order to create its products, it is often the case that the cheapest finite material will be considered, in order to maximize profit margins. However the CE incentivises durable, longer lasting, and easily recaptured materials. This ensures a product can be collected and transformed into a value proposition, through the various CE loops of service, reuse, refurbish, and recycle.

5.3.2. Principle 2: 'Resource Loops'

In order to fully define a CE, and the circular business models used to achieve a CE, an outline of the various 'loops' should be made. This process will aid in eventually defining and categorizing various case-study business models, and what 'loops' they utilize to create their own circular economies. For the purposes of this paper the focus will be on 'stock management' (right-hand side), since it is more often the case that consumer products, products designed specifically for use by consumers, incorporate finite materials as opposed to renewables. The diagram reveals four 'loops' that can be utilized to achieve a CE, each loop enters back into the forward supply chain at different levels, this means that business can specifically choose a loop that is suitable for their product or service. Firms and organizations are not limited to a single loop, however it is often the case that focus is set on the achieving of a single resource loop to generate value flow back into the forward supply chain.

Collection forms the general constraint by which firms and organizations recapture value. The process of collection can also be called the reverse supply chain, this is outlined in section 4.6 as a part of a closed loop supply chain, which combines the management of the forward and reverse supply chains. Collection refers to the act of collecting products back from the customers, this route is often incentivised by 'deposit-refund', 'legislative schemes', and 'product buy-back' (Rickli & Camelio). An efficient scheme is often critical due to the costs of product return that are imposed on businesses, these costs can dis-incentivize the adoption of a CE, and often the design of a circular business model incorporates the strain of collection in order to reduce associated costs. Value recovery can create a situation where consumers act as suppliers, thus creating a chaotic network of supply, with high levels of uncertainty. Circular business model design can strategize the value recovery network, this can be seen with the emergence of reduced-ownership or service-oriented model which retain product ownership. This is investigated further in section 4.5.

Servicing (maintain/prolong) is the shortest resource loop, where products are collected (can be done on site) from a consumer and serviced to be functional again for the consumer. This resource loop acts to extend the product life cycle and to delay the end of life (EoL) phase of a product (Takata et al., 2004). In turn reducing the need for new products to be brought on the market, and thus decreasing scarce material usage

and energy consumption. By extending a products life time, businesses can contribute to a circular economy by keeping their products and services in market circulation for extended periods of time. The servicing 'loop' incentivizes durable, functional, and high quality products to extend product life-cycles and increase the time needed between service intervals. This creates the need for design for serviceability principles to be used to ensure efficient servicing of products/services. The service loop returns the product directly to consumers.

Reuse cycles are often used to exploit the residual value of a product after a consumer has finished with it. An example of consumer reuse is the second hand market for products. When a product is no longer wanted by the initial customer, there are platforms in place by which the customer can sell the product for the reuse value. This creates a market for consumers to generate value from purchases made that are now under-utilized or not needed. The same can be done by firms, by collecting products from consumers they can exploit the products value by redistributing the product for reuse. This has the effect of extending a products lifecycle and delaying the EoL. The Reuse loop delivers the product back to a service provider or distributor.

Refurbish is the act of renewing, remanufacturing and restoring a product to a new condition and/or appearance. When products experience high levels of wear and tear, or are built up of many components, the option of refurbishing is used to utilize the working parts of a product. For example, a well-worn chair may have experienced wear in the cushioning and back rest areas where refurbishment of the textiles and cushioning materials is needed. This creates a position for a firm to reuse the frame of a chair while refurbishing the worn elements to restore the product to its original condition. Once a product has been refurbished it can be redistributed to consumers at a reduced price point, making it more affordable to new customer segments (King, Burgess, Ijomah, & McMahon, 2006). Refurbishment again extends the life cycle of a product, and requires minimal new material and energy requirements to achieve refurbishment. For more complex product configurations the process of remanufacturing can be used to achieve a similar goal. Manufacturers can recapture the intrinsic value of products by remanufacturing working parts into large product configurations (e.g. automotive industry). The refurbish loop delivers the product back to product manufacturers to be reintegrated into their forward supply chain.

Recycling is the most common resource loop, often utilized by governments via legislation to incentivise consumers to consider the material values of the products they dispose of. Recycling converts waste into reusable materials, this loop focuses on the intrinsic value of the materials being used in products. Raw material consumption is a key aspect of the wastefulness of the linear economy model, recycling is a method used to reduce the impact of this raw material consumption. Recycling focuses on the dismantling and processing of EoL products to return them to useable stages of natural materials. The recycle loop often returns the products component materials back to part manufacturers and suppliers, or to be used in other industries, where already processed materials may be needed. Recycling reduces the consumption of raw materials by creating alternative materials, often at a reduced price, to scarce resources.

5.3.3. Principle 3: 'Design for System Effectiveness'

The third and final principle identified in the Ellen MacArthur Foundation's overview of a CE is the fostering of the system's effectiveness. This principle refines the process of the circular economy by revealing and designing out negative externalities. Efficiency and effectiveness are key factors for the unencumbered success of a circular economy, principle 3 reminds firms to 'minimise systematic leakage and negative externalities'. Negative externalities are commonly known as a cost that is suffered by a third party, however within the CE setting, a negative externality should be seen as wasted resource recovery. An example here would be the underutilization of recovered products. Principle 3 aims to fully incorporate all aspects of the intrinsic product value back into the forward supply chain for the business or organization. Principle 3 can be seen as the 'making effective' of the reverse supply chain and the fullest use of recovered products.

5.4. Closing Resource Loops

Circular Economy business models often take into account the, raw material and energy input, and the residual value output of manufacturers (*Extended Value, Industrial Symbiosis and Service oriented models)*. The closed loop supply chain is a system that "strives for sustainability by improving economic and environmental goals simultaneously" (Winkler, 2011). With the increasing need for a reverse supply chain (RSC) due to factors such as e-commerce, warranty rights, service-repair costs and extended producer responsibility, businesses are implementing strategies for efficient and effective RSC management (Schenkel, Caniëls, Krikke, & van der Laan, 2015). Adoption of a closed loop supply chain, via the means of integrating the authentic forward supply chain (FSC) with the RSC, is creating value for firms on a global level. CLSC's achieve this by incentivising activities that reduce raw material consumption (re-purchasing of parts, return of products) and extending the product portfolio to accommodate second hand, refurbished or remanufactured products. (Guide Jr & Van Wassenhove, 2009) defines CLSCs as "the design, control, and operation of a system to maximize value creation over the entire life-cycle of a product with dynamic recovery of value from different types and volumes of returns over time."

The purpose of a closed-loop supply chain is to create value for a product in order to meet consumer demands (FSC), and to provide a method of absorption (take back of products) and a suitable strategy to use/repurpose these re-acquired products (Govindan & Soleimani). The key attributes of a circular economy, and those put forward in a closed loop supply chain are eerily similar. For the reason of a complete overview of a circular economy, the management style of a fully encompassing closed loop supply chain point of view should be taken by businesses willing to follow the business models suggested in Table 1.

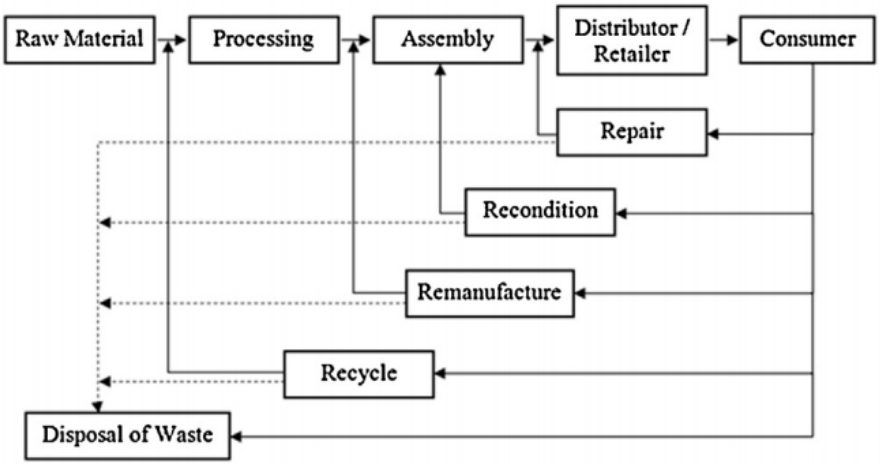


Figure 3. Generalized illustration of product absorption in a Closed Loop Supply Chain (Khor & Udin, 2012)

CLSC contributes to the value of a product via four avenues, economic, environmental, customer and informational value (Schenkel, Krikke, Caniëls, & der Laan, 2015). Economic advantages come from the absorption of products from consumers back to the business. Environmental value is achieved via the means of a lower carbon footprint (Krikke, 2011), and pollution prevention (Huppes & Ishikawa, 2009). Value with customers can be achieved by green corporate image, increased customer satisfaction, loyalty, and repurchase intentions, this leads to increased product quality/luxury perceptions. Information value from CLSC is due to the closing of the loop, consumer interaction is repeated at the end of product life, meaning another touch point for the gathering of meaningful product information (Schenkel, Krikke, et al., 2015).

5.5. Success Factors for CLSC Value Creation

Based on the work from (Schenkel, Krikke, et al., 2015) three key strategic factors for success in value creation for CLSC can be identified. These 3 factors are customer services, product design, and business models. These findings encourage a closer look at the 3 factors, this thesis will put particular focus on the latter two (product design and business models). Based off of the similarities between a circular business model and a CLSC it is understandable that these three factors affect the success of a circular economy and the circular business models being employed.

Customer Services. This refers to the 'absorption' cycle of consumer products. The factors within this area are certain uncertainties regarding quality, quantity and timing of product returns which may cause possible inefficiencies in RSC (Thierry, Salomon, Van Nunen, & Van Wassenhove, 1995). Third party service providers, strong service relationships with customers, and trade-in incentives can all influence the RSC of a firm. The base of a good end of life return cycle for products is consumer incentives and efficient logistical systems which can be used to close the loop with customers (Schenkel, Krikke, et al., 2015).

Product Design. Implementation of circular product design principles should be taken into account early on in the design phase, in order to reduce modification or alterations to existing successful product designs. Within this strategy of product design focus there are a series of trade-offs to be made with regards to

what concepts to use for what product. Designing long-life products aims at increasing the utilization periods of certain products (Nancy M. P. Bocken et al., 2016). i.e. Miele washing machine with a guarantee period of 20 years. Design for product life extension (design for assembly and disassembly) examines the strategy of designs that are easily serviceable, upgradeable, or re-useable. This may consist of multiple facets such as modular design, ease of maintenance, and upgradability. Depending on the product and market, design features that incorporate such concepts may be perceived as a durable, creating a new portfolio for leasable and easily serviceable products (Nancy M. P. Bocken et al., 2016; Schenkel, Krikke, et al., 2015). This design strategy then aligns well with service oriented (reduced ownership) business models due to reduced cost/risk of product failures and maintenance. A final product design strategy may be 'design for a biological cycle' which encourages the use of bio-degradable or bio friendly materials that can be re-purposed as nutrients for natural systems across their lifecycle (McDonough & Braungart, 2002).

Business Models. The choices made for the CLSC, including both the FSC and RSC, are often reliant on the business model being used by the business (Wells & Seitz, 2005). CLSC systems can only be implemented on the base of an overarching business model that creates value for the stakeholders in the system. The dependence of the CLSC on the business model archetype of choice, and there for the forward supply chain is high. CLSCs require a good overview of revenues, costs, earnings models, and so on, in order to be implemented successfully. Value Creation, and value retention are both integral to a competitive CLSC and these can only be described when a conceptual business model is chosen as the prime source of value for the business (Guide, Harrison, & Van Wassenhove, 2003). The importance of a business model during the envisioning of a CLSC is beneficial to create an all-encompassing point of view, and therefore allow for the development of a full closed loop system or circular economy.

5.6. Sustainable Product Design Principles

The CLSC outlines three factors for success, customer service, product design, and business models. This paper will focus on both product design and business model designs in order to facilitate a CLSC and a circular economy. In order to achieve suitable product design for use within a CLSC and CE combined, certain sustainable design principles should be followed. Firms can utilize these design principles to integrate good design with circular economy loops. For this to work product designers must understand the processes that their products will undergo during the EoL recycling and the loops for product extension. To create a holistic set of principles for product designers to follow, this paper will examine the current methods for sustainable design strategies. It is important to note that the number of stakeholders that will interact with the designed products, and what sort of interactions these will be is specific for each firm, and the principles being examined in this paper are considered a general design approach to achieve a form of sustainability.

In order to achieve sustainable practices, many of the loops involved in the circular economy focus on extending the product lifecycle. To this end, '*Designing long-life products*' (Nancy M. P. Bocken et al., 2016) ensures a longer possible utilization period for products. This principle is also known as "design for durability" and "design for reliability" and focuses on a higher standard of quality, and longer lasting material choices to

underpin the long-life of a product. By following the principle of designing long-life products firms are able to generate more eco-efficiency and slow down their consumption and need of finite resources (Cooper, 2005). It may be assumed that creating longer life products will decrease the sales of a firm, however (from example Miele) a focus on durability generates the beneficial perception of both quality and sustainability. Both of these factors play a role in establishing the price point of a product in the minds of consumers, who are more willing to pay a premium on both quality and a greener product.

The second principle for sustainable design can be entitled as '*design for product life-extension*' (*Nancy M. P. Bocken et al., 2016*). Product life-extension focuses on designing products which aid in the efficiency of achieving the circular economy loops. This principle can be achieved by designing products for ease of dis and re-assembly in order to achieve swift recycling and/or refurbishing loops. The design of products could be modular, to allow for ease of servicing and upgradability, thus having the added sustainable benefit of extending product lifecycle. The principle can be further used to design for functionality and usability, and in so doing, create a more fully utilized product. Product life-extension does not only refer to the usable lifecycle of the product, but also involves the extraction of the intrinsic values of the materials used in the product. Within this principle of product life-extension a few design strategies can be named: design for ease of maintenance and repair, design for modularity, design for upgradability and adaptability. These strategies each fall under this design principle and could be used by firms to achieve product life-extensions, creating either the opportunity for the use of a CE or aiding in the sustainability of an existing CE.

In order to fully close a product loop it can be designed to follow the principle of '*design for a cycle*'. This principle outlines a circular flow for technological and/or biological products. Smart design methods should be used to ensure a certain ease of disassembly to allow materials to be separated back into their original forms. A larger variation of materials involved in a product can create more difficulty in the loops for recycling and disposal methods, creating the need for new processes and energy requirements to separate the large number of materials. Focusing on the cycle of material value of products it should be noted that this principle should be considered by every designer, not just by a firm who is seeking a CE. This principle aligns with 'Cradle to Cradle' thinking (McDonough & Braungart, 2010), brought forward in the late 2000's, this ideology focuses on a holistic perspective of how a product is made, used, and disposed of. Cradle-to-cradle thinking is created to aid the linear business models with a more holistic design approach, however its suitability to a CE cannot be understated and can be followed under the principle 'design for a cycle'.

5.7. Why should a firm implement a Circular Business Model

The linear value chain has led to product-oriented business models having the incentives to maximize the number of products sold, and thus maximizing revenue, increasing market share, and generating profits. By moving away from the linear value chain, product orientation moves towards service-oriented business models (Tukker, 2015). A service orientation see's many advantages over traditional business models (see chapter 4.5), however there are multiple approaches a firm can utilize to create a business specific circular business model. This adoption of the circular economy, and sustainable ideals, alters the incentives for

businesses. Transitioning their earnings model and incentives to the quality of services rendered, in turn changing the role of products and consumables to becoming cost factors. Hence firms need to prolong the service life of products, and design them to be cost and material efficient in order to maximize turn over. This new model further takes the role of waste management out of the hands of the consumer and returns the burden to the service provider. Incentivising a service-oriented business to design smart products where material and energy requirements can be re-used or absorbed back into the company's manufacturing, refurbishing or re-using facilities. This entails the design of durable products for multiple lifecycles, design of take-back products and the design of products for ease of refurbishment or remanufacturing (Prendeville, Sanders, Sherry, & Costa, 2014).

Reduction and in turn cost minimization are attractive terms to any product-oriented business that requires an input of primary energy and raw (or recycled) material. The minimization of these aspects requires an improvement of efficiency in products (eco-efficiency) (Toxopeus et al., 2015) and consumption processes. Walter R. Stahel (2016) sees this area as an area for innovation; compact and lightweight products, better technologies, simplified or reusable packaging, simpler lifestyle, etc. Stahel believes that Circular Economy business models fall under two groups. Those that extend a products lifecycle by service, reuse, and refurbishment, and those turn used goods into as-new resources by recycling processed materials. The first group well is suited towards firms which create a value proposition in the form of a tangible product, incorporating luxury (sustainable) value addition (Janssen et al., 2014) with the evolution of more service oriented business models.

5.8. Circular Business Models

Before suggesting circular business model archetypes, it is important to define the term 'business' as a component of today's society. 'Business' is an organization or economic system where products and services are exchanged for one another or for money (Langlois & Robertson, 2002). The underlying goal of any business is to have its revenues exceed its expenditure, thereby turning a profit. In terms of value, a business aims to create value via a system of processes or services, and deliver this value to customers. The role of business is often to solve a problem and often to create a product/service that has some function and is of use to the customers. Businesses use business models as a strategy to find an adequate system of processes that allows a firm to create profits. These models can be broad in terms of an underlying system, or specific to each business depending on operations, customers, channels, cost structures, and revenue structures. Businesses often come in the form of legal entities and can therefore be controlled by governmental bodies and legislative regulations.

With "A good business model remaining essential to every successful organization" (Magretta, 2002), it is important to define precisely what a business model is, and how it's concept can be implemented within organisations to achieve success. Creating a business model is much like writing a new story, and at some level all new stories are variations on old ones (Magretta, 2002). Each of these stories consists of two parts, the first includes all activities associated with designing, purchasing of raw materials and manufacturing (the input).

The second part consists of the output, selling products, reaching customers, sales, and distribution. In today's market, there are 4 main types of business model; manufacturer, distributor, retailer, and franchise (Job, 2016). This paper will examine circular business model strategies primarily for the manufacturer business model, redefining the 'take-use-dispose' value chain (Cradle-to-Grave) to the circular value chain (Cradle-to-Cradle).

Business Model Archetypes	*Definition*	*Example Cases (Real World)*
Service Oriented (Reduced Ownership)	Provide the services or capabilities that satisfy your users' needs without them needing to own the physical products	✓ Car Sharing o ZipCar o Car2Go ✓ Housing Sharing o AirBnB ✓ Clothing Leasing ✓ Electronics Leasing
Extended Value	Closed Loop Supply Chains, exploiting residual value/materials of products, Manufacture-consumer-manufacture. Collection of products between businesses	✓ Electronics o Gazelle, buying and refurbishing electronics. ✓ Furniture Refurbishment o Ahrend ✓ Automotive Industry o Re-use/manufacturing of parts
Design for Durability	Prolonged life of products. Durable, repairable, or reusable product designs.	✓ Luxury Watches o Rolex (Longer than a lifetime) ✓ Retro, Cast Iron Kitchenware ✓ Nokia Mobile Phones
Industrial Symbiosis	Process oriented solution, takes residual outputs from one process as input for another process. Industrial Symbiosis benefits greatly from geographical location.	✓ Kalundborg Eco-Industrial Park (Denmark) ✓ Suzhou New District (China)

Table 1.Circular Business Model Archetypes. Adapted and Developed from (N. M. P. Bocken et al., 2014) and more closely from (Nancy M. P. Bocken et al., 2016).

The move towards circular business models is a radical change, and will require innovative ways of thinking and doing business (Nancy M. P. Bocken et al., 2016). These changes drive technological, design, and process innovations, creating value for both business, consumer and the global environment. Table 1, is based on the business model frameworks of (Nancy M. P. Bocken et al., 2016) and (N. M. P. Bocken, Short, Rana, & Evans, 2014) showing business model strategies that 'slow and narrow resource cycles'.

5.8.1. Service Orientated

Service Orientated (Reduced Ownership). This model focuses on a business strategy that fulfils consumer needs without their need for ownership of the product. A popular term for this model is "Product

Service Systems" (PSS) (Tukker, 2015) which was first conceptualized in the 1990s. The model delivers capabilities and services as opposed to physical products. A good example of this business model is car sharing platforms, where vehicle ownership is done by the business, and transportation options are made available to consumers.

The value proposition from a service oriented business model comes from the delivery of the service (Nancy M. P. Bocken et al., 2016), value is rendered in the form of ease of access and performance. The service and maintenance is taken over by the business, creating a hassle-free environment for consumers to use the service. This in turns attributes a luxury value allowing the firm to capture value from a circular model opposed to a linear model. The model allows an avenue of value creation for manufacturers operating in the secondary sector. The advantage of this service orientation creates incentives for businesses to increase durability, energy and resource efficiency, reusability and reparability. Since materials and product value stay owned by the company, closing the loop during the end life-cycles of the products, ease of re-use, remanufacturing, re-purposing or re-furbishing is greatly enhanced.

5.8.2. Extended Value

Extended Value. Extending the value of products is an opportunity for innovation. This model looks at the residual value of the materials used during manufacturing of a product (e.g. Gold in Electronics circuit boards.). The circular model incentivises the remanufacturing of goods to recover intrinsic product value (Aurich, Fuchs, & Wagenknecht, 2006), aiming at minimizing new consumption of new raw materials. The value proposition of this model is to exploit 'cheap' residual value in products, remanufacturing or refurbishing, those products and re-selling them as affordable "as new" products (Nancy M. P. Bocken et al., 2016).

Extended Value can be made achievable through innovations during the remanufacturing, reuse, or recycling phases. This circular model is made increasingly attractive by the constantly increasing costs of raw material extraction, and the scarcity of these materials. Enhancements during the design phase of production can also benefit the extension of value when design for modularity is incorporated. Designing durable or material intensive parts to be modular in design (easily removed and re-used) can greatly lower the costs of adopting this business model (Ulrich, 1995). Design for modularity is achieving popularity among consumers for the reduced waste, ease of use, and ease of upgrading, (especially noticeable in electronics) due to rapid innovations in construction and technology (Tseng, Chang, & Li, 2008).

5.8.3. Design for Durability

Design for Durability. In essence is a simple business model that can be easily applied to existing linear value chains in order to slow resource consumption. Design for durability creates incentives for businesses to extend product life-cycles and create more serviceable products with a non-consumerist approach. This business model may not constitute a full circular economy model, but it follows in the steps of the 'reduce'

ideology and should be considered for businesses that may see strong resistance to change, or limited options for a full circular model (due to geographical location, lack of a closed loop supply chain, or other hindrances to adopting a fully circular economy business model). The value proposition of this business model comes from strongly created association between durability and quality. This link has been pushed into consumers' minds by the marketing of durable products being perceived as high quality goods. (Garvin, 1984) Reminds us that quality, reliability and durability fall under one popular demand for long-life products. With the emergence of efficiency and reliability in the form of 'lean six sigma' (Pepper & Spedding, 2010), companies like Toyota have managed to achieve a competitive advantage over European and American counterparts while reducing waste, raw material consumption, and increasing reliability and conceived product quality.

5.8.4. Industrial Symbiosis

Industrial Symbiosis. The concept of symbiosis originates from biology, in the form of an interaction between two living organisms living in close physical association, typically to the advantage of both parties (Bucher, 1939). Industrial Symbiosis is a process oriented business model that focuses on the usage of waste or bi-products from manufacturing processes, to the advantage of geographically proximate businesses (Ayres & Simonis, 1994). The Kalundborg Industrial Park is a success story of industrial symbiosis, with the business model being employed as early as the 1970s (Ehrenfeld & Gertler, 1997). This Industry Park saw the benefits of location coupled with cheap resource procurement from the neighbouring organizations. The concept is simple, position the business to be within reach of valuable waste products from other organizations that are of value or substitute a form of material during the manufacturing of your products. By the utilization of undervalued by products from other manufacturing cycles, businesses can lower the costs of certain materials needed during their own manufacturing chain, and in addition, by products of their own processes can be sold off to proximate businesses. The value proposition seen during this model is a reduction in overall operating costs and risks. Collaboration between manufacturers reduce costs across the network, and innovative usage of 'waste' has opened market opportunities in many areas of manufacturing (Nancy M. P. Bocken et al., 2016).

5.9. Business Model Canvas

The Business Model (BM) Canvas is a global standard used by numerous individuals, businesses and organizations. It concisely identifies the essential parts of a business model. These parts are often referred to as 'building blocks' of which there are nine. The business model canvas strategically outlines elements that describe a firm's / product's value proposition, infrastructure, customers, and finances (Osterwalder, Pigneur, & Smith, 2010). It is a tool to align firm's activities and to sport potential trade-offs to be made. Osterwalder's work has proposed this singular reference model, and it has been designed to accommodate a variety of different business models.

The BM canvas is used as a tool to create a concise overview of a firm's business model. The canvas is made up of 4 pillars, each with specific building blocks that build up the pillar. The pillars are; infrastructure

management, value proposition, customer interface, and financial aspects. Each of these pillars aims to outline the significance of different elements of a business model, they often include processes, customers, value additions, and finances. Osterwalder envisioned the tool to help build new businesses, by allowing them to align themselves in a concise overview of operations and value creation steps. Figure 4 presents the BM canvas as a simple framework by which this paper can evaluate various types of circular business models, and create a comparable study of case studies, where key building blocks can be outlined that inherently are involved in the transition from a linear BM to a circular BM.

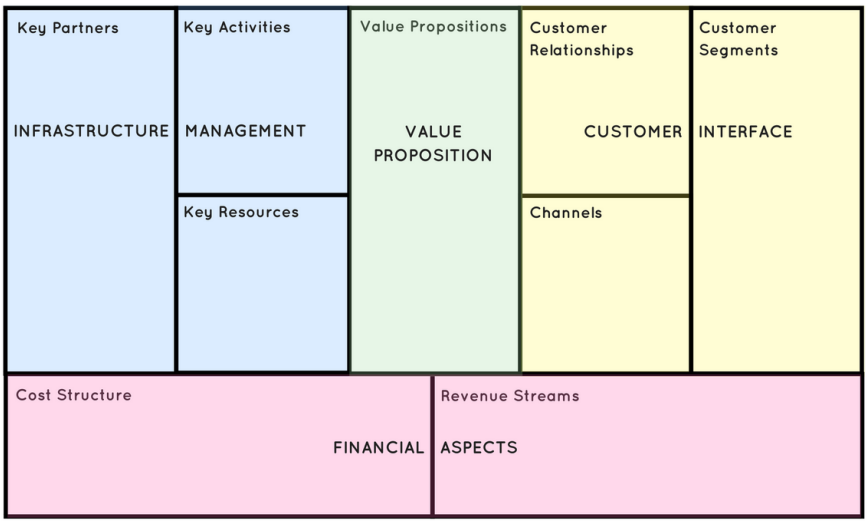


Figure 4. Osterwalder's Business Model Canvas

5.9.1. Infrastructure Management

The infrastructure section involves three of the building blocks; Key Partners, Key Activities and Key resources. This pillar is about how a company achieves its value creation (Osterwalder, 2004). It describes what abilities are necessary in order to achieve its value propositions and maintain its customer interface.

- **Key Partners:** The canvas outlines key partners in order to optimize operations and reduce the risks of a new business model. This is done by the creation and maintenance of buyer-supplier relationships so that a firm can focus more on their core competencies and activities. The aim behind a partnership can be to provide added value to a business model, such as software expertise or global shipping experience etc. Joint Ventures and strategic alliances may also be considered.
- **Key Activities:** These are the most vital activities involved in achieving a firm's value proposition. These activities range from manufacturing processes to raw material acquisitions and outline only the most vital activities of that business model.
- **Key Resources:** Key Resources include human, financial, physical, and intellectual aspects, these are necessary in creating the value propositions for a firm's customers. They are generally considered an asset with which a business can sustain and support its business model.

5.9.2. Value Proposition

The **Value Proposition** is the overall view of a company's bundle of products or services that are considered of value to the customer. This is the overview of what a company 'offers' a customer segment, and is often used as a point of differentiation from competitors (Osterwalder, 2004). The value proposition can provide value through various key elements, these elements range in style and can often be considered as a products unique selling points (USP). Value propositions could be newness, modularity, customizations, design, price, cost reduction, risk reduction, accessibility, utility, brand and status and factors such as usability. Value propositions further may be quantitative and/or qualitative, involving price factors or experience factors.

5.9.3. Customer Interface

Outlining the Customer Segments, Channels, and Customer Relationships will aid in understanding the essence of and the relationship between a company's value propositions and its customers (Osterwalder et al., 2010).

- **Customer Segments:** During the creation of a strong business model, a firm must identify which customers it is trying to serve. Various sets of customers can be segmented based on various factors. The main segmentations can be done on different consumer needs and attributes. These segments range from mass market to niche markets, and the outlining of these is important to tailor the implementation of corporate strategy.
- **Channels:** The routes by which a firm delivers its value propositions to its customers. The aim of the channels is to distribute the businesses value proposition fast, efficiently, and cost effectively. A firm can reach its customers via its own channels or partner channels, occasionally combining both avenues of distribution.
- **Customer Relationships:** The way in which a company reaches its customers and how it interacts with them. Identifying the type of relationship that the company wants with its customer segments. There are many forms of customer relationships including; personal assistance, self-service, automated services and co-creation.

5.9.4. Financial Aspects

Financial aspects I the final segment of the business model canvas, it involves the outcome of the rest of the business model's configuration. The financial aspects are composed of the company's revenue model, and its cost structure. In conjunction these two aspects determine the firm's profit (or loss) making logic, and there for its ability to survive in competition (Osterwalder, 2004).

- **Cost Structure:** The (most important) monetary consequences of operating under the selected business model. These are the costs a firm incurs in order to create, market, and deliver value to its customers. A business model's cost structure can be defined in terms of classes, cost-driven

and value-driven, and further defined by its characteristics. These characteristics include, Fixed Costs, Variable Costs, Economies of Scale and Economies of Scope.

- **Revenue Stream:** This entails the way in which a firm makes income from the customer segments. Often a revenue stream involves pricing mechanisms which a firm can capture from its value creating activities (Osterwalder, 2004). There are several ways in which a firm can capture revenue. These range from; Asset Sale, Usage Fees, Subscriptions, leasing, and licensing and each method creates unique opportunities and forms of company consumer interaction

6. Conceptual Framework

Change is always a dangerous prospect for existing and successful businesses, their tried and trusted linear business model has been well established and iterated to a point of a profitable existence. With the rising price of raw materials, scarce resources, and the value attraction of sustainable products this profitability is being encroached upon by disruptive and innovative circular business models. Organizations which embrace the "disruptive business model innovation" are often lead by entrepreneurial leadership and have identified early the many opportunities created by these new circular business models.

This style of a disruptive innovation can help companies expand its market through the creation, alteration, and innovation of new and existing products or services (Markides, 2006). This concept falls in line with the circular business model archetypes of 'service orientation' and 'design for durability'. A disruptive business model may also expose current operations, identifying opportunities in areas of process and/or structural improvement. This process is enhanced by the CBM archetypes of 'Extended Value' and 'Industrial Symbiosis'. These advantages become tangible with most styles of large scale change, however a circular business model (CBM) gives a broader number of options in these areas. This is due to the CBM incentivising the use of a closed loop system, and the procurement of materials from other external organizations. This, in turn, expands the possibilities for process and design improvements to the existing, more confined, linear business model (LBM).

This paper will use a conceptual framework to identify the key building blocks involved in the conceptualization of a CBM. During the analysis of the multiple case studies, the opportunities for the sustainable design of products will also be investigated. The industries where the cases exist include automotive, electronics, manufacturing and packaging. This framework is built from the insights gained during research and the writing of the theoretical background sections. The goal of the framework is to answer the research questions. This will be done by in-depth analysis of active circular business models from which common key building blocks can be identified. These will be cross examined in an attempt to identify the reasons behind the building blocks importance, and in what way they shape the overall business model.

The conceptual framework will be analysed using in-depth case study analysis, to examine how, why, and with what outcomes firms that have moved to CBMs. This allows for an objective overview of CBM introductions and implementation in the multiple areas of industry. Industry equivalents that use a LBM will also be considered, and examined to determine how disruptive a move to a circular economy could be for that

firm, and with these examinations draw conclusions for strategic CBM implementation for that industry. The industries in question have been chosen based on the emergence of businesses utilizing CBMs within those industries. This will give a more accurate overview of how these firms operate with respects to which business model they use, what benefits they have seen, and what kind of changes/disruptions have had to be made.

The Conceptualized Framework will be used to estimate the extent of the disruptive measure for the circular business models which are being employed in several different industries. The framework (Figure 4.) outlines a method by which the disruption caused by the circular business model in four distinct industries can be examined. The concepts, associations and theories that are used to create this conceptual framework are carefully taken from detailed past studies, research papers, and analytical reviews, and are used to create an overview of the circular economy and its effect on the different industries. By the hand of in depth case study analysis this paper will examine the disruptiveness of circular business models on these four areas of industry. The framework will aid in validating previous research, as well as identifying the disruptive nature of the circular economy. The results should show whether CBMs are an advantageous and strategically valid option of businesses. This will be made evident by outlining the key building blocks of the business model canvas that are of strategic importance to a firm. The framework also reveals the added value from the transition to a circular business model, combining previous knowledge with a well-formed idea of circular business model strategies. The added value being created will be analysed as 'value chain disruption', where the value chains of a business's operations are either positively or negatively influenced by the move to a circular economy.

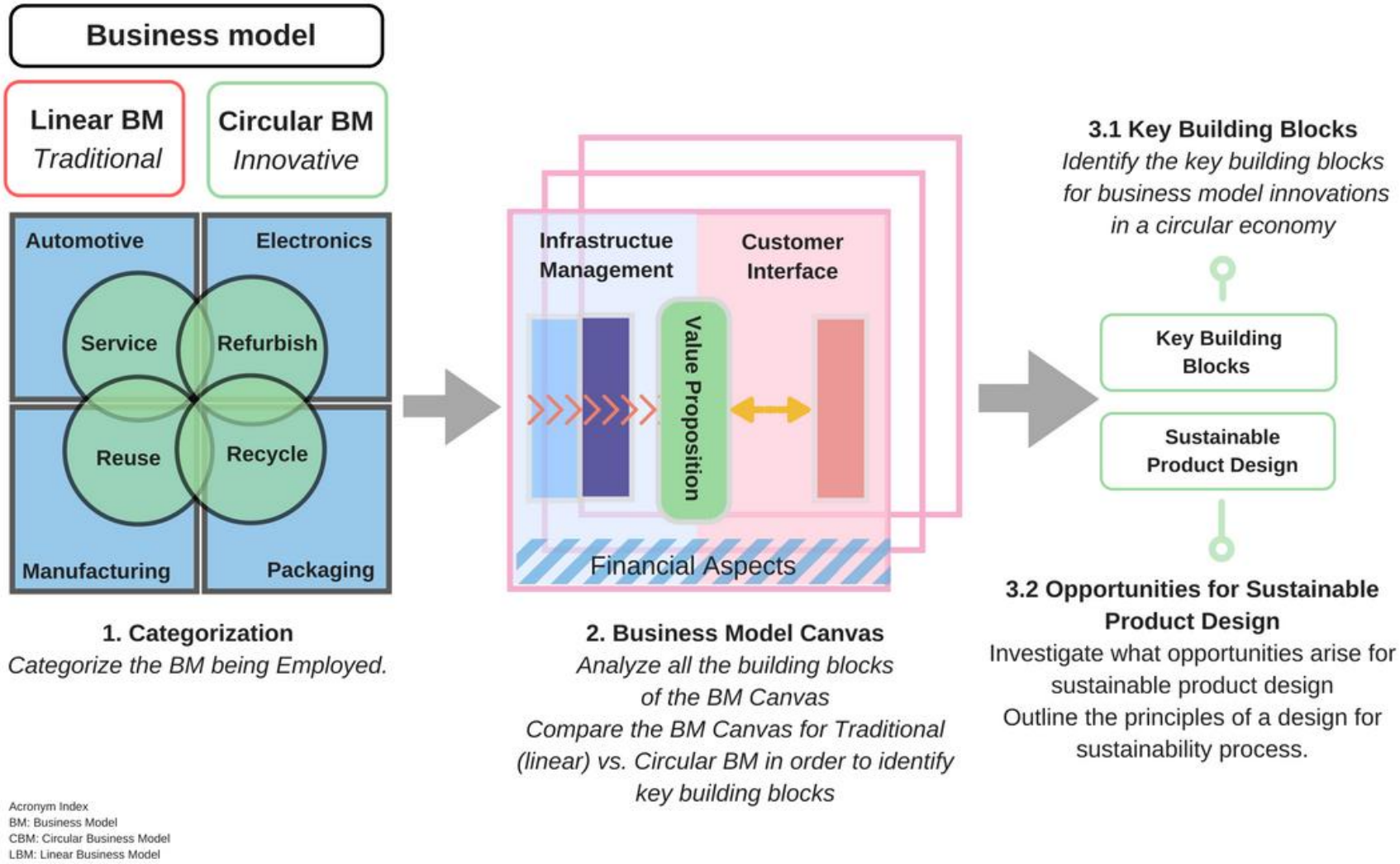


Figure 5 Conceptual Framework to analyse multiple case studies within various industries and a range of different circular economy business models. The aim of which is to identify key building blocks for circular BM innovations and outline the opportunities created for sustainable product designs.

6.1. Categorization

Categorization of the case studies is the initial step of the framework, aiming to concisely identify the industries, and the case studies innovative business model structures. Outlining the four industries, each with its own set of unique key factors for success, and very different styles of manufacturing and linear business models is important to set the stage for the BM canvas analysis. These four industries are being examined due to both their differences, and their similarities. Each industry has a product out-put, and each have different raw material and process inputs, additionally each industry has been consistently employing linear business models for an extended amount of time. Recently each industry is seeing emerging successful start-ups (Uber, Car2Go, AirBnB, Gazelle, etc.) which successfully employ circular economy strategies. Some of these firms are start-ups with innovative approaches to a typically stagnated market and others as large scale real world tests with high levels of investments e.g. BMW DriveNow. These tests are to validate the value additions that circular business models can bring to certain industries and markets, large companies are slower to adapt, and require firm evidence for prospective success. This shows that market leading companies are beginning to see the potential in circular economies and disruption this creates in their current operating markets. Larger firms typically have a higher resistance to change, and there for the 'test' like products and services they are launching are a low risk probe to evaluate the prospective success of the circular economy model.

Each of the Industries, mentioned in the framework, typically operates under a traditional linear business model. These models have been built within the industry as a standard way of operating, with a take-make-dispose model being highly utilized within these industries. Categorization of the circular business model that a case study employs is important to gain a comprehensive overview of the innovations being made. In order to simplify the overview, categorization into four key sustainable strategies, the four R's, is done. There is much controversy in research and different opinions as to the most important R's, but this paper will include Service, Reuse, Refurbish and Recycle. Each CBM has an overarching focus on one of the R's, they often overlap such as the service orientated BM leading to both Reduction and Reuse of products. Dependent on the case study, and the CBM being used, choices will be made to categorise under a certain area, making the framework easier to overview in regards to strategies being employed.

6.2. Key Building Blocks

Identifying the key building blocks of the business model canvas, that come into play when employing circular business models, is an important area of investigation. These are the building blocks which will repeatedly see serious disruption between a LBM and CBM. Making them key to the implementation of a CBM and achieving a circular economy. The aim behind understanding the key building blocks is to allow businesses to know in advance which areas of the business model canvas are likely to change. This allows for proper preparation to be made and extra attention to be given to these points of disruption. A circular business model will often only affect certain areas of the canvas, this may differ per industry, but the overall disruptive areas will be relatively similar for most CBMs in general practice. Conceptualizing the expected 'key building blocks'

allows the conceptual model to be tested against the case study analysis and will enhance the arguments behind what makes that building block a key factor for success. For this reason, outlined below are four distinct building blocks for the business model canvas.

- **Key Partners:** Often overlooked, partnerships allow firms to focus on their core competencies while creating avenues to exploit the core competencies of the partnered firm and vice-versa. Circular business models often create the need for new innovations in a range of operational areas. Partnerships often alleviate the disruptiveness of a CBM for the internal operations of a firm, by allowing another business to take over certain tasks. Partners can allow rigid firms the opportunities to operate in new market segments by creating new opportunities for sustainability or circular business models. This is often an important requirement for the success of a circular economy, partners are necessary to keep from risking over extension and a loss of your core competencies. A partnership can also act to decrease for a firm during the implementation of a CBM, sharing the risk between the two partnered firms.
- **Value Proposition:** The essence to a circular business model is often an innovation in how the value proposition is created, or translated to the consumer. Value may be increased due to sustainability enhancements, process innovations, and design. It is important for every firm to consider how their value proposition is altered by the use of a CBM. This is the most important block of the business model canvas, and alterations in the value propositions are often a source of risk for many established businesses employing a LBM. For these reasons the disruption in the value proposition should be considered closely.
- **Channels:** With research supporting the importance of an integrated CLSC with many circular business models, it is evident that the channels by which a business reaches its customers can change when employing a CBM. Disruption to the channels means innovative ways of reaching customers, predominantly through software platforms, in order to utilize new technologies to help facilitate a circular economy. Channels may also be internally altered, with regards to models such as *industrial symbiosis*, where materials are acquired directly through proximal positioning. Where linear channels dominated, raw materials to manufacturing to customer, circular business models will call upon a re-thinking of how channels are changing to accommodate product returns due to leasing, or for refurbishment and/or reclamation.
- **Revenue Stream:** Disruption will even reach the revenue stream of a business. New models such as service orientations call for more subscription based payment methods, due to services being leased or paid for monthly. Alternatives also come in the form of online shopping, bundle prices, return costs and pre-paid for return postage. A firms flexibility in the way in which it designs it's revenue stream is a great asset in a circular economy model, since elements of value may not be realized immediately at time of purchase.

6.3. Opportunities for Sustainable Product Design

With a particular focus on design, this section aims to identify product design opportunities that occur during a business's transition to a circular economy. Sustainable strategies are a joint long-term strategies that aim to develop the current needs with human and environmental impacts at mind (Elmansy, 2016a). By this definition, it is possible to identify the opportunities that businesses may encounter during the realization of their sustainable strategies. Narrowing down the number of factors that affect this change, this paper will examine the principles of sustainable design. These principles act as a philosophy that is applied by business, government, and non-governmental agencies to achieve the reduction of consumption of the earth's resources. From research there are many examples of methods to implement sustainable design principles, this paper will look at identifying which principles can be associated with the circular economy.

Looking at design through an overarching holistic approach within a business can uncover untapped capabilities to consider sustainable solutions that can replace the more traditional method. The key to designing sustainable products is to create innovations that stay cost effective and do not alter the quality, utility, and use of the product or service. For circular economies it is important that designers consider alternative materials, manufacturing process, and incorporate minimalistic design goals. One of the designer's roles is to solve problems and provide innovative solutions through products and services (Elmansy, 2016b). Designers are, for these reasons, an integral asset for a company to exploit from the earliest conceptual phases of a products development to ensure that sustainable strategies are achieved to their fullest degrees. This importance is further emphasised by the redesigning of the business models being used, and the ways in which the building blocks are altered. By example, changing the channel by which a product or service is revealed to a consumer adds a platform by which consumers and businesses interact; designers must consider the holistic user interface of this platform. With importance being set on brand style, and interactive interfaces, brands which have, in the past, not been in direct contact with consumers are becoming more engaged with their end users, e.g. product orientation move to service orientation.

Design principles have often been modified to adapt to changes in the marketplace. The conceptual model (Fig. 4) hopes to provide evidence that design principles require adaptation to become integral during a move to a circular economy. In order to fully embrace many of the circular business models being examined in this paper, there will be certain aspects of design that re-occur as a key factor during this transition. The aim of this section is to predict what design principles will be of key importance during a business model shift, and then to examine (via case studies) whether these principles are indeed key. Below are outlined the key design principles that may come forward in the case study analysis, these can be seen as opportunities for a business to holistically approach a circular economy. It should be noted that sustainability does add a value component to a product and this may be exploited when products are being priced (Brockhaus et al., 2017), this factor should be considered as competitive advantage, and not as a model for design.

The three design principles and their underlying strategies this paper has outlined are:

- *Designing Long-Life Products*
  - Design for Reliability

- Design for Durability
- Design for Functionality and Usability

❖ *Design for product life-extension*

- Design for ease of service
- Design for dis and re-assembly
- Design for modularity
- Design for upgradability

❖ *Design for a cycle*

- *Design for ease of disassembly*
- *Design for recyclability*
- *Material choices*

Due to the specific circumstances of each case study, and due to the differences for each industry, each of these design principles will arise. Each contains certain strategies that are applicable for individual firm needs for their products and services. By incorporating these principles designers can add to the efficiency of the circular business model they operate with. Variations and mixing of different strategies under each principle should come forward, as the principles have some overlap in which loops they exploit from the CE model. This only reinforces the importance of the principles as a tool for success that firms can utilize during the design process of new products or the redesign of older 'linear' oriented products.

7. Categorization

The six case studies that span four different industries give this paper a broad basis from which to analyse circular business model archetypes. The cases have been selected due to their current status being active in the marketplace, this gives a real-world perspective on the success of the CBM's being implemented by each case study. The cases that will be examined in this paper are: BMW's 'DriveNow', Renault's 'ICARRE95 initiative', Google's 'Project ARA', Philips' 'Lighting as a service', Miele's 'Durable Products', and Mars' 'bio-based film'. These cases span the Automotive, Electronics, Manufacturing and Packaging industries, and are each unique in the way they approach the circular economy respective to their own industry.

The automotive industry contains two case studies, one incorporates a service oriented outlook, and the other an extended value CBM. While BMW's DriveNow focuses on service with the added benefits of retained ownership to ensure reuse and recycling, ICARRE95 focuses on primarily refurbishing and reusing old vehicle components and often recycling the material assets of an end of life vehicle (see Fig 6). These two case studies take two different routes to create a value proposition within a circular economy, and each is set up to increase the sustainability and to ensure a more circular value cycle for the firms.

Within the consumer electronics industry, this paper examines a single, failed, case study named "Project ARA". This case is one created and developed by Google to design a modular smartphone with upgradable components giving the product a longer lifespan than its competitors. This model would have focused on the Reuse cycle for the smartphone, focusing primarily on the action of upgradability to facilitate

the reuse cycle. The CBM archetype being employed here is one of extended value, the same as ICARRE95 however this model creates a new disruptive market for smartphones. Project ARA would create a marketplace where a single platform could be reused to create new configurations making it perfect for consumers with specific smartphone needs, such as a focus on photography, or a configuration that creates extended battery life.

The manufacturing industry sees two business case studies, one focusing on a service orientation (Philips), and the other focusing on a long term strategy for durability (Miele). Philips creates a product which is often used until the lifecycle has reached its end and then is disposed of and a replacement is purchased. With competing firms offering similar products at lower price points it has become difficult for Philips to compete on larger scale lighting solutions. Their innovative service orientation creates a pay-per-lumen leasing contract with consumers that create the need for all four cycles to be used, including servicing, refurbishing, reuse, and recycling. Due to the nature of a service oriented business model Philips is able to retain ownership over its products making it much easier for the firm to complete these circular loops. Miele on the other hand has focused on its CBM archetype since its initial start-up phase over one hundred years ago. This has created both competitive advantage and a sustainable business model for Miele to employ and rely upon. Miele focuses on servicing and material choices that facilitate the ease of recycling.

Packaging is an industry which is predominantly linear, products are often designed, developed, and produced to fulfil a single use cycle before the packaging is disposed of. For this reason it is an interesting industry from which to find a circular business model case study, this paper will examine the case of Mars' and Rodenburg Biopolymers who have jointly developed a bio-based polymer film that is cheaper than its oil based counterpart and can be used at 100% efficiency in the existing packaging process Mars employs. It is the only case study which does not conform to the cycles for the technological cycle, but rather focuses on the biological cycle of a product, and is created from waste flows of existing producing methods for the potato industry.

Industry	Cases	CBM Employed	Design Principles Employed	Service	Refurbish	Reuse	Recycle
Automotive	BMW DriveNow	Service Oriented	Product Life-Extension & Long-Life Products				
Automotive	ICARRE95	Extended Value	Product Life-Extension				
Electronics	Project ARA	Extended Value	Product Life-Extension				
Manufacturing	Philips	Service Oriented	Long-Life Products & Product Life-Extension				
Manufacturing	Miele	Design for Durability	Long-Life Products				
Packaging	Mars	Industrial Symbiosis / Extended Value	Design for a cycle				

Figure 6. Categorization of 6 Case studies based on CBM, Design principles, and the 3 R's (Green represents implemented and red represents not implemented)

8. Empirical Study

In order to validate the conceptual framework, put forward in this thesis, various case-studies of firms which operate under a circular business model will be thoroughly investigated. With the aim of identifying the key building blocks, barriers to sustainable design, and disruption of the value chain, when compared to the existing linear business models with which they compete and/or originate from (directly and indirectly). The goal is to gain insights into the disruptions caused by circular business models, and to reveal the extent of new opportunities and markets being reached, additionally innovations in process and services will, in turn, be examined. Case studies are a stalwart example of disruptive business models in practice, and via in depth analysis from business reports and news articles, links can be made to show circular economies in action.

The methodology being employed focuses on research to understand the phenomena of a disruptive circular business model in depth, rather than to understand the relationship of variables (Henning, Van Rensburg, & Smit, 2004). The main objective is to test the theoretical constructs proposed, in the 'real world' environment. The research being mainly exploratory, uses a qualitative method and adopts an interpretive orientation on how businesses employ BMs, and to what extent these CBMs are disrupting existing LBMs. This paper will seek to use case studies to investigate the four circular business model archetypes put forward by prior research, and examine the level of 'disruption' each model inherently provides, examining the key building blocks of the canvas model and the design barriers to success.

In order to accumulate the information behind 'real-world' case studies numerous sources of information were used. In so doing this paper strives to give an unbiased overview of both linear and circular business models in action. The sources used include web pages, new articles, research papers, interviews, and presentations from various outlets. Information stating the success of a business model will be retrieved from unbiased sources, and information regarding the design of both business models and products is sourced from more direct sources. These direct sources include a firm's website, marketing, and news articles focused on the examination of innovative business models. During the analysis of business models a reoccurring source of information are indirect research papers and news articles which have tried to analyze the strengths and weakness of the BM. By sourcing from unbiased pools of information this thesis aims to create more accurate insights into the key building blocks of firms, trying to avoid the overwhelmingly positive information often offered by the firms themselves.

8.1. Automotive Industry

The automotive industry includes organisations and firms that are involved in the general realization of motor vehicles. These firms have employed a linear business model for the greater part of 100 years, and with much success. The supply chain leverages suppliers for parts, and utilises brand image and dealerships to reach a wide customer base and sell vehicles (Figure 5). However growing pressures from service oriented start-ups (e.g. Uber, ZipCar, Car2Go, etc.) that provide vehicles as a service for mobility have begun to prove the opportunities of a new model.

The conventional business model being linear is of no surprise, the firms have been focused on the manufacturing of the physical vehicle for years. The carmakers have three main strategies with which they

generate sales (Sakkers, 2016), the first is competitor advantage, meaning heavy spending on R&D to create differentiated, high-end vehicles with a higher margin and pricing advantage. The second strategy is advertising the brand and brand image, this is their connection to customers and via this brand image they gain a wider customer base. The third is the leveraging of an elaborate network of distribution via dealerships to ensure vehicles reach customers. These strategies are simplified generic strategies that the majority of carmakers have been employing in order to succeed. For firms operating in the automotive industry key performance indicators can be set on costs, market share, and competitor advantages.

The traditional model being employed by car manufacturers (Figure 5) facilitates the creation of one vehicle for a singular customer. This has been the standard for the mobility market, it has led to a very low rate of vehicle utilization and high levels of production, meaning high levels of material and energy consumption to realize the mobility needs a single customer. Innovations in digitization, automation and electrification are beginning to reshape the automotive industry, revealing new markets or identifying underlying gaps in the market. Urban areas are being targeted for a move towards a service orientated model to provide multiple users a vehicle sharing platform to satisfy their mobility needs. Innovations in recycling have also brought to the point product retrieval incentives to extend the life-cycle of parts and materials used in vehicles. To examine these changes BMW DriveNow will be examined to reveal opportunities in the service orientation model, and Renaults ICARRE 95 initiative will also be investigated to show how the extended value model can create opportunities for car manufacturers.

The business model canvas in fig. 7 represents the traditional linear business model being employed by the majority of automotive industry leaders. Each building block outlines the important stakeholders, actions, materials, and requirements needed to accomplish the realization of that block. Looking from left to right, it is seen that the canvas is set up to transition from infrastructure, to value proposition, to customer relationships. This is the most important process for a business, to create value, and in turn, deliver value to its customers.

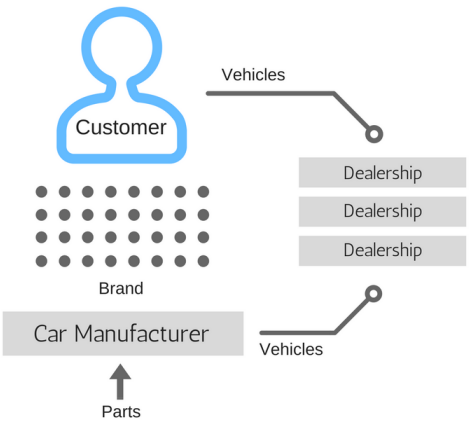


Figure 7 Linear Business Model for Car Manufacturers

Traditional Supply Chain

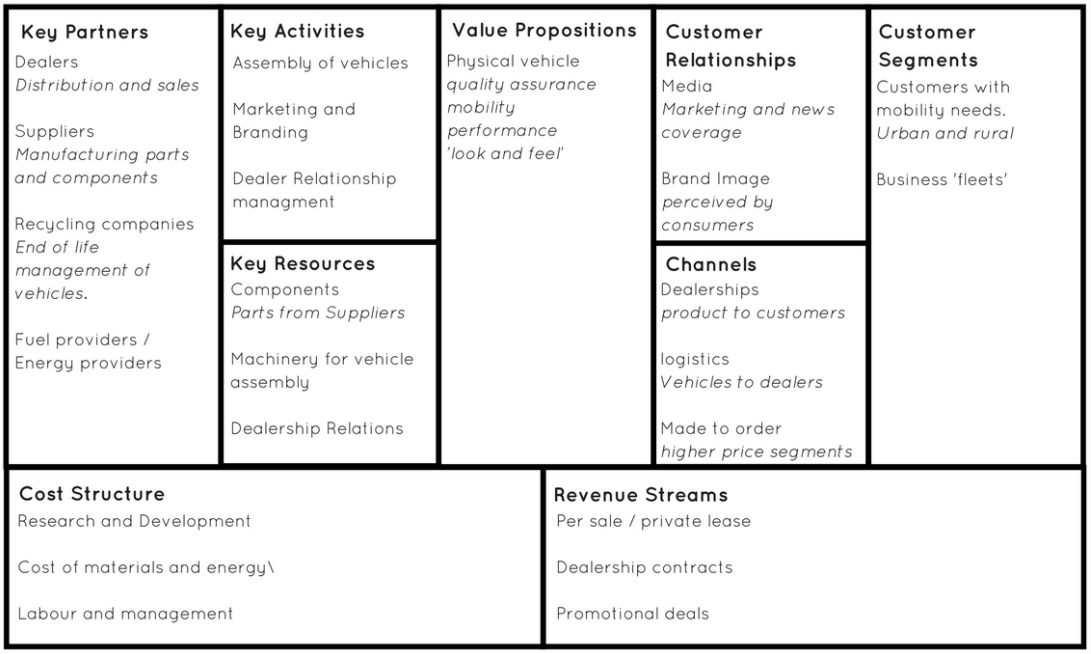


Figure 8 Canvas of Traditional Linear Automotive Business Model (generic)

8.1.1. Business Model Canvas 'Generic Automotive Model'

In order to outline the various building blocks it is important to describe the canvas in four sections; infrastructure, value proposition, customer interface, and financial aspects. Each of these segments plays a role in the creation and understanding of a business model. By defining the importance and major roles played by each block, we can decisively identify differences between the LBM and the CBM in regards to which building blocks are being disrupted.

Infrastructure's role in the building of the automotive industries linear BM is dominated by Dealers, Suppliers, and manufacturing components. The importance of these building blocks is common for manufacturing firms which operate under a LBM. Partnerships with dealers are key, acting as an operational component for the delivering of the value proposition to the customers. Dealerships are often intermediary customers, purchasing vehicles and selling them to the end user, often under terms of financing. Suppliers contribute the majority of the material requirements; these are often delivered as components/parts for the car manufacturers. When considering the consumption of raw materials, the sustainability of these suppliers is brought into question, and should be considered in an overall evaluation of the environmental impact of a vehicle manufacturer.

The value proposition consists simply of the vehicle being manufactured. Much like many products the quality, design, and performance are of key importance to manufacturers. The success of the LBM relies heavily on the value proposition of the firm, the automotive industry shares a common value proposition of 'mobility' this is achieved by the creation of vehicles. This is the area in which competitive advantages are created, demanding heavy investments in research and development, and often copying competitor strategies.

In order to interface with customers, the automotive industry utilizes a range of dealerships. These dealerships offer the vehicles as a purchasable product, often offering financing to entice customers. In combination with brand image and marketing, the value proposition is sold to consumers. Branding is a large part of the automotive industry, customers have high brand retention and tend to stick with brands they trust, prefer, or have good experiences with. The combination of brand and customer segments cannot be ignored, the current market has brands filling each of the segments of customers, from low to high end products. Outlined in fig 7 are two customer segments, consumers and business, however each of these segments have various sub categories, each with their own individual needs and preferences. This generic grouping is to identify the common goal of mobility, where the current LBM does not differentiate products for rural and urban consumers.

Linear business models often call for a linear cash flow, this case is no different, automotive manufacturers often purchase parts/components, manufacture vehicles and then sell the vehicles. This represents a simplified version of reality, however as far as the financial aspects of the LBM go, this does outline the process by which the value proposition is achieved. This linear system captures none of the value back from the customers after the vehicles have left the showroom floor (Dealership). The linear financial flow goes hand in hand with a linear material flow through the manufacturing process. Recycling and reusing terms are established by third party stakeholder via second hand markets, vehicle maintenance workshops and governmental schemes for the capture of raw materials from end of life vehicles.

8.1.2. Opportunities for Sustainable Product Design

The traditional model of the automotive industry does not require innovative design techniques, rather design is used as an element of differentiation or/and competitive advantage. Design strategies are being employed to facilitate better vehicle design, chassis', components, and parts. The strategies are standard ways of re-iterating and building upon past designs, new innovations come forward on the forefront of the automotive industry, the performance racing industry. These innovations often come around due to the need for faster acting parts, efficient maintenance and other factors that play large parts in that industry. These design innovations often take their time to reach the generic automotive customers. Occasionally, due to being considered as useless for consumers, or to time consuming to implement, these innovations do not even reach the traditional vehicle creation process.

R&D for process design is quiet important for the automotive industry leaders, efficient manufacturing processes, with very low tolerances for defect parts are key to a good brand image and delivering quality products to customers. This is an industry which spawned a systematic approach to parts not falling under tight specifications, a process named Six Sigma, coming from giants such as Motorola, General Electrics and Toyota. These innovations are common with a linear model since they tend to be creative solutions to problems that are being identified during the value creation process.

8.2. BMW DriveNow

BMW is a large player in the automotive market, creating a range of vehicles with an ambition for quality and the aim of staying competitive. With the global financial crisis, BMW began struggling, with a 90% drop in profits year-on-year from 2007 to 2008 (Velamuri, 2013). The car maker was under pressure to begin to re-think its strategy. The challenge that BMW was faced with meant they would need to diversify product and service portfolio's, aiming to find new business models and revenue streams (Velamuri, 2013). EU imposed emission regulations, strained the conventional car model, and BMW began investing in innovation for environmentally friendly vehicles, and bring an array of new ideas about the transport market.

The public and governmental pressure behind BMW created the innovation of a social car sharing platform, and with a partnership with SIXT (Car Rental Service Provider), they launched DriveNow, a premium for car-sharing inside the highly urban city of Munich. The concept (Figure 7) was to provide a platform for users to access, reserve, rent and drive a fleet of vehicles within the zone of use. This platform required IT services from Vodafone, vehicle rental expertise from SIXT, and the vehicles from BMW. The model requires users to pay per minute for vehicle use, and gives them incentives for re-charging or re-fuelling the vehicles they use. Figure 7 shows a simplified model of the mobility service that BMW DriveNow has created.

The car-sharing platform that DriveNow employs is an innovative adaptation of the Service Oriented circular business model. DriveNow allows customers to reduce their ownership of independent underused vehicles and instead it provides a service for urban mobility based on minutes of vehicle use. This model has attracted over 500,000 customers in 5 German cities (Fischer & Nauman, 2016) (Berlin, Hamburg, Munich, Cologne and Dusseldorf), and the service operates with just over 2500 vehicles for these five cities alone (June 2016). This means that, on average, 200 users share a single vehicle in these urban environments. In

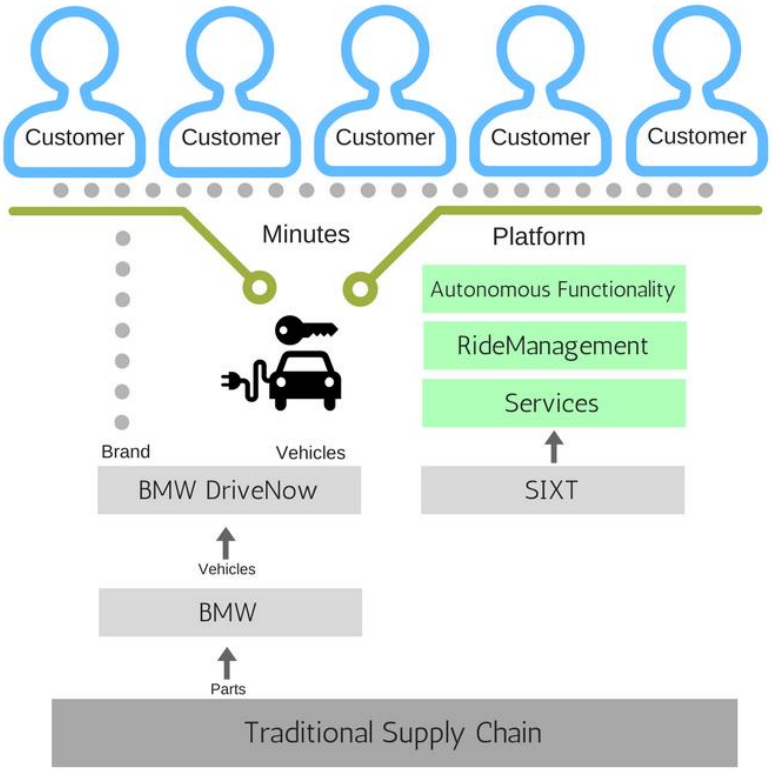


Figure 9 BMW DriveNow. Mobility Service Business Model Overview

practice this is creating vehicles with a much higher percentage of utilization, minimizing physical space requirements, physical vehicle requirements, and substantially decreasing CO2 emissions via the means of efficient cars, reduced congestion, and incentivising a decrease in personal vehicle usage.

It is important to note that the supply chain for this case has not been altered. Vehicles being produced by BMW are also being used by the DriveNow service in order to provide mobility. The parts for manufacturing are being sourced in the same way, using the same production processes, etc. however ownership of the vehicles is being kept 'in-house'. This brings about opportunities for DriveNow to being extending the value of the materials, parts, and value imbedded in BMW vehicles and readying them for re-purposing. This case study reveals opportunities for businesses which produce products and see advantages in their retaining ownership of the product, but leasing out the services which such a product provides. A few underlying constraints are the platform by which this is done (software), service expertise and use management systems, and hands on deployment of such a system is linked by geographic accessibility. This creates new market opportunities for organizations to fill such gaps, in partnership with product manufacturers in order to realise such a circular business model.

The disruption caused by the success of car-sharing platforms and a service oriented mobility market is substantial. The linear business model is no longer the singular means of consumer mobility, and urban areas are reaping the benefits of the reduced ownership model. DriveNow reduces the number of vehicles per capita, city congestion, and pollution caused by vehicles in a large city while still being able to increase urban mobility for customers. The car-sharing platform is one which suits the urban environment, where vehicles can be picked up in a location beneficial to users, users can access the vehicles at any time, and vehicle management is done by the service provider (DriveNow).

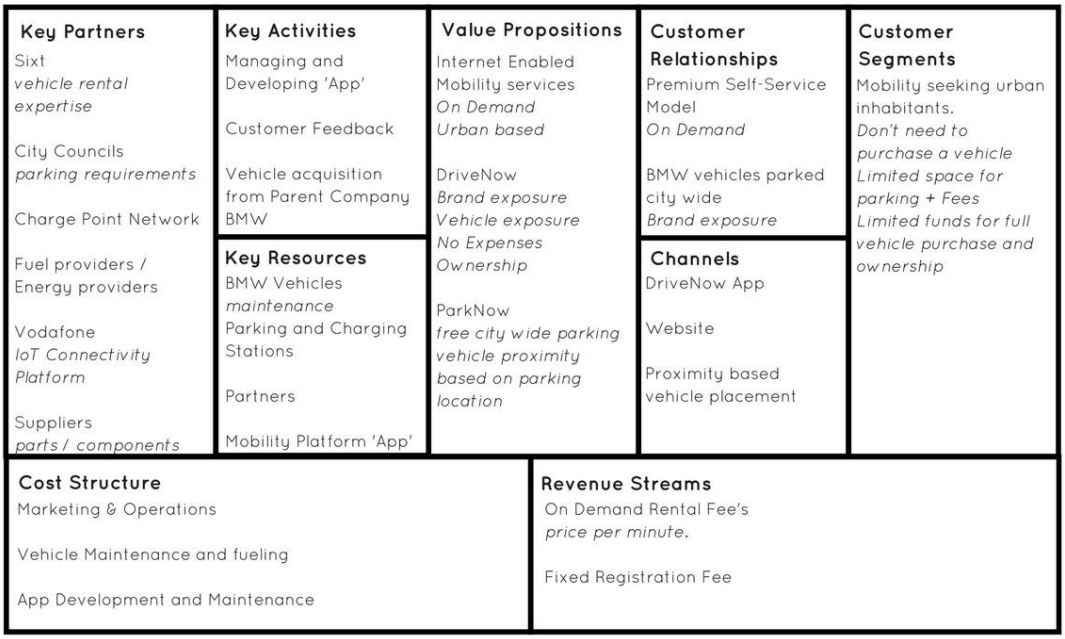


Figure 10 CBM Canvas of BMW DriveNow Case Study.

BMW's DriveNow initiative has become a great success in many urban areas, however they were not the first to employ a revised service oriented model for mobility. This start-up builds on models coming from services such as Uber and Car2Go, who have disrupted the linear model by offering mobility as a service per mile or per minute. The model is based on the cost price being more affordable for short distance urban commutes. Their canvas will look similar to fig. 9 however the DriveNow start-up has the backing and brand of BMW who operate as a German based automotive manufacturing firm. For this reason, the case study was chosen to represent the disruptiveness of the CBM more directly within the automotive industry.

8.1.1. Business Model Canvas 'BMW DriveNow'

In order to create an overview of the disruption caused by this circular business model the canvas building blocks that differentiate the model will be examined. With regards to the infrastructure, it should be noted that the key partners have changed with the exception of the suppliers of parts. The addition of SIXT, as a 50% partner, has a large impact on the structure of the BM canvas. The value that SIXT brings is an expertise and long-term experience in vehicle rental services. This relationship includes the added value of maintenance and customer relationships, where the partner increases the competencies of the start-up. Further partnerships with urban councils are required for vehicle parking and charging schemes within the urban environment. The business model adds free parking and fuel as a value proposition, this partnership makes that value proposition achievable. Both BMW and SIXT had limited experience in software platforms for allowing consumers to access and rent a vehicle, and so another major partner was asked to provide these competencies. The partnership with Vodafone achieves this goal, allowing BMW and SIXT to create the service for consumers. The platform is of key importance due to it being involved in the customer interface blocks of the canvas, creating a connection between consumer and service provider.

The value proposition of DriveNow still focuses on mobility, however it additionally incorporates a reduced ownership model, free parking, and On-Demand mobility (Wijnen, 2016). Fees are set at a pay per minute rate, and refuelling is incentivised in the form of free minutes, and vehicle maintenance is taken care of by the service providers. The Start-up focuses on solving the problem of parking, car ownership fees, and expensive public transport systems. By solving these problems DriveNow achieves its value propositions, and is able to disrupt the product oriented model of its competitors. Further value is seen (for the consumers) in the burden of vehicle maintenance, refuelling costs, and ELV management falling to the service provider (BMW DriveNow). Further value propositions include the smartphone app, to provide a mobile service access point, and integrated billing, including fuel and parking costs. Vehicle access is also granted by the smartphone app, acting as the vehicle key after the vehicle has been booked.

DriveNow has a much stronger ability to interface with its customers than the traditional linear business model. Creating a service platform in the form of a smartphone app means that DriveNow is in constant contact with its consumers. They can track activities, routes driven, peak times, and hot zones for vehicles. This informational feedback loop is a huge advantage for DriveNow to better focus its efforts on areas of improvement. To further iterate their customer relationship the app also allows for comments on vehicles

and ratings on the services being used. This creates a constantly open and active link between firm and direct customers. The DriveNow start-up must also have a fleet of vehicles available in the city, meaning positive brand exposure, and each new customer can be seen as a test driver of BMW's vehicles. BMW's focus on vehicle quality, and reliability means that customers can be converted towards favouring the BMW brand over other automotive manufacturers, playing both into the favour of DriveNow and BMW. The customer segments that DriveNow targets are a new form of consumer which favour mobility as a service rather than ownership of a vehicle, with which high monthly costs are intrinsic, these costs being further exaggerated in highly urban areas.

With respects to their 'financial aspects' this service oriented CBM focuses on a price per minute revenue stream, and fixed sign up fees to ensure customer retention. This is a form of revenue which ensures that the firm's revenue is tied in with its vehicle utilization rates. By increasing vehicle utilization DriveNow can advertise its sustainability, more use is being realized with its vehicles, meaning that DriveNow incentivises R&D in more reliable and longer lasting vehicles. This acts as a driving factor for BMW's R&D focuses, creating the need for a stronger focus on design for durability. The cost structure is relatively similar to the Linear model (Fig. 7) with the additions of vehicle maintenance and refuelling, due to these costs going from consumer to service provider. App development and maintenance also creates a large cost for DriveNow, this is a important part of the canvas, playing a large role in customer interface, and realizing the value proposition, it is further labelled as a key activity for the firm (Wijnen, 2016). Thus the importance of the partner Vodafone is further re-enforced with the CEO of DriveNow, Nico Gabriel, stating "For our carsharing concept, we needed a strong partner with experience in networking technologies. We have found that partner in Vodafone" ("DriveNow offers a flexible carsharing concept," 2016).

8.1.2. Opportunities for Sustainable Product Design

Design for Durability is a strong driver for this service orientated CBM where vehicles with longer life spans, reduced requirements for maintenance, and durable surface materials to minimize wear and tear of multiple users are needed. The DriveNow start-up is unique due to the parent backing of a large manufacturer like BMW, this means that these needs can be met, and the achievement of these requirements is valuable for both firms. This is one way to overcome the barriers that exist between a product and increasing that products durability. Firms which do not have the link to a large manufacturer will need to think about ways to incentivise the car makers to create more durable vehicles. This hinders the circularity of the business model due to non-durable vehicles being over utilized and problems occurring before the vehicles expected end of life.

For a service orientation business model it is important that the products being used for the service have a high life expectancy and a suitable level of durability. There are multiple ways of incentivising manufactures to focus on a design for durability. Leasing the vehicles used for car sharing is a valid way for making the car manufacturers adopt a design for durability, since creating longer life vehicles is then in their best interest. Customer pressure for durable vehicles is also a factor, communicate these pressures to the

manufacturing firm, group with firms that see the benefits to durable vehicle design. Offer incentives for a value recapturing scheme, offer manufacturers the opportunity to re-acquire their product after a certain distance travelled or time owned. This will create the need for sustainable durable design, creating value propositions for the manufacturer that align with the benefits of a durable design.

DriveNow has the availability of a direct channel through which it can pressure its vehicle manufacturer. This strategy of BMW's to separate DriveNow as a separate firm, is initially considered as a risk reduction in case of the DriveNow initiative becoming a failure (Velamuri, 2013). The split has however allowed DriveNow the opportunity to partner with firms that add serious value to the start-up and allow the BMW base to focus on vehicle design, maintenance, performance and durability. As a carsharing platform, importance should be set on a number of factors, it is important to define that a reliable and durable vehicle for mobility purposes is a key for the success of the business model.

8.3. Renault ICARRE 95 (Innovative Car Recycling 95%)

ICARRE 95 is an initiative which aligns with strict EU regulations stipulating the recycling and recovery targets of up to 85% (recycling) and 95% (valorisation) by mass by 2015 (Renault, 2016). This comes under the ELV (End of Live Vehicle) directive which forms the statutory framework for end-of-life vehicle requirements. Due to the push of government legislation, and Renaults global leading position in environmental strategy the car manufacturer set up the ICARRE 95 scheme. To achieve these goals Renault partnered with a number of stakeholder, including INDRA, SYNOVA and DUESSMANN. These partners created short loop supply chains to reuse automotive materials and parts (short identifies that the materials and parts are used within the automotive industry).

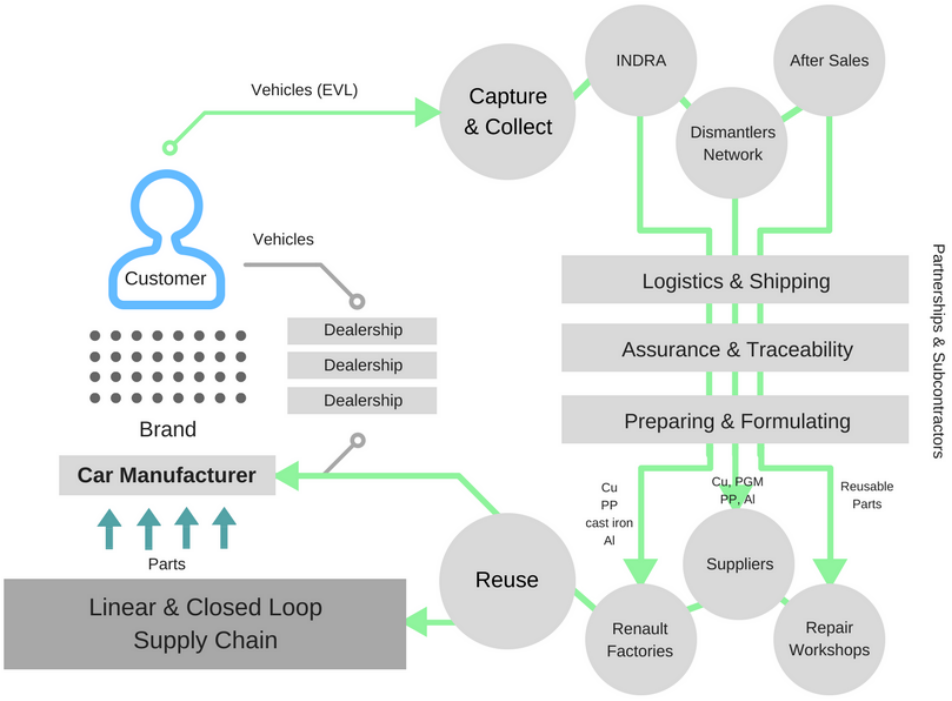


Figure 11. Renault's Circular Business model for Extended Value
Adapted From pg.6 of (Renault, 2016)

The innovative recycling of a ELV is a virtuous solution brining a reduction in landfill wastes, decrease in energy and virgin material needs, and a creation of local jobs. Job creation is achieved by means of innovative recycling plants, and the dismantling of ELVs. The challenge of such a system is to create a cost-effective means by which vehicles are first depolluted then dismantled and finally shredded and sorted. These steps exist to recapture the predominant areas of value of a vehicle. This includes reusable parts, which can be immediately reused or refurbished to fit newer vehicles, this comes at a reduced price for consumers than new parts, and reduce material needs for the creation of original / spare parts. Removal of plastics (PP), seat foam, and wires (Cu) is done during the dismantling phase, these materials can see extended use by recycling into base input materials for car manufacturers, or back to part manufactures in the supply chain. Finally the chassis and metallic parts of the car which consist mainly of steel (69% by mass (Renault, 2016)).

ELVs are captured and collected, shipped to a network of dismantlers, undergo destructive dismantling and parts are sorted and sent to the relative partner or stakeholder to undergo material processing, or part refurbishment. This process outputs either, alternatives to raw materials for the car manufacturing industry, and, reusable parts that can go straight to consumers or be sold to repair workshops as parts stock for customers. The importance of a circular supply chain is seen not only by meeting EU regulations, but by reducing the amounts of raw material requirements for new vehicle production. During the projects duration, more than 135,000 catalytic converters, 480 tons of electrical harness and 2200 tons of PP have been collected and processed (LIFE10, 2016). Renaults challenge was to achieve this closed loop supply chain in a cost effective, efficient and manageable way. The only way for the car manufacturer to achieve this was by partnerships, and involving many stakeholders from waste management companies to research Lab, professional organizations, education, and a range of other small and medium sized enterprises (SME).

By employing the extended value model (Figure 9), Renault is able to leverage the advantages that a closed loop supply chain brings, namely, reduced raw material needs, increased customer feedback cycles, design feedback (wearing parts etc…) and a reduced environmental impact for Renault,

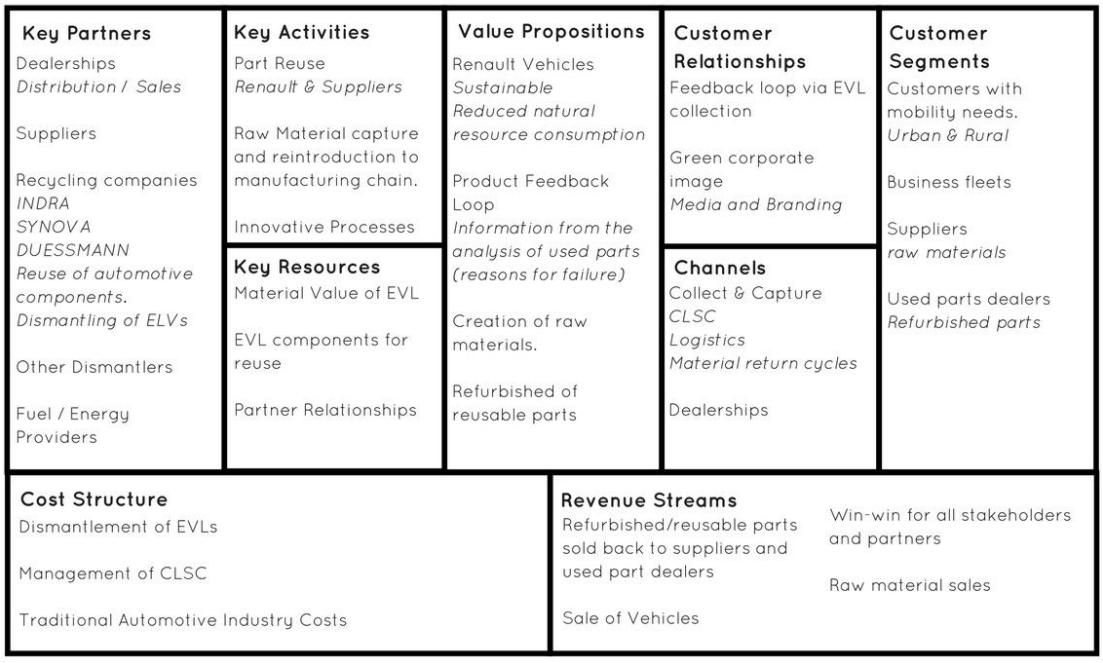


Figure 12 Renault ICARRE 95 circular business model canvas

leading to opportunities for a greener corporate image. Renault is keeping ELVs off of the landfills, and instead investing time and energy into the recovery of the intrinsic value of its vehicles. When this process is achieved cost effectively, many stakeholders can benefit from the lower costs of recycled materials, and unique material properties brought about by their original method of manufacturing.

During the dismantling process, Renault identified a few areas that needed improving these consist of, the efficiency of dismantling through design, and the development of a destructive tool for automation of dismantling (LIFE10, 2016). The first area brings the idea full circle, meaning that during the design phase of vehicles and vehicle parts, a thought should be had towards the ELV dismantling process. Incorporating recyclability into the original design of vehicles, not only for material recycling, but in order to reduce work force costs, and costs of vehicle dismantling for part re-usability, depollution and material take back processes. This reveals a gap in research with regards to the extended value model and that is the aim of reducing End of Life costs by designing products with lower economic and energy needs for dismantling. This requirement of 'design for recyclability' will continue to grow as more and more businesses are required to adhere to stricter legislation, and while raw material prices increase. When the time comes that the quantity of EVL's increase, the second area of improvement is an autonomous tool to allow for the dismantling of the vehicle. This means that car manufacturers experience and abilities in a vehicles creation will become increasingly more valuable during the end of life cycle for the vehicle, where dismantling needs are required.

8.3.1. Business Model Canvas 'ICARRE95'

In order for Renault to facilitate the ICARRE 95 initiative, the infrastructure of the business model required some serious re-thinking. Where partners, activities, and resources were previously focused on for the manufacturing of vehicles, the extended value CBM has introduced the need for various processes; including EVL dismantling, raw material extraction, part refurbishment, and extensive logistical requirements for the recapture of vehicles. Key partners has seen the addition of new firms, INDRA, SYNOVA, and DUESSMAN in order to help facilitate the recapture of value from ELV's. The partnership with INDRA is to realize the efficient and cost effective dismantling of ELVs, they specialize in the dismantling of vehicles. As dismantling specialists, much of their expertise and experience has been disseminated to other smaller dismantling points or ELV centers, to realise a "best practice" methodology (LIFE10, 2016). INDRA creates the means by which vehicles can be effectively dismantled, this is important due to energy requirements needed to be kept to a minimum. The ICARRE 95 needs to meet a cost effective business model, otherwise the costs of the CBM disincentives the programme. It should be stated that governmental regulations played a large role in the implementation of this circular economy, however the strategies used to turn a sustainability requirement into a successful business model was done by Renault's own initiative.

The SYNOVA partnership allows for the recycling of the Polypropylenes (PP) materials in the ELVs. SYNOVA acts as a supplier of recycled PP for the automotive industry, the partnership allows ICARRE95 to define the quality of sourcing of the PP with regards to the automotive specifications. Expertise in processes for the recycling of PP has made SYNOVA an invaluable partner, and the relationship created between Renault

and SYNOVA has even led to a new process innovation NOVAFORM. This process uses recycled PP material and will be used for some parts of future vehicle projects (LIFE10, 2016). Duesmann is a partner with experience and specializes in the recycling of precious metals. With upwards of 65% of the material (by weight) of an EVL consisting of steel, experience with metal recycling is needed. Further precious metals found in the catalytic converter and other specialised parts of the vehicles, unique recycling methods are required.

The value proposition that ICARRE95 has is the focused on the extended value of ELVs, capturing, collecting, refurbishing, reusing, and recycling of parts and materials creates the value proposition (LIFE10, 2016). These parts and materials can be reintegrated at a reduced cost into the manufacturing chain, or sold to 3rd party stakeholders for resale or reuse. The proposition allows Renault to meet governmental requirements while exploiting the residual value integrated into its own products when their end of life is met. The creation of a feedback loop is also of value due to informational gains on the front of part failures, life expectancy of parts, and product degradation over time. The recapturing of vehicles also reveals unforeseen use scenarios and/or part failures, creating the opportunities for improved designs, parts, and processes.

The customer interface has not seen large disruption with the extended value CBM, the existing vehicle customers are not impacted, and the channels by which customers are reached are kept relatively similar to the linear BM. New customers are created by this CBM creating value for part suppliers, in the form of refurbished of reusable parts and raw materials. The use of a CLSC means that customers have the ability to return ELVs to collections points, decreasing their responsibilities for the proper recycling or disposal of vehicles (Renault, 2016). Renault see's benefit in the customer relations building block by creating a greener corporate image, being able to show that it adheres to the strict governmental requirements, and reuses parts and materials in their supply chain. As shown by research this customer perception of a firm's sustainability adds value to the products which they deliver.

Renault viewed the governmental regulations not as 'just another cost' but has redesigned their linear business model into one where the extended value of their products can be captured and turned into a value proposition. The ICARRE95 initiative is a solid example of turning a cost into a source of value for the firm, both in the terms of environmental impacts, and as a revenue stream for the business. The main disruption is the added logistics required for a efficient CLSC and the costs of EVL dismantling, however with government subsidies being available to meet their requirements Renault is able to minimize these costs. Revenue is further gained by closer connections to suppliers, value from EVLs going back into the manufacturing chain, and a higher perceived value of Renault automobiles due to a greener cooperate image.

The disruption caused by the extended value circular business model is visible mainly in the number of stakeholders the model creates. It creates new market opportunities for businesses with innovative recycling techniques or those with specific needs for recycled or reusable parts. Renault itself has identified a creation of a reusable parts market, for customers with damaged vehicle parts or cosmetic damage to the outer shell. These are cases where the costs for the customer are drastically reduced if they choose a recycled part that may be refurbished or reused as is. Renault has seen needs for second hand vehicle panels, which from OEM have a high cost, but can be easily dismantled and repurposed via this recycling system. A cost-effective recycling system of EVLs has meant Renault can reuse and recycle many parts of their vehicles in the

French market. It disrupts the linear business model by reducing raw material input needs, creating a green corporate image, leveraging multiple stakeholders to recycle vehicles creating new markets and value chains for SMEs, and incentivising radical innovation in recycling methods.

8.3.2. Opportunities for Sustainable Product Design

The design for a cost effective and efficient CLSC is of core importance to the success of the ICARRE95 project. The business model canvas outlines the need for various partners and newly introduced key activities, chief among these is the establishment of a closed loop supply chain. Where Renault can effectively capture and collect the value back from their products. To ease the dismantling process of vehicles a design for both durability and modularity may be of value to Renault. Modularity will allow for the quick disassembly of vehicles while allowing for part reuse to be standardised with the implementation of standardised modular interfaces. By example a dashboard console may not have reached the end of its life cycle by the time a vehicle is considered at the end of its life cycle, this console could be made to be reused in numerous vehicle models instead of just the model it came out of.

Strategic design for durable parts could also be seen as a form of disruption caused by this CBM. More robust and durable parts could mean a longer cycle of reuse for these parts. Despite a vehicle having many moving parts, which reach the end of their life cycle at predictable points, based on distance driven. A vehicle does have many parts which are predominantly static or see very little movement; these parts are often re-usable well beyond the lifespan of the moving parts. By designing these parts with durability in mind, Renault can exploit the residual value of these parts when reusing them during their own manufacturing, or by selling them to 3rd party stakeholders like vehicle repair garages or the 2nd hand vehicle components market.

Materials are often recycled to resemble their raw material counterpart, these materials often meet the same specifications as they did prior to manufacturing. With continuous innovations in recycling methods and processes, Renault may be able to further exploit the uses of these recycled materials. Implementing strategies to make more sustainable choices for materials is often a barrier to a sustainable design. Large investments are made to test the suitability of certain materials, this is often done when considering the value and manufacturability of these materials. This can act as hindrances to a design team which wishes to use alternative materials. Implementing the extended value CBM means that Renault does not have the growing pressures to redesign its manufacturing processes, it can rather use recyclable materials to create a circular economy in which it can severely reduce its raw material needs by focusing on recycling processes to create materials with similar properties to its more scarce counterparts.

8.4. Electronics Industry

Consumer electronics range from televisions and computers to smartphones and tablets, these are purchased for personal use rather than commercial, hence the term consumer. This industry has seen major

growth since the turn of the century, growing to an estimated $211.3 billion in 2014 in the U.S. alone. This large industry has many stakeholders all operating in different and often overlapping consumer segments, product segments, and other business solution segments. For this reason it is very difficult to describe the generic business model for a firm operating in the electronics industry, these firms however generally operate with a linear business model. Most consumer electronics producers follow a take-make-use-dispose model, and with the rate of advancements in technology and electronics, it is not surprising that the average lifecycle of a consumer electronics product is short.

The electronics industry is one that puts heavy importance on intellectual property and patent management. This is often an area for competitive advantage, until competitors develop innovations for a different technological advancement achieving the same purpose. The market is one which incentivises short development times, and fast times to market as a competitive strategy. This means that firms invest heavily into R&D and tend to create innovative iterations on successful products, in turn further shortening the useable life span of their own products. This fast time to market creates heavy investment costs meaning that electronics brands often disregard the EoL of their products, often also overlooking CBM's due to their costs, and/or difficulty to implement.

The typical business model for a smartphone brand is outlined in figure 11. This shows the linearity of the strategies being employed to create a value proposition and deliver this to consumers. It should be noted that the model is an overview of the generic model being employed, and specifics behind a brands strategy are not included. This overview simpily outlines the product life cycle from raw materials to consumer. Suppliers, channels, retailers, manufacturers, and brands each have independent strategies by which this process is achieved but figure 11 hopes to aid in a firm overview of the linear cycle that can be attributed to most consumer electronics.

It is noticeable that the consumer electronics industry exists of many stakeholder and various types of business model, each positioned to create a value proposition for the firm employing it. In order to create a good comparison between the case study (Project ARA) and a linear business model from the electronics industry, this paper will examine Samsung's business model canvas for the manufacture and sale of their smart phones. This is a firm that will be in direct competition with other smartphone manufacturers, including the disruptive circular model created by Project ARA. Samsung employs a similar business model to most of the stakeholders who deliver to the smartphone customer segment, therefor making it a comparable base from which to draw conclusions in the disruptiveness of the circular business model being conceived by Project ARA.

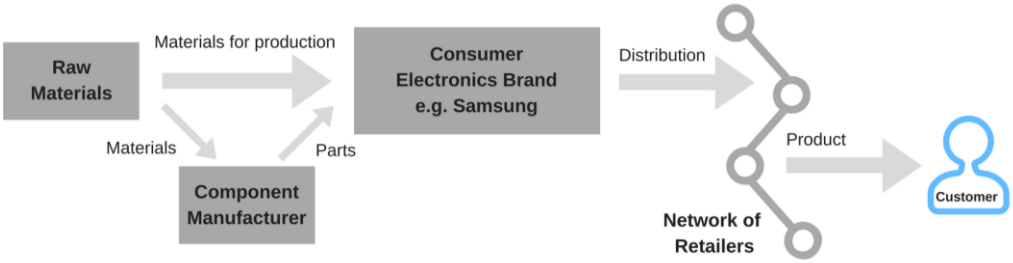
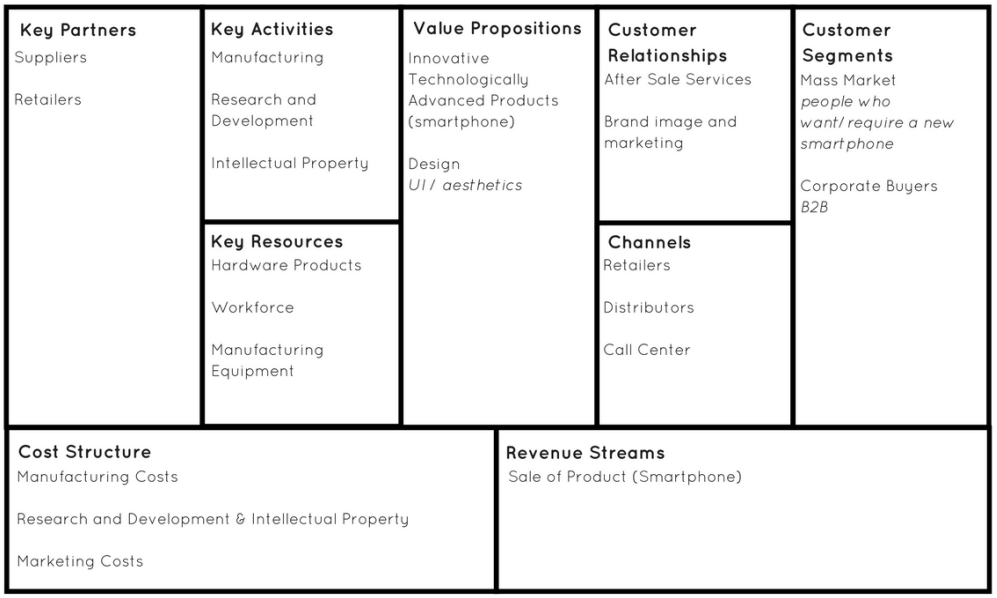


Figure 13. Overview of the electronics industry business model (Based on Samsung Smartphones)

Figure 14.Business mode canvas (Based on Samsung Smartphones)



8.4.1. Business Model Canvas 'Samsung Mobile Phones'

The business model canvas being analysed is one that is being successfully employed by Samsung to bring smartphones as a mass market product onto the consumer electronics market. The firm focuses on research and development to create incremental innovations in their products and to efficiently integrate the innovations into new product iterations. It is common for consumer electronics brands to release new product iteration on a yearly and/or bi-yearly basis, often only providing minor advantages over current models. This often incentivises users to purchase new iterations due to older models not being able to keep up with software and graphical updates, this is especially true in the smartphone segments.

The infrastructure employed by Samsung is similar to that of a manufacturing firm. This is due to the consumption of raw materials to manufacture electronics, this is done both in house and as parts from suppliers. Further activities include R&D and intellectual property management, both of which are cost heavy endeavours especially in the ever changing technology sector. Advancements are put into the process of manufacture efficiently through the use of techniques such as SIX SIGMA, statistically ensuring the quality of every product manufactured. Samsung has worked hard to create an infrastructure which easily allows for product iterations, and can incorporate innovations found through R&D into the products they produce.

Samsung's value proposition consists of bringing the newest technology to the consumer electronics market. This is done while keeping to certain design principles for consumer appeal. By often iterating products Samsung re-enforces its position as a front runner in the technological race, however this marketing strategy increases e-waste and continuously shortens the life cycle of previous products. Samsung has put some effort into creating a green corporate image by including recyclable materials into its product designs, however this is not an innovative strategy and is often done as more of a marketing/publicity stunt to gain favour in the eyes of consumers.

In order to create a positive customer interface environment Samsung has created traditional channels and relationships with consumers. These relationships are often tethered to after sales support and marketing where the firm stands distant from consumers and is rather seen as an impersonal or unapproachable organization. The smartphones that Samsung produces are target at the mass consumer market, often for current users of smartphones as well as users who are new to the industry. This broad, mass market target has created a broad, global customer base making disruption to their business model as major risk for the business.

The financial aspects consist of product sales for a strong revenue stream, and heavy investments for R&D to stay ahead of the competition. This creates a linear system where costs are used to generate value and competitive advantage for the product, and revenues are later gained by the consumer purchasing of the products. This model is often consistent with the wider range of consumer electronics stakeholders. Creating a market place which fills with under-utilized products, mass disposal of older models, and the constant shortening of the lifecycle of products in the market, creating a volatile environment for consumers where choice between brands is become ever limited, and larger corporations are setting trends for smaller businesses which are trying to stay competitive.

8.5. Project ARA

PhoneBloks was a concept for a modular smart phone, arising in late 2013 from Dutch design student Dave Hakkens, the concept (video) went viral gaining aprx. 370 million views within the first month. The concept outlines a mobile phone that was modular by design, allowing important components to be swapped out by consumers (Hankammer, Jiang, Kleer, & Schymanietz, 2016). The idea was brought about by the increasing amount of 'e-waste', the waste caused by out dated electronics. In an effort to reduce this waste Hakkens conceptualized a smartphone where components that were becoming outdate could be replaced, without the need for a new mobile phone purchase to be made. The consumer response was overwhelmingly popular, and was subsequently picked up by search engine giant Google who would work together with Hakkens's, PhoneBloks.

This cooperation resulted in the beginnings of Project ARA, a modular smartphone device that would have an open source framework to enable any electronics firm to create modular components for the phone. Utilizing the experience of Google owned Motorola, a long time mobile phone manufacturer, the idea was put into the process of realization. The concept falls under the idea of Mass Customization (MC), which has become a major trend in the consumer goods market, enhancing product value by means of customization options for consumers. One of the key components of a MC is a modular product framework based on the standardisation of product interfaces and upgradability.

Mass Customization is an approach that seeks to individualize products to appeal to the uniqueness of each customer, changing the products to suit the specific needs of each customer (Gilmore & Pine, 1997). Instead of a firm focusing on meeting the needs of every consumer, and competing with the 'average' offering, mass customizers have identified the dimensions along which their customers differ in their needs. Gilmore &

Pine (1997) outlined four approaches to customization, adaptive, cosmetic, transparent, and collaborative. Collaborative is the approach that Project ARA aims at under taking, the approach relies upon the customers' ability to resolve trade-offs on his or her own. This is an area of concern for Project ARA as smartphone components are not an intuitive area for consumers to understand, often trade-offs are between specifications of one product vs. another are being based off of quantitative values that a consumer has very little knowledge over, unless an in-depth approach for learning is undergone.

Design for Modularity allows a product to benefit from outsider knowledge and innovations, increases product utilization, and improves the length of a products life cycle. Modular products often offer increased flexibility to consumers by allowing easy transitions to alter the specifications of their devices. This is especially important in a market where products are made of various components which work together, and each new product has an iteration of one or many of these components. The PhoneBloks idea arose primarily to combat e-waste caused by the increasingly short lifecycle of mobile phones and other consumer electronics. The modularity would allow for easily upgradable components such as battery, camera, processor, memory, and storage capacity which are some of the leading causes for consumers to buy new phones. When consumers believe that newer iterations have advantages in these area's it is a cause for them to purchase the new product (smart phone), this is apparent in many areas of consumer electronics and are what drive innovative iterations for devices.

The business model of Project ARA is disruptive due to the open platform which it offers for multiple firms to create competing solutions for modular upgrades for the smartphone. This drives innovation in components, and creates an ever changing environment for consumers to purchase modular parts. Each part is marketed individually and creates value by adding to the base platform the users already own, Project ARA aimed at providing the base standardised modular platform via which these modules can be added.

After much deliberation, postponement, and three stages of prototyping Project ARA was cancelled in favour of the competitive top of the range smartphone created by Google, named 'Pixel' (Madanapalle, 2016). The consumer driven marketplace of smart phones has led to the increasing success of slim, lightweight mobile phones. A modular smartphone would consist of a bulky platform by which modular parts are attached and detached, a space consuming and heavy framework which is not necessary in 'out-of-the-box' smartphones. This creates a smartphone that is too bulky for consumers which negatively impacts the attractiveness of the modular platform. Additionally the project was scraped due to the disruption in the software ecosystem of the modular device. This was due to the need for software to be present on new modules, this software would need to match up to the current software on the platform of the device, as time would advance, updates

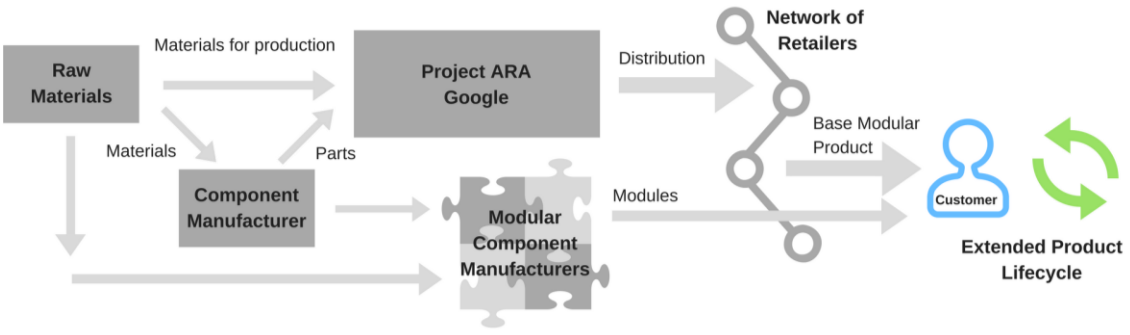


Figure 15. Project ARA business model overview

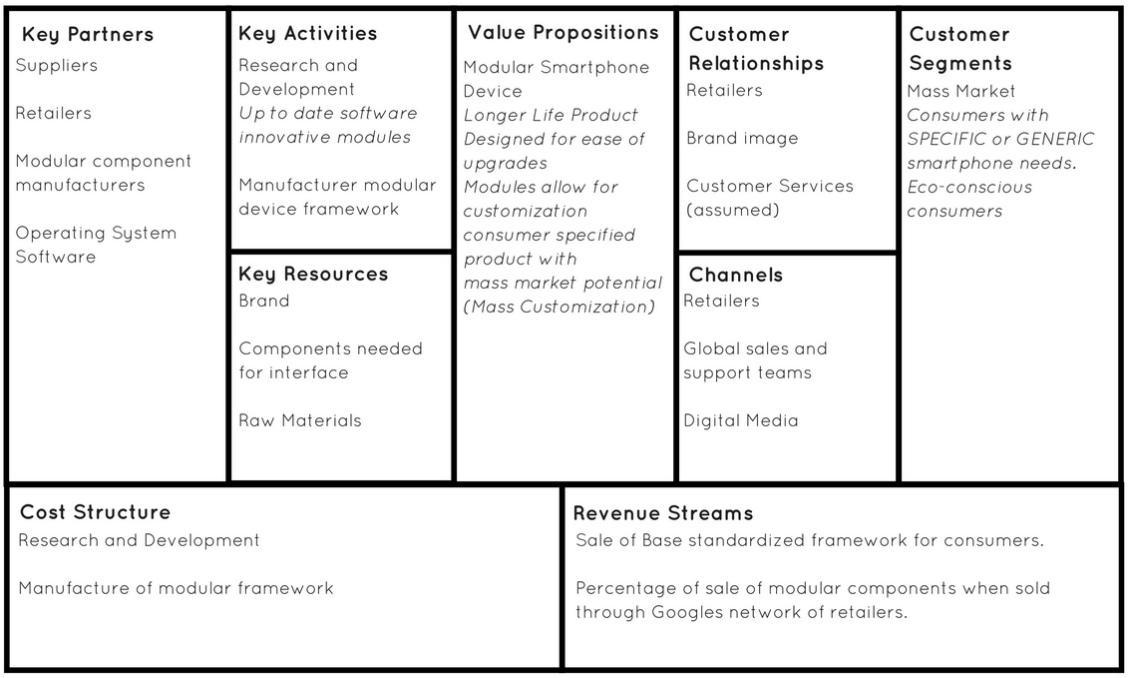


Figure 16. Project ARA business model canvas

would not be possible due to out of date modules, parts, or operating systems (Madanapalle, 2016). This would create a smart phone where the hardware may be exactly how a consumer wants it, but the software is constraining the activities of these newly added modules. This fragmentation of the overall software picture for the mobile phone is a concern due to smartphones not only acting on hardware but are often limited by software, and as technology advances the software in these modular phones would either be left behind or be mismatching with new modular additions. Such a system creates both problems for hardware manufacturers, and software developers, whom do not often work together and would have many hurdles to overcome to create a soundly operating smart phone.

8.5.1. Business Model Canvas 'Project ARA'

Project ARA was not brought to the market place after many delays and possible flaws with the modular smartphone's business model. The fact that this project was not brought to full fruition was placed at the hands of technology not being advanced enough for the successful launch of the product. Although this may be true, this paper will investigate the possibility of a flawed business model, which would have been existent as early as the design phases of the project. The canvas has not altered much from Samsung's business model, with the exception of added availability for modular component manufacturing and sale, and a percentage of the sale price contributing to the revenue of Project ARA.

The infrastructure outlined from the business model canvas shows a few new partners, which are not well defined, and would have to be new business ventures for emerging or existing businesses. This includes the modular component manufacturing and a modular software system for the mobile phones operating system, to add to functionality and usability of the modular smartphone. These key partners are not outlined as concrete firm but rather as possible partnerships with manufacturers to ensure product compatibility. The

design and manufacturing of components was conceptualized as open source, meaning any firm with a design would be able to enter this market, leading to the risk of competitor domination or the risk of few firms taking the opportunity to produce these parts. If key partnerships are not made early in the project, it would have led to the launch of a modular product platform where no modular components are ready for market, rendering Project ARA smartphone near to useless.

A key activity outlined by this BM canvas is the need for successful R&D. For project ARA this was not the case, research and development was hindered by the bulk of the design for the modular platform, this was a 25% increase over competing models. In a market where weight and size of product is a strong source of competitive advantage, a 25% handicap would have led the eventual product to be less favourable for consumers. Further activities and resources involve the use of raw materials, one of the reasons for the idea behind project ARA is to reduce consumer electronics waste and to extend the value of raw materials being used in mobile phones. Some reports speculated that a design for modularity may not effect the raw material consumption due to the speed of progression the mobile phone market is seeing. This pace of innovation would quickly render modules as obsolete, thus shortening the lifespan of modules for the phone, and despite the smartphone having a long lasting framework, the modules would need to be replaced and updated as frequently as most generic smartphones are today. These components are often the parts which require the scarce raw materials that computer components demand, this would lead to the same problem of an increase in e-waste.

The value propositions stipulated in the canvas include the delivery of a modular smart phone. This modular phone would need to compete on every level with current smartphone competitors, in a very competitive market of incremental changes. The value that project ARA adds falls under the model of Mass Customization, an approach often taken to increase the individualization of the smart phone. Often individualization goes hand in hand with complication for the everyday users, where competitors offer a complete package, project ARA would offer a wide variety of configurations for its products. The group of users who just need the basic functionalities does not want to deal with the configuration processes and paradox of choice, often putting users in an overwhelming situation (Hankammer et al., 2016). This devalues the propositions put forward in the business model canvas, and creates an adjusted customer segment that would appeal to only the most savvy smartphone users. This pulls Project ARA away from the mass market and into the niche market, a position that would in turn disincentives key partners in their creation of modular components as products for the project ARA framework.

Project ARA was positioned to follow a comparable customer interface, offering after sales services, connecting to consumers through marketing channels, and placing the project with a network of retailers. The important factor of the customer interface is the segment which project ARA aims to appeal to which is the mass market. This is a disruptive product entering a market saturated with competition and an array of choice for smartphone consumers. Short times to market have led to the existence of multiple similar products being sold at similar price categories and often a variety of products even from the same brand. Samsung released

and sold over 56 types of smartphone in 2014 alone (Whitwam, 2014). This places project ARA as a complicated, almost artisan, alternative to hundreds of similarly priced, performing, and aggressively marketed smartphones. Redesigning the business model to target the more involved smartphone users, may have led to a better business model for the creation of this modular smartphone, despite the well-received idea of PhoneBloks, average users would have quivered at the idea of more choice in the smartphone market.

The financial aspects of Project ARA are also similar to the Samsung BM canvas, with a heavy focus on R&D and manufacturing as a source for the majority of the costs. The revenue stream is adapted to include the added revenue from the sale of the component modules, this is only guaranteed if Google sets up a marketplace for the modules, and ensures they are sold through their own channels. The revenue stream runs the risk of becoming diluted when modular component manufactures will use different channels to reach customers, lessening the revenue for Project ARA. Since the framework specifications and details will be made open, to allow manufacturers to compete and create useful products, they run the risk of broadening the channels of sale for modular component manufacturers.

8.5.2. Opportunities for Sustainable Product Design

Project ARA follows a circular business model for extended use, and has included design principles for a durable design, and increased functionality and usability. Design for modularity is often considered a sustainable strategy due to the product lifecycle extension it offers existing products which are with consumers. Modular products are also often easy to deconstruct and recapture value from, working components can be removed and re-sold, smaller parts can be easier to recycle to raw materials, and modules can be refurbished individually. Project ARA is conceptually a modular product; however it loses many of the advantages to its modular design due to the volatility of the smartphone market, and the technological innovations being made currently that often render parts/products obsolete after a short amount of time.

8.6. Manufacturing Industry

Manufacturing is the fabrication, processing, or preparation of products from sources of raw materials and/or commodities. This industry predominantly follows a fairly unsustainable and linear value chain. Manufacturing is really the process which perfectly fits to the linear ‘take, make, use, dispose’ model, manufacturers roles are generically include the processing of raw materials to create a product. Often manufacturing firms deliver products to businesses that are closer connected to the end users, or manufacturers create parts of overall services or products. This model often puts them in a supplier position of other businesses, making their primary channels predominantly B2B.

It is often the case that manufacturing firms, when acting as a supplier, have static specifications and information behind exactly what their products should look like, what materials are used, and how they are to be manufactured. This minimizes the opportunity for design alterations, and a more sustainable production process. However there are techniques by which manufacturers can offset some of their more rigid properties

with a circular business model, creating flexibility in the way products are created or the way in which they are delivered to the customers. Manufacturing firms have been designed to complete a linear business model efficiently and cost effectively, this has been their focus for years, and the value of a CBM that does not disrupt the competencies that have been built up will be the most suitable for a manufacturing firm.

The basics of a manufacturing firm's business model are relatively linear. The flow is generally a in the line of R&D, design, supply chain management, production, go to market, and aftersales service. It is often the case that manufacturers are disconnected from the disposal phase of their products, leaving waste management to governments and organisations. This means that materials are processed into products to create value and this value is sold on to the customer, at which point the manufacturers engagement is ended. The reason that manufacturers use the LBM is due to the ease at which such a model can be managed, and additionally the way in which a LBM acts is in line with the functions that manufacturers carry out.

8.6.1. Business Model Canvas 'Manufacturing'

The generic BM canvas of a manufacturing firm is built up of rigid parts, often involving large fixed costs for machinery acquisitions, and workforce costs for machine control and maintenance, and standard revenue per product manufactured incomes. Manufacturing firms are often not the organisation that delivers the product to the end users, and are often seen as suppliers for product parts, or fully realized products. For this reason the customer interface section of the BM canvas is lacking some definition, since each manufacturer acts independently and is often advised by customers on what its products should be. This leaves very little room for customer relationship and a variation of the channels by which products are received by the customers.

Figure 17. Overview of the LInear Business Model for the manufacturing industry

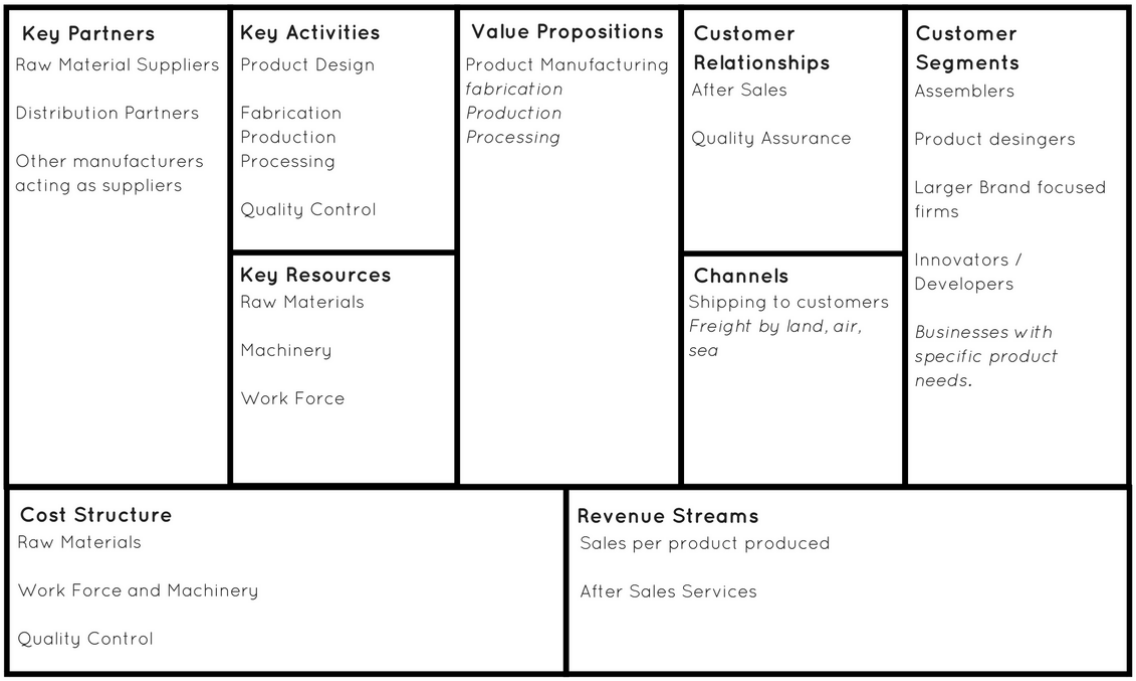


Figure 18. Business model canvas for generic manufacturing firm

The Infrastructure of manufacturers consists of the procurement of raw materials and/or commodities, which is transformed into a product via fabrication, production, and processing methods, by using the resources at hand such as machinery and a company's workforce. This is a good example of a traditional linear business model canvas, representing exactly what needs to be done in order to create the value propositions. However with the increasing pressure from governmental legislations and public opinions on the matters of sustainability it is time for manufacturers to begin to rethink their business model canvas, and attempt to find ways to create new value from stricter regulations.

The value proposition consists of the products being manufactured, it is the core competency of a manufacturing firm to create a full product, or part of a product. The ability to realize the creation of a product outlines the success of a manufacturer, this success can be attached to the cost price of manufacturing, quality of the product, time taken and other factors that play a role in the value of a manufacturers product. It is important to note that value can be seen as not only the translation from raw material to product, but also by the speed at which this is done, the quality of the manufactured part, or the 'cheapness' of manufacturing. These are regularly seen as points of differentiation for manufacturers and often define the firm's USPs. These are important factors for a manufacturing firm to consider when realizing a transition to a CBM.

A manufacturer's customers include other businesses, manufacturers, and occasionally the end users, depending on the customer segments, the customer relationship and channels are directly affected. CBM's are often designed to disrupt the way in which a business brings value to the customers, this is done to reduce the amount of a product that is needed or extending the lifetime of a product so less are required, using less raw materials. Section 7.7 will outline an example of a manufacturer which attempts to employ the

service oriented BM, and section 7.8 outlines extended value of products, where quality is key and a longer life cycle becomes a USP for the manufacturer.

The financial aspects of a generic linear business model and that of the manufacturing BM are relatively similar. Manufacturing firms often have the majority of their costs in the key resources, and the revenue stream coming from the value proposition being delivered efficiently to the customers. The raw materials, work force, and machinery make up the prominent cost structure of a manufacturer, as with each product being produced, raw materials are used and a workforce and machinery are needed to realize the value propositions. For each product created revenue is generated from the customers, who are used to offset the costs for the products.

8.6.2. Opportunities for Sustainable Product Design

Since the majority of manufacturing firms operate under strict specifications from consumers, it is difficult for the firm to reorganize the design of products. The pressure for adhering to sustainable design principles should be placed on the customers, and often the businesses which are in direct contact with the end users. Manufacturing firms can try and create pathways for efficient production, and waste reduction, this creates the room for a design for cost effectiveness. Cost effectiveness can be used for the firm's processes, material usage, and even logistics. Cost effective products are those which can be manufactured and shipped efficiently, this can lead to the manufacturers sparing costs in unnecessary areas.

Efficient work flows, material usage, and cost effective products are design strategies that manufacturers have used to increase sustainability while reducing costs. The firms are however still hindered by the LBM they are currently using, often requiring them to manufacture products which do not follow the sustainable design principles. The disruption a CBM may cause is to create new avenues by which manufacturers can better reach sustainable targets, not being limited to a linear value flow can create new opportunities for value recapture and resale.

8.7. Philips, Lighting as a Service

Business model innovations are often overlooked for more obvious product or design innovations. In terms of sustainability an innovative business model, such as that employed by Philips, can reveal new opportunities to reduce environmental impacts. This model comes in the form of 'Circular Lighting' or more accurately a 'lighting as a service' model. This transition for Philips comes from a drive to contribute to a world with minimal waste and optimum conservation of natural resources ("Circular Lighting," 2017). Philips reveals that a strong core vision for sustainability and reduced environmental impact helps dampen the negative disruption within a firm for the transition to a circular economy.

The new business model aims to change the way in which Philips does business. Their goal is to "remove financial obstacles and free you from the burden of ownership and maintenance" ("Circular Lighting," 2017). This illustrates the extent to which Philips will go to as a service provider, their model reduces the

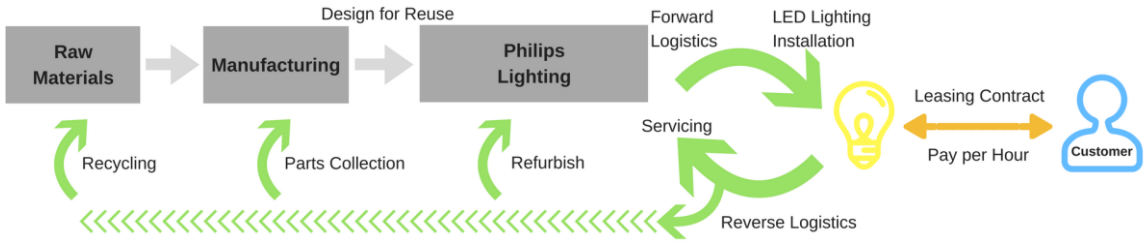


Figure 19. Overview of Philips 'lighting as a service' business model

burden of ownership and with that the value proposition is enhanced to encompass the servicing and replacing of lighting when and where needed. This model further incentivises Philips to focus on a design for durability and serviceability, this is because they stay owners of all the lighting and fixtures at the client's location. The model focuses on a pay per use revenue stream, advertising that consumers only pay for the light they use. Philips creates the full package due to comprehensive service contracts for maintenance, optimization and services.

Philips has long been a leading manufacturer of lighting solutions; however their business model ever followed the LBM like most generic manufacturers. Focusing on product design, manufacturing, and delivery to customer, Philips is able to get products to owners cost effectively and with minimum input to EoL management of their products. The service orientation Philips is operating under means they can reuse and refurbished used products, such as LED lights, and fixtures. The designs of their products have come to incorporate principles of durability, serviceability, and reusability. Philips states that the lighting fixtures will last up to 75% longer than conventional fixtures, and energy efficient LED lamps can reduce an organizations power usage by 50% ("Philips provides Light as a Service to Schiphol Airport," 2016).

Applying circular economy principles Philips has created a lighting solution service for a number of organizations, ranging from airports (Schiphol Airport) to university parking lots (Eindhoven University) ("Circular Lighting," 2017) ("Philips provides Light as a Service to Schiphol Airport," 2016).

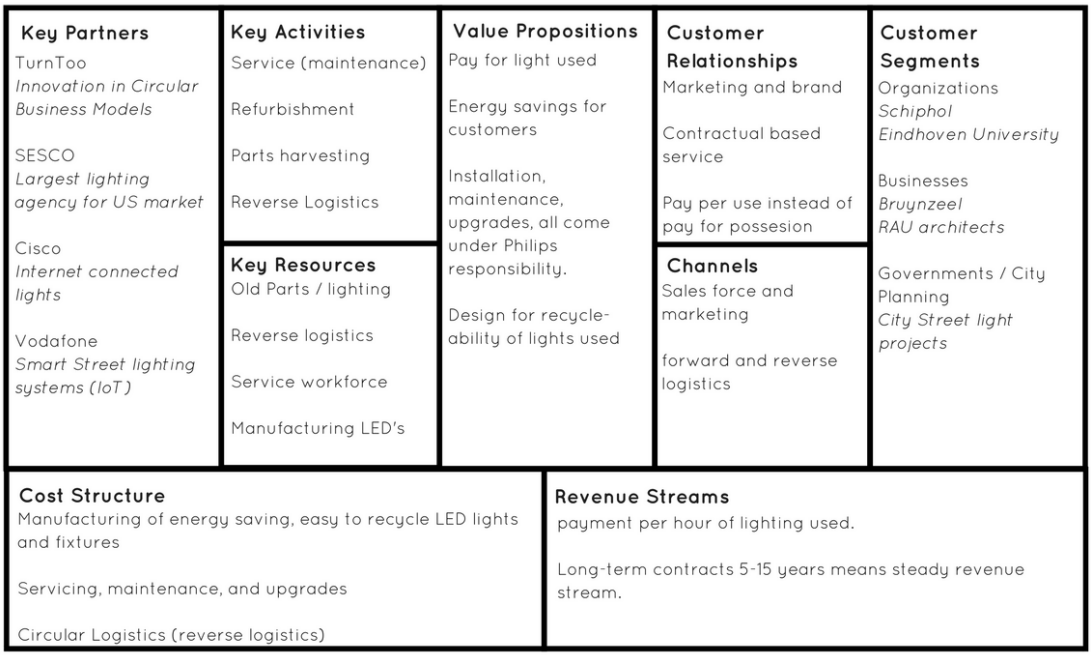


Figure 20. Business model canvas for Philips 'lighting as a service'

The offer gives consumers the sensation of carefree lighting services, Philips and its partners receives the majority of the burden for the lighting service. Harrie Arends, Operations Manager at the Campus of Eindhoven states that “Thanks to this service concept we do not have to look at our lighting for the next decade” (["Car parks 10 years carelessly lit," 2016]). This statement underlines the benefits brought to customers by implementing a service oriented CBM.

8.7.1. Business Model Canvas ‘Philips, Lighting as a Service’

The service oriented business model that Philips has transitioned to, creates disruption in many areas of the business model canvas. The BM canvas reveals the need for numerous partnerships with organizations that assist Philips in achieving its value proposition. These partners help Philips innovate, market, and build the infrastructure for ‘smart’ lighting systems. Disruption to the canvas is substantial, disruptive key activities, customer segments, and new value propositions have led to a manufacturing firm that now has direct contact to customers, retains its product’s value, and has a more valuable product due to added value propositions.

The infrastructure of this service oriented business model has largely changed due to the needs of having to accommodate new activities, and to strengthen the firm via new partnerships. These partners have added value to Philips’s core competencies as a manufacturer and enable Philips to accomplish the new value propositions. This business model is a good example to support the need of partnerships to achieve a successful circular economy, partnerships allow Philips to focus on manufacturing and remanufacturing while knowing that its partners complete the other roles that are required. Key activities to achieve the reverse flow of products disrupt the traditional only forward facing role of a manufacturer. These activities allow Philips to recycle, refurbish, collect parts, and easily service the fittings and LED lamps used for their lighting services. Meaning Philips keeps all its assets, product value, and material value in house, allowing for the reduction of raw material input, and work needed for the new manufacturer of lighting solutions. Old parts, fittings, and bulbs can be reused in different areas of the business. This take back loop captures the value of the leased products, and allows Philips to further exploit their products in other leasing programmes by numerous customers. This CBM for service orientation incentivises the design of durable, recycle-able, reusable, and modular lighting solutions for customers, in order to allow for efficient reverse logistics and serviceability of lights and fixtures.

Philips value proposition has been altered from one where a product is delivered to one which focuses on the service that product provides. Their value proposition is no longer to deliver light bulbs and fittings as products, but rather to provide lighting as a service, and to have the consumer pay per hour of lighting used. This strategy means that Philips can create a revenue stream by, essentially, leasing their products to consumers at fixed rates. Leaving assembly, servicing, and disassembly as a burden on Philips, they have been able to recover many reusable, refurbish-able, and recycle-able products. This is an innovative strategy for a manufacturer, since ownership stays in the hands of the service provider, Philips creates a circular value chain, recapturing the value of used products. This type of value proposition incentivises a

durable design, and a design for the recapture of product value, while also creating the drive for more eco-friendly lighting solutions. This is noticeable since Philips has included the energy usage of their clients as a part of Philips's cost structure, thus incentivising the design of more energy efficient lighting solutions. As an additional value proposition, this service orientated business model further decreases the burden on consumers, an important facet of the BM, due to the installation of the lighting, extended service, and maintenance periods, all of which Philips provides.

The customer interface of Philips has been significantly disrupted due to the inclusion of long term contracts with consumers, this means that service and maintenance needs has been taken up by Philips. This creates a need for suitable channels of contact between service provider (Philips) and consumers. This falls under the newly conceived reverse supply chain, when the products need replacing or fixing, the replaced product is taken up into the supply chain and delivered at a certain point in the forward supply chain. This CBM reveals that products which can be recovered and entered back into the value chain reduce the need for raw materials and manufacturing costs, creating new value for Philips to integrate into its supply chain. Customer relationships are enhanced due to green corporate image, and the consumer perception of sustainability. Sustainability, for many organizations and businesses, has become a large and ingrained long term vision, not only in an effort to create their own green corporate image, but also as a moral obligation to the planet and its inhabitants.

Philips has ensured this CBM to be a profitable enterprise, despite the addition of a large range of new costs. Partnerships, eco-friendly and efficient designs, and a well-managed closed loop supply chain has allowed Philips to minimize the costs incurred. By reducing the burden on consumers for lighting management, and purchasing, Philips is able to demand a premium on its product. The added benefit of the business model being circular, sustainable, and more energy efficient, allows for further value to be placed on the lighting solutions provided. The revenue stream is based on long term contracts, and agreements between consumers and manufacturer. These contracts are priced on the amount of light being provided, and the hours of usage that the consumer needs, this means that eco-efficient lights reduce the energy needs, thus creating a larger margin between the revenue of service provided and the cost of energy required.

8.7.2. Opportunities for Sustainable Product Design

This CBM used by Philips has created incentives for eco-efficient lighting and design for reusability and/or value recapture. In order to achieve its value propositions, Philips help to the sustainable design principles, and designed a light bulb specifically for functionality, usability, durability, and modularity in order to create a long lasting product, that is easy to re-use or recycle. The Philips SlimStyle A19 LED is a unique design which places 26 tiny LED bulbs in a flat geometry to eliminate the need for a heat sink (cost effective) ("Philips SlimStyle A19 LED,"). The design also integrates a sandwich construction which assures separation during crushing and recycling (Brummelhuis, 2015), meaning materials and parts are easily recovered for recycling and reuse. This case study shows that innovative designs can aid in the actualization of a CBM for a

manufacturing firm. Sustainable Design principles aid firms in creating products that often align with the value propositions put forward by CBM's.

The redesign of their product creates a light bulb which is long lasting (22.8 years ("Philips SlimStyle A19 LED,")), cost effective (10.5 Watt replacing a 60 Watt bulb ("Philips SlimStyle A19 LED,")) and designed for ease of value recapturing (sandwich construction), allowing Philips the availability of profitably achieving this BM. This case study shows that product redesigns or innovative sustainable product designs can create the opportunity for a CBM. Without such a light bulb, Philips cost of operating under such a business model would heavily strain the profitability of the firm. Disruptive product designs like that of the SlimStyle A19 LED play a large role in the success of this case study, and by re-aligning the firms design incentives Philips has created new customer segments, an improved value proposition and the can benefit from a greener corporate image.

8.8. Miele washing machines

Extending the value of a product is a method by which a manufacturing firm (such as Miele) can add value to its products, while employing a distinct type of circular economy. Extending the life time of a product creates two distinct advantages, the first is the reduced need for new products on the market, thus reducing the need for production, and reducing the use of raw materials. The second advantage is a brand image and product which is defined by properties such as quality, durability, and reliability. Miele's customers are assured an average washing machine lifespan of 20 years, over the industry average of 7-10 years ("Miele Durability and Reliability,"). This decreases the need for consumers to purchase new washing machines, as well as benefiting from longer product value in the second hand markets for long life products. Miele's slogan of "Forever better" ("Miele Durability and Reliability,"), was introduced at the beginning of the 20th century, and as the firm has progressed, this slogan has become a united firm vision. The manufacturer has therefor always been employing the extended use CBM, and been very successful in doing so.

The extended value business model has, for Miele, been a successful example of focusing on the sustainable design principle for a durable design. This has allowed Miele to manufacture a product with the highest level of quality (both in physical and consumer perceived terms) in its market segment. Miele is also the only manufacturers left that produces a washing machine which is 100% recyclable (Macarthur, 2015). In an article from the Ellen MacArthur Foundation, a world leader in innovative circular business models, it is stated that Miele is really the only choice for a Netherlands based start-up (Bundles) who offer clean clothes on a pay-per-wash basis (Macarthur, 2015).

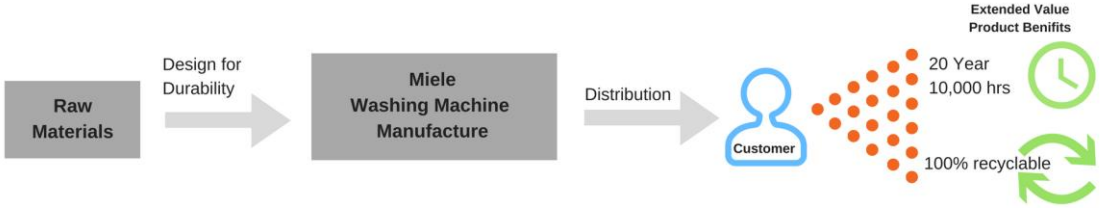


Figure 21. Overview of Miele business model

What makes extended product value, and extended and/or intensified use periods a circular business model approach is due to this model resulting in the "slowing of resource loops" (Nancy M. P. Bocken et al., 2016). This method is shown to be a fundamental strategy for the circular cycling of resources, a slower resource loop aids in the slowdown of the use of natural resources, commodities, and raw materials. The longer a products life cycle lasts, the lower the likelihood of consumers replacing or buying a new product to fulfill their needs. This is especially the case in areas where technology has stagnated and only incremental innovations are being explored by product manufacturers, as is the case with washing machines. Research reinforcing this proposition was shown in a 2006 study performed by the German consumer research association GfK ("GfK Living, Useful Life of Large Electronic Appliances"). According to this study, newly purchased Miele appliances were in use for an average of 17.0 years after their initial purchase, whereas the average useful life of other brands products is only 13.7 years. This 3.3 year difference is attributed to the quality of Miele's products by extending appliance life times, Miele has managed to reduced its raw material consumption and slowed its resource loops.

Using 100% recyclable materials also means that Miele's appliances can be recycled and reverted back to their raw material components. Despite this action not being undertaken by Miele as a manufacturer, many governmental legislations and targets have begun to incentivise the recapture of value from such goods. Washing machine manufacturers and different brands are often choosing non-recyclable components as a cheaper alternative, for instance stainless steel being exchanged for thermo-plastics, and cast iron components for concrete. This has taken the average lifetime for washing machines down from 10,000 hours for high-quality products down to 2,500 hours for low-quality machines (Macarthur, 2015). This has a drastic effect on the consumption of raw materials for these appliances, showing that a single Miele machine can perform the same job that four separate lower quality machines achieve.

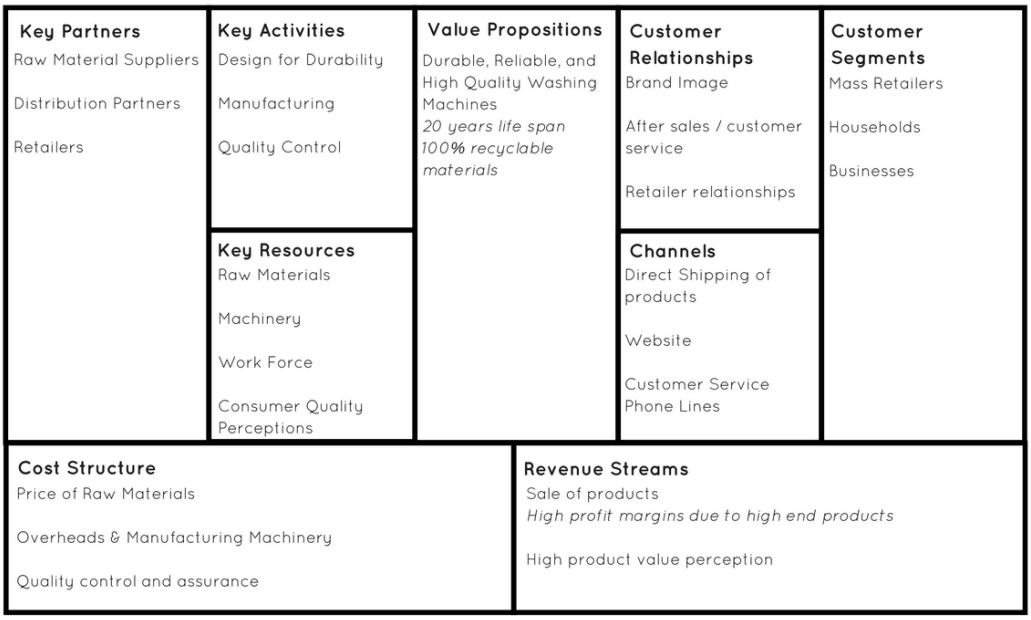


Figure 22 Miele's business model canvas

8.8.1. Business Model Canvas 'Miele'

Miele has effectively and successfully slowed their resource loops by employing an extended value CBM. The manufacturer has upheld to quality, reliability, and durability standards, creating a product which is both of higher value than its competitors, while being environmentally conscientious. It has been able to achieve this circular business model while seeing very little disruption to its own business model canvas. Since the birth of the company, Miele has been following its goal of "forever better", focusing on the quality of its products and appliances while simultaneously benefiting from the extended value business model.

The infrastructure of Miele is comparable to that of a standard manufacturer, with key partners supplying raw materials, distributing goods, and retailers to bring the products to the customers. The only infrastructural disruption between the characteristics of Miele's BM canvas and that of a standard manufacturer is the processes for quality control, and quality assurance in manufacturing practices. Sourcing 100% recyclable raw materials from reliable suppliers, and incorporating these into an appliance that is designed for durability is what creates the value proposition for Miele. This is achieved through minimal disruption to the BM over the generic manufacturer.

Value is brought forward in the form of a durable, reliable and quality product, with a lifecycle which can span four times that of a low-cost alternative. Value is further created by the slowing of resource loops, avoiding the wasteful processing of raw materials, and there for creating a more sustainable approach to manufacturing. Miele has created a brand around a variety of appliances and products which all align to the same vision of durability and quality. The design principles used revolve around creating durable products and rigorously testing them for flaws or possible problems, this has the further effect of elevating the quality label on Miele's products and enhancing their brand image.

Miele's customer interface has similarly not been drastically disrupted, the firm communicates its ideals through the products that it manufacturers. Marketing is done to enhance and build on these positive associations consumers have with Miele's products. As a manufacturer Miele is not unique in a focus on customer service, however as a creator of daily use appliances, Miele has put large emphasis on its ability to communicate with and help consumers. The global firm has invested a lot of resources into enhancing its customer experience and has pointedly created a concrete channel of communication with consumers through its globally accessible website and call centers.

The revenue stream is aided by a firm premium on Miele products, being positioned in a higher price bracket creates the opportunity for Miele to choose for more costly approaches to its manufacturing chain. Through the focus on an extended value chain, durable products, and longer than average life spans of products Miele has created a customer segment which is willing to pay a premium for Miele appliances. This disrupts the generic manufacturers BM canvas by exploiting the value created during the supply and manufacturing processes. This is a necessary value addition for firms operating with a higher cost structure as opposed to most manufacturers who 'cut corners' due to price of raw material and manufacturing processes, these often operate a lower margin and are more driven by a cost effective design principle. Expensive raw

materials, chosen for durability and recyclability, is a large burden on the firms cost structure, however this is a necessary factor in order to achieve the firms value propositions for a durable and high quality product.

This case study outlines the importance of a clear, long term vision for a business. The manufacturer has aligned its designers, workforce, and even the management segments of its business to uphold a united strategy of quality. It should be pointed out that Miele is a family owned and run business, a partnership between two families for over 110 years, Miele and Zinkann, owning 51% and 49% respectively. This may aid in the ease of aligning such a business to a united vision, firms with numerous shareholders will see more difference among its owners and thus more resistance will be presence towards a united firm vision. This may hinder larger, publicly owned businesses in employing such a model successfully.

8.8.2. Opportunities for Sustainable Product Design

Miele focuses on the principles of high quality material procurement, functionality & usability, and a durable design focus (Bhamra & Lofthouse, 2007). These principles have led to Miele's conquering of the higher price segment of appliances, while adhering to a strategy for sustainability. Refusing to outsource manufacturing and supply to cheaper alternatives Miele predominantly manufacturers its products in Germany, creating its own set of specifications for the appliances Miele manufactures. The manufacturer further aims at reducing its appliances energy consumption and a design for upgradability / serviceability (Bhamra & Lofthouse, 2007). This allows Miele's team of service engineers to easily fix or replace broken components, and easily provide software updates for older machines.

Design for durability is a design principle which fits well with a 'long life' product orientation, while simultaneously slowing the resource loop Miele operates with. Manufacturing longer life products reduces the need for new products to come to market, decreasing the need for raw material usage and washing machine manufacture for both Miele and competing brands. Although this approach may seem illogical, it allows Miele to ask for a premium price on its products, which means that the firm is able to operate profitably while still reducing consumer needs for new appliances. This business model is one that is not often considered as being circular by design, however the strategy of slowing resource loops can be considered as both sustainable and circular in the way that products are longer lasting, and eliminate the need for new appliances to come on the market place. This in turn reduces the demands for washing machines, subsequently reducing the natural resource usage of Miele and competitors, creating a marketplace where longer lasting products have higher consumer perceived value through the reduced burden of repurchasing, servicing or modifying lower quality products.

8.9. Packaging

Systems for storage, transportation, protection, longevity, and marketing, have long been bundled together in the form of packaging (EuroStat, 2016). This system is put in place to ensure the safe transportation of goods from producers to consumers. Packaging has long fulfilled its duties to arrive safely

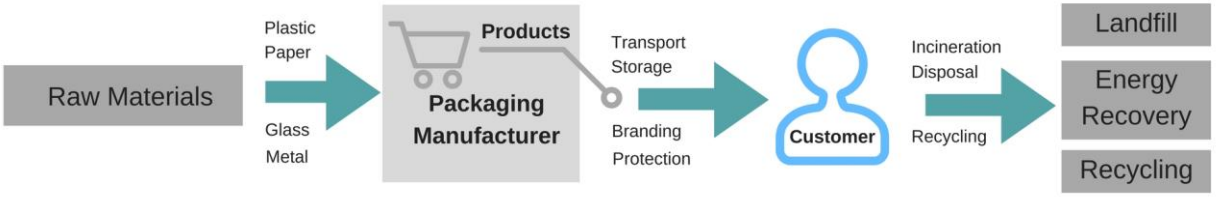


Figure 23 overview of a linear packaging business model

with a consumer and from there the packaging's life becomes a sorry state of affairs. Packaging systems are widely a onetime use solution to ensure the delivery of products being in the state that producers have promised them. With the growth of outsourced manufacturing plants, online shopping, and food safety regulations packaging solutions have become major strains on the world's material resources, and eventually these solutions end up on land fill sites. Unfortunately, the majority of packaging solutions are not sustainable i.e. plastics, which do not biodegrade and can last for centuries buried in a landfill. The importance of packaging is as such that we can sadly not do without, there is however alternatives to traditional plastic packaging systems exist and via technological innovations more and more alternative solutions are coming to the market.

In the constraints of the circular business model archetypes set forward in this paper it is challenging to find a valid case study to examine a singular model with regards to packaging. The linear business model in packaging system is quite straight forward. As seen in figure 23 the model reveals the role of packaging as being singular in purpose, and linked to the products life cycle, in so far as until product delivery to consumer. In the year 2013 as much as 156.9kg of packaging waste was generated per inhabitant of the EU-28 (EuroStat, 2016). For a product with a singular use, packaging is one of the most wasteful products being produced. With this in mind it is important to review and analyse some of the innovations in the packaging industry that aim to combat this increasing source of waste.

As an example of a linear business model this paper will examine the soft drink bottler and distributer

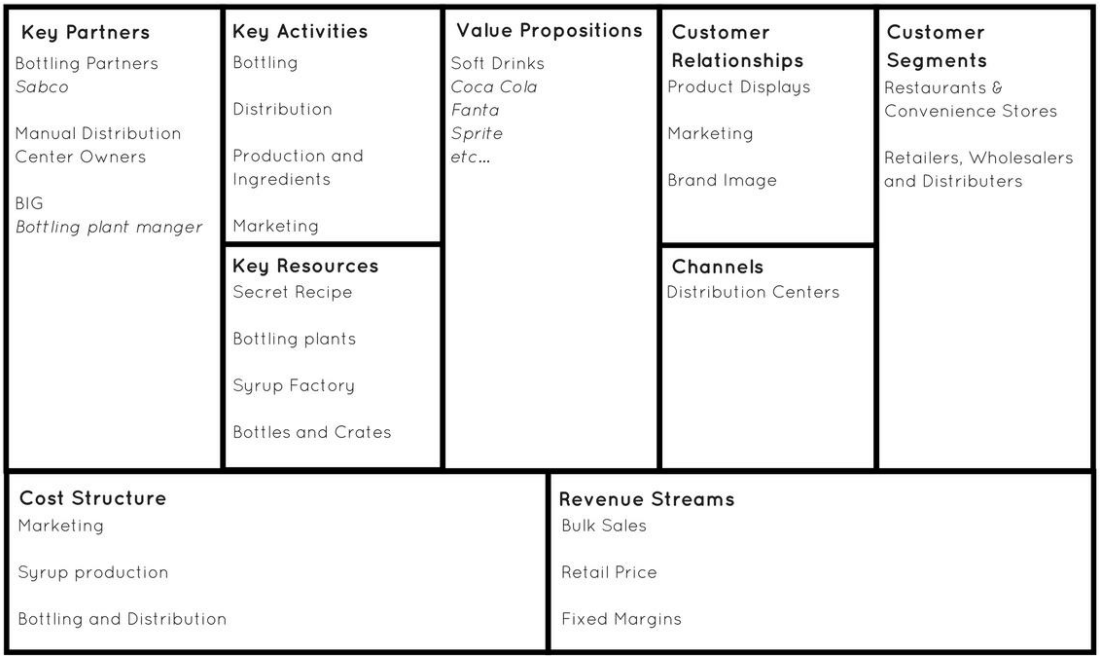


Figure 24 Business model canvas of Coca Cola's linear packaging.

Coca-Cola in order to create a BM canvas with which to compare the CBM canvas. They are employing a perfect mass production model of the linear business model, manufacturing bottles and cans for their products, shipping these to consumers, consumption of the product is undertaken and eventually the packaging is left as a wasteful by product. This waste is incinerated, land filled or recycled making it a great example of the linear take, make, use, dispose model.

8.9.1. Business Model Canvas 'Coca Cola'

The linear business model that Coca Cola uses, outlined above, reveals a very straight forward system to achieve the value proposition and deliver this on to the consumers. The infrastructure of the canvas consists of a few common processes, bottling, distribution and syrup production. Bottling and distribution are both a focus for a packaging solution in which Coca Cola ships and sells its product. The packaging materials used are plastic (from crude oil), aluminium for soda cans, and the original glass bottles. The infrastructure upholds true to most linear business models as the set of processes needed to be undertaken to achieve the simple value proposition. Once the product has reached the consumer the disposal phase of the product comes into play, it is evident that Coca Cola's role during the disposal phase is relatively distant leaving the consumers and the government with the burden of waste. The waste created falls under common house hold waste and where many modern countries have schemes and initiatives for recycling and energy recovery, the packaging manufacturers role is generally emancipated.

Coca Cola predominantly brings to market many refreshing soft drinks, this is the value proposition which the business model is achieving. Coca Cola is able to transport, protect, and store its soft drinks by means of a packaging system. These are designed to create a stable transportation platform, and lengthen the longevity of the product. Many consumers are not aware as to the packaging of a product, and are not conscious of the environmental impacts such a system has on the world's raw material and energy usages. Due to the manor of the value proposition, bottles and cans are a 'need' for Coca Cola's business model, the means of packaging has become an iconic creation which Coca Cola further uses for recognition of their product, by employing visual marketing and branding on their packaging system.

Coca Cola is able to interface with their customers through the packaging methods. The bottles carry a sleeve of advertisement and marketing, predominantly using the colour red. Cola cans carry up to 95% of their visible outer layer in marketing and branding, also predominantly using the colour red. Through the use of many distribution centres, Cola is able to mass produce, and mass distribute its high demand products. The act of distribution is often a question of efficient logistics, and in turn efficient supply chain management.

The cost structure is a simple mixture of production costs, distribution costs, and marketing. With cost emphasis on marketing strategies, and cost minimization techniques being used for production and distribution, it is no surprise that the packaging methods used are chosen due to lower manufacturing costs. This is a good example of the cost structure of the majority of firms operating in the packaging industry. The revenue stream comes from the sale of products to distributors and clients. The revenue is also a widely applicable method for many packaging firms.

8.9.2. Opportunities for Sustainable Product Design

The packaging industry is often neglecting the principles of sustainable design, using cheaply acquired materials to realize packaging solutions often means that sustainable alternatives are overlooked. Often manufacturers do not consider the end of life (EoL) phase of their products, often relying on a countries own regulations and infrastructure to adequately dispose of packaging materials. Packaging waste is becoming an increasing strain on the disposal methods a country employs, often being left on land fill sites, and being used for energy recovery via incineration. The costs of sustainability in design become a strain on an industry where profit margins are often tight and competitive price positioning is a major point of competitive advantage. Cost effectiveness is a ruling factor for the design of packaging products, often looking at material reductions, and focusing on the short term functionality of packaging solutions. This industry shows great potential for innovation in sustainability, and the employment of closed loop supply chains to recapture the value of one time use packaging systems. Both material and value flows are linear, reaching the end user and often being disposed of in the 'easiest' way possible for consumers.

8.10. Mars' bio-based film wrappers

Blazing the trail, and winning awards at the 11th Global Bio-plastics Awards, is Mars' bio-based film as an alternative packaging solution for their range of chocolate products. The joint project to produce the bio-based film began in 2012. The project is a partnership between three companies, the first being Mars, joined by Rodenburg Biopolymers (Netherlands based and focused on the production of starch based granulates based on waste streams of the potato industry) and Tagleef Industries, using a manufacturing plant situated in Poland (Mohan, 2016). Rodenbug biopolymers is the specialist in bio-plastics and the company commercialized the industrial waste from the French fry industry to create feed for cattle, they were left with a waste water stream which was rich in starch deposits. In order to fully utilize this waste, they developed an innovation in a starch based bio polymer compound named Solanyl.

Solanyl is a food grade polymer that meets the specified requirements from the food industry and by Mars. The bio-polymer is compostable, biodegradable and takes only a third of the energy needed for traditional oil based polymers such as polypropylene (PP). The importance of the polymer coming from waste streams is such that it becomes a second-generation biomass, and does not require an increase in agricultural productions (Laird, 2016). The final advantage of Solanyl is its price, ranging from 10-50% cheaper than its competitors, three synthetic polymers PE, PP and PS (Nancy M. P. Bocken et al., 2016). The bio-polymer not only competes on economic value, but it completes a design for a biological cycle ideology. This means that the business model being employed is not circular in terms of value, but circular in terms of closing material loops. The material flow of the business model is outlined below in (figure…)

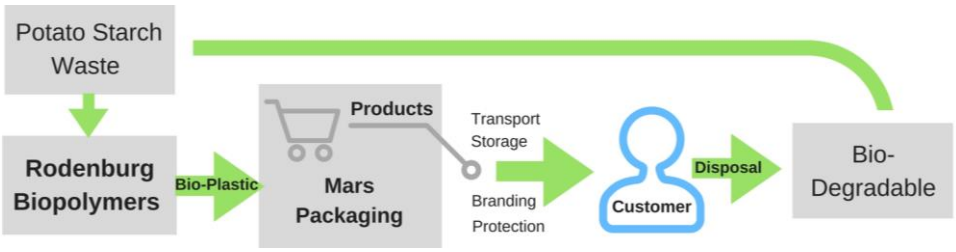


Figure 25 Mars' Bio-Based polymer business model overview

This case study underlines the importance of long term partners and relationships for successful innovations in the packaging industry. Thijs Rodenburg, CEO of Rodenbug biopolymers, emphasized "This unique cooperation is a best-practice example for the whole bio plastics industry. Without a joint effort, this success could not have been realized." (Rodenburg, 2016) By focus on eco-innovation, funding from the EU Eco-Innovation program and four years of development and modification the successful design of the food grade bio-polymer was realized. Further down the supply chain, Valerio Garzitto, CEO of Taghleef Europe stated, "This is a great example of a long-term collaboration within the whole value-chain of packaging material and processing … this project shows that cooperation and expertise are key to success" (Rodenburg, 2016). Both CEO's identify the importance of collaborations and partnerships as a key factor of success, this is due to the nature of the project involving many stakeholders in the packaging systems for Mars. Expertise and inherent ability for a manufacturer to achieve a certain link in the supply chain is an important factor when considering an alteration / innovation in the way packaging systems are assembled.

The success of the project is also enhanced by the efficiency of Solanyl's design to be incorporated into Mars' manufacturing process. According to a spokesperson at Mars, the Bio-based film 'has not compromised the efficiency of its packaging lines' (Mohan, 2016). Mars further states that the running speed is equivalent to that which was previously achieved by polypropylene films. In order to develop an

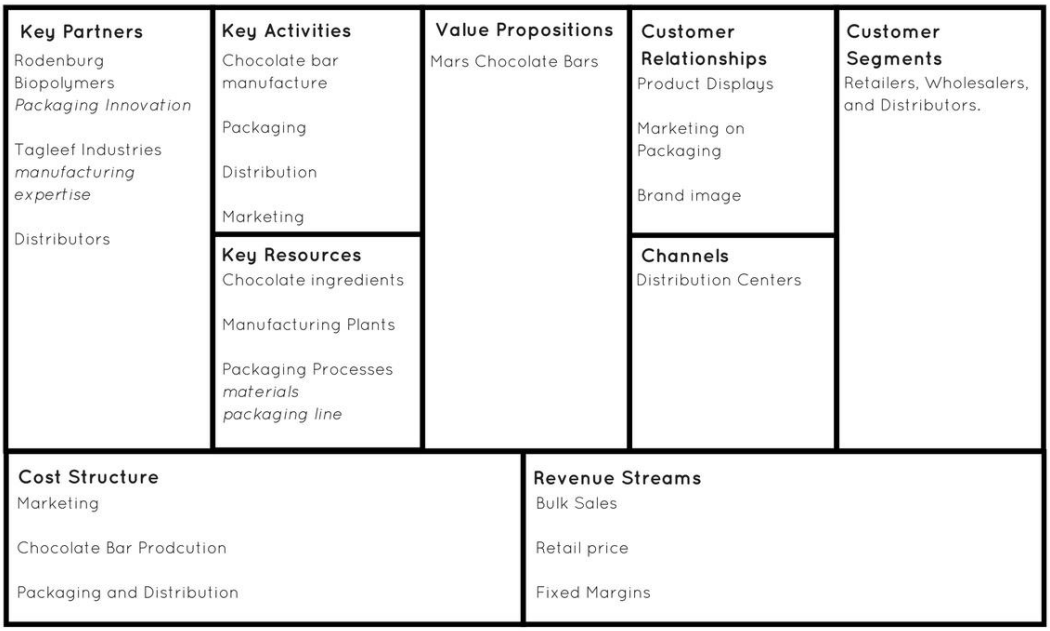


Figure 26 Mars' business model canvas for the bio-based packaging system

appropriate alternative to PP films, the limited disruption of Mars' current production lines and speed of production should be a target. This can be applied in broader terms to exaggerate the importance of material and packaging innovations that fit well into the current packaging systems. When a company faces major alterations in speed or machinery to its packaging lines, the adoption of such changes will be strongly compromised. Successful innovations should aim to enhance or integrate into existing systems without compromising speed or efficiency, these are key factors that businesses have targeted to enhance over the years of operating, and to hinder these advances would be seen as a step in the wrong direction. Hence one advantage that Solanyl has created is limiting the disruption to current operations, this means that Mars' transition to a circular material flow for packaging production is an attractive alternative to current production methods.

8.10.1. Business Model Canvas 'Mars Bio-based Polymer'

The business model canvas of Mars' has not seen the same amount of disruption as other case studies. The reason behind this is the design of the material innovation being created. The new biopolymer can be used in existing manufacturing processes at a rate that is similar to the rate of regular polymers. By design, the packaging solution becomes a more viable alternative to standard finite resource packaging, the material can be printed on, manufactured, and protects the product in the same way as a regular polymer, and has the advantage of being between 10% - 50% cheaper than the traditional alternatives. This is an example of a perfect transition to a circular material chain for the packaging of Mars products.

In regards to infrastructure the canvas shows changes primarily in the key partners. Allowing for a partnership between Rodenburg Biopolymers has created the opportunity for this material innovation. The partnership allows mars to continuously focus on its core competencies while allowing Rodenburg to source the raw material (potato starch) from waste potato manufacturing flows. The material can therefore be acquired at a low cost, and manufactured into the bio-based film by Tagleef Industries. They produce the packaging material on a large scale and further distribute the material to Mars' own manufacturing facilities. Here it is integrated into existing packaging and printing processes, without a loss in efficiency. This again outlines the strengths of key partners when employing a circular business model, where competencies of other firms can be used to strengthen one's own value proposition.

The value proposition put forward is not altered from the linear model, Mars still creates high quality chocolate bars for consumers. The only added value may come in consumer perception of sustainable packaging systems. The bio-polymer is fully biodegradable meaning that it can decompose back into its base elements without the external input of energy. The innovative material creates a neutral material chain with regards to packaging. Using waste flows from another industry to create value in packaging for Mars.

Consumers need not alter their purchasing behaviour, the transition to a waste neutral packaging system has not disrupted the operating consumer interface with Mars. The added value of a sustainability label for the packaging may be the only reference consumers get to Mars employing a more circular business model strategy. This creates a better customer relationship with those customer segments that have interest

in environmental impact and sustainability of the products they purchase. Research has shown that consumers are willing to pay more for products with an element of sustainability, this can increase the perceived value of a product (O'Dea, 2015).

Increasing the perceived value of their products, allows Mars to increase their potential revenue stream. Sustainability has become tied in with product quality and firm loyalties, more environmentally conscious consumers are the driving factor for innovations in sustainability. Sustainability often impacts the cost structure negatively by increasing costs, in this case study Mars and Rodenburg have been able to develop a viable and cheaper alternative to traditional polymers. The bio-polymer allows Mars to remain competitive in pricing, while increasing its value perception with customers. This combination is a great advantage that material innovation has brought to Mars and outlines strongly the importance of easy to adopt material innovations and alternatives.

8.10.2. Opportunities for Sustainable Product Design

This case study outlines the strength in a material innovation that does not disrupt the business model of a firm to a large extent. The design of the potato starch based bio-polymer created for Mars, is perfect in the way that it is implementable into the manufacturing chain with minimal disruption to on-going production processes. The bio-polymer can be integrated straight into the manufacturing chain, this means that the packaging of Mars chocolate become neutral with respects to material usage/waste. Designing the material in such a way that meets specification and is easily implemented into existing processes is a key factor of success for the new material. The impact at the EoL of the packaging is minimized by the carefree factor of biodegradable packaging solutions, often ending up as litter in public places, this bio-polymer will quickly disintegrate with the help of sunlight and oxygen (O'Dea, 2015). Biodegradation is a simple process that both minimizes impacts and supports a sustainable packaging cycle.

The design of the bio-polymer meets many of the key principles for a sustainable strategy, covering functionality and usability, cost effectiveness and material innovation. These innovations do not happen over-night, Rodenburg Biopolymers spent almost four years developing the biopolymer with the project starting back in 2012 ("2016 Bioplastics Award," 2016). This case study is an example of an almost perfect material innovation for an existing packaging solution, the packaging can be easily adapted to incorporate the new material which makes the packaging sustainable. The process can be done with minimal cost and disruption to the manufacturing firm (Mars), this should be the goal of any innovative new material if it wants to become a new alternative to existing materials. Those innovations that do not hold to these principles will become too expensive to implement, disruptive to the manufacturing process, and/or doesn't meet the specifications of the material it is attempting to disrupt.

9. Discussion

In order to completely analyse the case studies presented in the previous sections, it is important to provide an overview of each of the case studies individually. This overview will address and summarize points made during the case study analysis, and to provide a coherent summary of the information gained from the case studies. This 'discussion' section will analyse further with the aim of investigating the relationships between each of the circular business models being presented. This includes the key building blocks of the BM canvas, the strengths and weaknesses of the business model canvas being used, and the opportunities that have arisen for the improvement of product design for sustainable strategies.

The case study summary aims to provide a coherent overview of the case studies. This will include the differences present in the design of each business model, in order to accurately analyse each model separately. The summary will examine the choices being made by the firms, and the reasons each firm has for attempting to transition to a circular business model. Summarizing the extent of 'real-world' success each case has seen, and the disruption each circular economy has created within its own industry.

The conceptual model is used to create a framework by which this paper can accurately suggest the key building blocks of the business model canvas. These key building blocks come forward when analysing the disruptiveness of each case study and the CBM being used. In the framework a hypothesis was made supposing four key building blocks; key partners, value proposition, channels, and revenue stream. From the case study analysis this paper narrows the selection down to the three major key building blocks that need to be considered when transitioning to a circular business model. These three building blocks are the, key partners, Value Proposition, and Revenue Stream, being examined in order of importance respectively. The key building blocks are important for a firm to consider due to their 'make or break' impact on the business model and the conceptualization of the business model canvas. Each of these building blocks has been a disruptive pillar of the canvas, often differentiating the circular business model from the linear business model. The aim of this investigation is to underline the importance of these building blocks, and to reveal why these building blocks are the key to creating a disruptive circular business model that favours the firm that executes it.

Circular business models are often being considered due to their advantages for the environment, raw material usage, value creation, and the green corporate image that goes with them. In order to fully realize these benefits, the conceptual model has included the opportunities present for firms to design products for sustainable strategies. Each case study has revealed a different approach to product design, ranging from design principles for durability to those for functionality and usability. This paper will aim to investigate the opportunities for a sustainable design and link those to the type of CBM being employed.

9.1. Summary of Case studies

9.1.1. BMW DriveNow

BMW DriveNow is an innovative approach to disrupt the stagnant and predictable automotive industry. With increasing costs for vehicle owners in urban areas, strict emissions regulations, expensive parking spaces, and the rising costs of fuel, BMW and partner SIXT created DriveNow to efficiently provide mobility for customers situated in built-up urban areas. The model uses a disruptive pay-per-minute leasing scheme to lease mobility for short term trips across an urban environment. The circular economy DriveNow creates increased vehicle utilization, decreased emissions (eco-vehicles), reduced ownership burden and costs for consumers, and reduces the volume of vehicles in the urban area. Essentially a car leasing and sharing system, customers are able to reserve and use vehicles, without the added costs of fuel, road tax, vehicle tax, parking costs etc…

The Business model relies heavily on key partnerships as a method of creating the value proposition. BMW's role is to provide vehicles, SIXT uses its experience in car rentals and maintenance, and Vodafone creates a platform for users to reserve, access, and pay for vehicles easily and carelessly. This combination of partnerships allows each of these firms to focus on their core competencies while collaborating to achieve the value proposition for consumers. The circular business model can only be successfully employed if these partnerships are maintained, and each stakeholder fulfills their specific role in the business model.

The CBM falls under the service orientated (reduced ownership) archetype. Providing services that satisfy the consumer needs without consumers needing to own the physical product. The model creates a situation where the business retains ownership over its products, this means that material value recapture can be executed easily when vehicles reach their end of life. Retaining ownership over products does not always constitute a circular business model, however if, by leasing, product utilization can be increased, and individual need for the product decreased, it reduces raw material requirements. The model creates a circular economy driven by car sharing concepts, where multiple users can share a singular product while not owning that product. This further incentivises BMW to manufacture vehicles with longer life-cycles to accommodate the increase in utilization, thus having a knock on effect for the car manufacturers to employ a 'design for durability' circular business model archetype.

9.1.2. ICARRE95

Renault's ICARRE95 initiative aligns with governmental regulations and is designed to create a circular business model for product value retrieval from its End of Life Vehicles (ELV). The car manufacturer has created a circular business model that incorporates circular material flows through closed loop supply chains to reduce the firm's raw material and manufacturing needs (costs). The CBM used allows Renault to profitably capture and collect vehicles from consumers, and by utilizing a number of key partners, dismantles and recaptures value from the vehicles. This is done in the form of reusing parts, refurbishing parts, and repairing older parts, this reduces the need for the manufacturing of new components. These parts are often integrated back into the forward supply chain, being sent to suppliers or being used by Renault in its own manufacturing facilities. These parts can also be sold on the second hand market, or distributed to garages and repair

workshops for use in 'on the road' vehicles. The scheme allows Renault to recapture 95% of the material and part value of the vehicles it processes.

ICARRE95 is the first step in the direction of a fully closed loop supply chain for Renault. The automotive manufacturer employs the strategy to create a value recovery chain, recovering material and monetary value from ELVs. The business model focuses on a network of partners that are integrated into the reverse supply chain of Renault, this means Renault can focus on its core competencies (vehicle design and manufacture) while partner dismantle and retrieve value from ELVs. The business model is value driven, recovering material value from EVLs and processing this into recycled raw materials, reusable parts, or parts for refurbishment and resale.

The initiative is government driven to meet with new legislative regulations. The strategy of creating a business model out of the regulations is beneficial for Renault to reduce costs for recycling and EVL management. Many firms are under constant pressure to meet government regulations, and this is a positive case study which successfully employs a CBM to meet specific requirements while creating value for the business and its partners. The CBM adds the benefits seen with CLSCs which, for Renault, are increased knowledge in consumer use (through used parts inspections) and reduced raw material needs. This influences the manufacturing process and design process of Renault, allowing the automotive manufacturer to design more functional and useable vehicles, while reducing raw material consumption and manufacturing needs.

9.1.3. Project ARA

Consumer electronics is a large industry which often sees disruptive technologies arise altering the behaviour of consumers and the design of products being delivered onto the market. One such disruption would have been Project ARA's modular smartphone, allowing consumers to modulate and personalize their smartphone experience. Features included a standardised platform allowing a variety of manufacturers to compete on the modular component market, allowing consumers to create specific modular configurations. This could be used to maximise battery life, focus on storage space, or a quality camera component. These modifications would be purchased through a Google owned and managed modular marketplace, where percentages of the profits would be taken as a source of revenue for the Project ARA smartphone.

Despite the cancellation of this project in late 2016, the concept is still widely sought after by consumers, however various reasons have delayed the project, one of which may be the ambiguity of Project ARA's conceived business model. Another reason stated for the delay is that technology is not up to the task of fully achieving the product, the modular interface is too large, bulky, and weighted to compete in today's electronics market, where slim and lightweight designs are a sure factor of competitive advantage. Project ARA stipulates a concept for a circular business model, however the model was never brought into detail by Google's team, and the product never achieved it's sought after position in the marketplace. This can be attributed to the complexity of modular electronics for the everyday consumer, where 'all-in-one' designs are a simpler choice for the consumers who need simple lightweight smartphone functionality. This would place Project ARA in a niche market for smartphone users with a set of more specific needs, creating a smaller

market for the product, and thus dis-incentivising modular component manufactures from investing in the production of modular device upgrades.

The interesting part of the Project ARA case study is the openness of their key partnerships. Modular component manufacturers are intended to compete on a free market space to gain market share with consumers. Google did not intend to favour a singular manufacture or to create a mutually beneficial partnership with key modular component manufacturers. This led to the ambiguity in the key partnerships building block, where stakeholders are not brought into the business model, but rather play a part in the external value chain of the product. From an external point of view, reasons for the design and manufacture of components would solely come from the success of the standardised platform, which Project ARA never created. The standardised platform would have been presented as a standard low-budget device with simple functionality and a low price point of 50$, this meant that without modules to bring the smartphone up to a competitive level, the device was not an appealing alternative for consumers.

9.1.4. Philips 'lighting as a service'

The service oriented model is often used by firms who provide a product which can easily be converted into a leasing type service. Philips is a business which wants to promote a service style lighting solution for firms and organizations to provide lighting for spaces, the model focuses on reducing the burden of maintenance, service, and energy costs from the consumer and placing it on Philips. The CBM is designed to retain ownership over Philips' products, creating a product lifecycle that can easily be integrated into a reverse supply chain to recover value from these products. Philips exploits both the benefits of a service oriented BM as well as an extended value BM, where intrinsic material and product value can be recaptured and inserted back into the forward supply chain. This closes the supply chain loops for Philips and reduces need for raw materials and manufacturing requirements. Lights and fittings can be efficiently recovered when reaching their EoL to be serviced, refurbished, dismantled (for parts) or recycled back to base raw materials.

The innovative design of the circular business model canvas means Philips can focus on its core competencies (manufacturing of lights) while offering a 'full picture' solution for customers. This is done by numerous key partnerships to provide maintenance and service, reverse supply chain logistics, and increased energy efficiency by creating a simple inter-connected management platform for the lighting solutions. Philips incentivises the design of eco-efficient lights by taking on the cost of energy supply for the lighting solution, where consumers pay for the lighting being generated without the costs of the energy being supplied. This model works especially well for a product that off-sets its cost of initial purchase by minimizing the cost of energy over its lifetime. This means that economic gains may not be seen for consumers who use the singular products over a short period of time, however Philips can exploit the long life time of its products by circulating them between the customers of the service. This means that Philips can fully utilize the designed life-cycle of its lights and fittings, then recapturing the value from the products when their life-cycle comes to an end.

The CBM creates multiple advantages for both consumers and Philips, consumer benefit from the value propositions being achieved by the model, and Philips can retain the material value of its products while providing a service which can achieve 100% product utilization. This in turn reduces the need for new raw materials to be consumed thus minimizing the manufacture of under-utilized products. The disruptiveness of this business model can be seen by creating new customer segments, key partnerships and creating efficient channels for value recapture. Competitive advantage is achieved through green corporate image, and the reduced ownership role of consumers. The model is suitable for organizations, businesses, and can achieve value for larger plans such as city street lighting.

9.1.5. Miele

Miele focuses on a 'design for durability' circular business model, manufacturing high quality, longer lasting, and fully recyclable products. The design for durability model allows Miele to slow its resource loops, reducing the firm's consumption of raw materials. By providing durable products Miele creates a higher perceived value for consumers, allowing the firm to ask a premium price for its products. The case study outlines the importance of an overarching company vision, in this case "forever better", and how such a vision can align a firm's value creation to provide a more sustainable, durable, and high quality product for customers.

This case study is the only one which outlines a business model canvas which sees little disruption from the generic manufacturing canvas. Miele does not require strategic key partnerships, it does not alter its revenue streams, or show disruption in most of the canvas building blocks. The key feature to this case study is Miele's unrelenting focus on its value proposition, providing a durable product for customers. Home appliances are often features of a customer's 'home' an area which is often specifically designed for stability and a sense of solidness. Thus disruption at 'home' is often negatively perceived by consumers, so the purchasing of multiple washing machines (and other large appliances) can have an adverse effect on home owners. This creates a need for durable, long lasting home appliances, where consumers need not worry about their appliances for a number of years. This is often the feeling of security, reliability, and effectiveness that Miele consumers consider when purchasing a Miele washing machine or other product.

Miele shows manufacturers that a long term commitment and the vacancy of compromises can create success for a firm. The principles of design for durability can be followed to reduce raw material consumption, create more valuable products, and positively influence a brands image. These design principles include, material choices, design for extended use, and usability and functionality. By incorporating these design principles Miele manufacturers, not quantity but, quality products to deliver the value proposition to consumers. This is a successful circular business model by slowing resource loops and creating a fully recyclable product that can be efficiently processed back to its original raw material elements. The key features of this case study are, strong core competencies and vision, design for durability, and the successful iteration of product designs based on consumer needs.

9.1.6. Mars Bio-Based Packaging

Mars, and close partner Rodenburg Biopolymers, have designed a packaging solution which has the potential to substantially disrupt the packaging industry. This was achieved after a long development cycle of 4 years, where Rodenburg Biopolymers (RB) has designed a packaging material that achieves the goal for a natural biological material cycle. The packaging material is created from the waste product of the potato processing industry in the form of a potato starch. In order to utilize this industrial waste RB positioned itself to benefit from a form of industrial symbiosis, where its facilities are positioned within the Netherlands and close to large potato processing plants. The starch based bio-polymer is designed as a packaging material which consumes another industries waste product, and achieves the value proposition of protecting Mars' chocolate products. The importance Solanyl is further enhanced by its cost effectiveness (10-50% cheaper than traditional polymers), and its similar properties to competing packaging materials.

This similarity allows the Solanyl bio-polymer to be integrated into Mars' current manufacturing systems and not compromise the efficiency of its packaging lines. This material innovation outlines the idealistic case of a successful sustainable material innovation. The bio-polymer completes the same value proposition as traditional polymers, it can be efficiently integrated into current packaging methods, and it adds the value of biodegradability by design at a reduced cost to the traditional alternatives. Printing methods where disrupted by the implementation of Solanyl however the quality of the marketing on the packaging is comparable to that of the older system. The innovative material creates benefits in each area that it disrupts. The Solanyl material has limited downsides, one of which is the production capabilities being limited by the scale of potato processing to create the potato starch waste product needed for production.

This circular business model has seen little disruption from the traditional linear packaging chain. The model is not circular with regards to product flow, but it gains it's circular trademark through the circularity of the biological materials being used in the packaging process. Circular material flows also constitute a circular business model, added to the use of industrial symbiosis further attributes to the business models circularity, from waste product to biodegradable elements for soil.

9.2. Cross-Case Analysis

The commonality between each case is that they all offer a variation of consumer product, and employ a distinct and specific circular business model to achieve added value propositions. In this chapter this paper will discuss the common features and/or differences for firms that operate under similar circular business models, identifying the building blocks which see the highest disruptive qualities, and outlining the similarities in the design principle each firm employs. The eventual goal of this chapter is to identify the key building blocks for each case study and to link the CBM employed with the design principles that contribute to its success. The cross-case analysis is done to create a holistic overview of the several case studies being investigated, allowing the reader to swiftly analyze the results of the case study analysis as a whole abridging several case studies. An overview of the cross-case analysis can be found on table 2.

9.2.1. Service Oriented

The service oriented business model is a rising choice for many firms who are struggling under the weight of finite resource prices, and cheap product 'clones' from eastern countries. The service oriented circular business model seeks to reduce a consumers ownership and burden of ownership over a firms products, while simultaneously allowing the firm to retain ownership therefor intrinsic product value (e.g. materials). For the firms BMW and Philips it has become an innovative model to reach consumers who otherwise may not purchase their singular product. This circular business model has shown to require strong partnerships, especially during the transition to the new business model. These partners allow the firms to focus on their core competencies (vehicle manufacture & light bulb manufacture), while bringing new expertise into the CBM. This expertise allows the predominantly manufacturing firms to target new customer segments, and re-invent their revenue stream as a 'pay-per-…' delivered scheme. This is often deemed beneficial for consumers who do not need the ownership of the product, including the burden that comes with ownership of the product.

Both cases (Philips and BMW) operating under a service orientation model have chosen a combination of product life-extension and long-life product design principles to follow. Both cases also design under the same strategies, ease of service and design for durability, where Philips adds the further strategy for ease of dis and re-assembly. This is because the Philips case study further utilizes the product life-extension principles by creating a dynamic take back loop for semi-utilized products. These are products which have not yet reached their EoL but are no longer needed by customers; these products are then re-integrated back into the forward supply chain of Philips at multiple process levels. This creates further value for Philips by allowing them to recapture and profit from what would otherwise be disposed / recycled products.

9.2.2. Extended Value

The most common CBM examined in this paper is the extended value CBM, this model is being utilized by the ICARRE95 initiative as well as Project ARA and Mars (to some extent). The commonalities between the case studies identify the need for new strategic and long term partnerships, extension of the firms current value propositions, and new channels to generate revenue through. All three case studies that employ the extended value model rely on partners to achieve their value propositions. Renault requires a network of collection stations and dismantlers to act as it's reverse supply chain and to generate the value from ELV's. Project ARA relies on partnerships with willing modular component manufacturers, to generate value for their product platform. Mars requires Rodenburg biopolymers to do the research and development behind its new packaging material, while also requiring them to create the polymer, this in turn allows Mars to enhance its value proposition. From this it can be stated that in order for a CBM to effectively achieve extended value of products, partnerships are needed, in order to facilitate operational, informational, and

infrastructural needs. These partnerships should create value for both parties, either through capital, or through some form of industrial symbiosis where partners can use another firm's waste/bi product.

The extended value CBMs focus on the design principles for product life-extension. This choice is personalised for each case study via the strategies it employs, ranging from a design for recyclability to design for modularity. The strategies fall under the common principle which involves creating value loops for each case study and for the case of project ARA a new value loop for consumers. Mars is a unique case study, in that out of the six analysed Mars is singular in its use of the industrial symbiosis archetype. For this it employs the design principle 'design for a cycle' for which it is designed to achieve an environmentally neutral packaging product. It should be noted that this CBM is not outright disruptive but changes the material choice for packaging mars products, and for the rest their business model stays fairly stable. This small change has created sustainable opportunities for Mars and has added the value of a biodegradable packaging material in which consumers may see added value.

9.2.3. Design for Durability

Miele is the only case study analyzed which employs a successful design for durability business model, and contrary to the other case studies it has no need for a long term partnership to achieve its CBM. This is due to its long term vision which focuses on a design for durability and design for long-life products. This vision has created a BM for Miele which it has employed for the last one hundred year and to great success. This suggests that the need for partnerships is emphasized during a transition to a CBM rather than as an integral part of a CBM, at least this can be stated for the design for durability business model. Miele sees the lowest amount of disruption through the use of the design for durability business model. This is due to vision of the company aligning with the circular business model archetype, and thus allowing Miele to operate under its core competencies while achieving sustainable manufacturing.

This model has facilitated Miele to become one of the highest quality, white goods manufacturer, and allows them to utilize their vision to achieve long term quality in order to justify its prices. This means Miele can operate successfully in a market with high levels of competition while selling a relatively low quantity of units. By doing so Miele has achieved a more sustainable method for the manufacturing of white goods, this allows Miele to leverage the value perception of consumers further by integrating their sustainability in the minds of consumers. Miele follows simple design strategies to create durability, reliability, functionality and usability, manufacturing a product that meets consumer's needs. They see further benefit through the use of high quality materials such as steel, to design a product that is fully recyclable back into its raw material value. This aids in the EoL phase of Miele's products, needing low energy input to be recycled back into its original components, thus making the product even more sustainable when a holistic point of view is taken.

9.2.4. Industrial Symbiosis

This is the least common form of a CBM, and involves utilizing the waste products from industrial processes. Mars and Rodenburg are able to employ this model due to Rodenburg's close proximity to the potato industry in The Netherlands. This geographical proximity has allowed Rodenburg Biopolymers to innovate a new material for the packaging of Mars' chocolates. The material innovation comes from the potato industry and uses the starch waste produce from the French-fry manufacturing industry. This organic compound is used to create a polymer that is cheaper than traditional oil based polymers, and can be incorporated into the existing packaging chain of Mars. The key to this CBM is geographical location, and partnerships with firms to create a need for a material innovation. Industrial Symbiosis allows a firm to find value from another businesses waste, this often means it can take and use the waste products at a very low cost.

Industrial Symbiosis is the least common CBM archetype due to a number of challenges firms face. The first is the location of the firm, if a business finds itself positioned at a far distance from the waste product it requires, it creates the added costs of logistics to transport that waste to its own location. Often the waste products can come in the form of energy, such as residual heat from a thermal nuclear reactor, or biological waste, for these forms of waste there is a need for swift usage of the material or energy source. Firms that wish to create an industrial symbiosis are also reliant of the volume outputs of the waste producers, if a producer shuts down for an amount of time, firms which wish to use the waste may be put in a loss creating position. Industrial symbiosis is also only an option when it is apparent that a waste output of one producer is of value to you as a firm, and if this is not the case then this CBM is not an option for some firms. These challenges increase the cost barrier to entry and often firms will not transition to such a CBM unless it is made attractive by government incentives or the ease of the transition.

Cases	*CBM Employed*	*Key Partners*	*Key Activites*	*Key Resources*	*Value Prop.*	*Cust. Rela.*	*Cust. Segments*	*Channels*	*Cost Struc.*	*Revenue Struc.*
BMW DriveNow	Service Oriented	SIXT 50/50 Partnership	software development for customer interface and usability of service	Vehicles / App / Servicing	Internet Enabled Mobility Platform	Self-Service	Urban mobility seekers	App	Vehicle Servicing and fueling / App development	Pay-per-minute
ICARRE95	Extended Value	Disassembler and Recyclers	Part Reuse / Collection Points	Intrinsic value of ELV	Refurbished & Reusable Parts	*No Change*	Used parts market	Collect & Capture (RSC)	Dismantaling / Recycling / Refurbishing costs	Recycled raw materials / reusable or refurbished parts
Project ARA	Extended Value	Modular Component Manufacturers	Modular Device Framework	Raw materials & Modular parts	Modular Smartphone	Additional complexity for consumers in modular parts purchasing	Eco-conscious / specific needs users	*No Change*	R&D / Modular Framework	Sale of modular framework / percentage of modular component sales
Philips	Service Oriented	TurnToo *innovative thinking*	Service / refurbish / reuse / RSC	Underutilized & Reusable light fixtures and LEDs	Lighting as a service	Contract based service	Larger organizations & businesses & governments	RSC focused	Servicing / energy costs	Pay-per-lux
Miele	Design for Durability	*No Change*	Design for Durability	High Quality Materials	High Quality & Durable Products	*No Change*	High-end market / customers looking for quality	*No Change*	High Quality Materials / services	High value product perception
Mars	Industrial Symbiosis / Extended Value	Rodenburg Bio-polymers *packaging innovation*	Packaging Production	Packaging Processes	Bio-degradable chocolate bar packaging	*No Change*	eco-conscious consumers / *No Change*	*No Change*	Solanyl material costs	*No Change*

Table 2. Cross-Case Analysis to Find Significant Disruption in the Building Blocks of the Business Model Canvas

9.3. Key Building Blocks Based on Disruptiveness

Disruptiveness is a term that often arises when discussing innovative, new, and possibly industry changing business models. This paper emphasises the role of disruption in the success of a circular business model, attributing changes in the building blocks of the business model canvas as disruption to a firm, both internally and externally. The conceptual framework suggested four potentially disruptive key building blocks in the realization of a CBM. Through the in-depth analysis of six case studies, only three building blocks have shown the potential for being the main sources of disruption for a business acting to achieve their value proposition.

From the case study analysis key partnerships, value proposition, and revenue stream are the key building blocks that are the leading causes of positive disruption for a circular business model. Key partnerships are used to optimize the operations of a firm and to reduce the risks of a new business model. Key partners allow a firm to focus on its core competencies, often the results of an efficient linear business model, and allow partners to realize added value for the circular business model. The analysis of the case studies revealed that partnerships are often created, altered, or removed in order to achieve the value proposition stipulated by the circular business model. The value proposition is the second source of disruption. The third disruptive building block is the revenue stream for a firm, this building block allows firms to design a pricing model that suits the CBM. The revenue stream is a key component for choices made behind the pricing of products, and is often revised to better suit the flexibility of a circular economy.

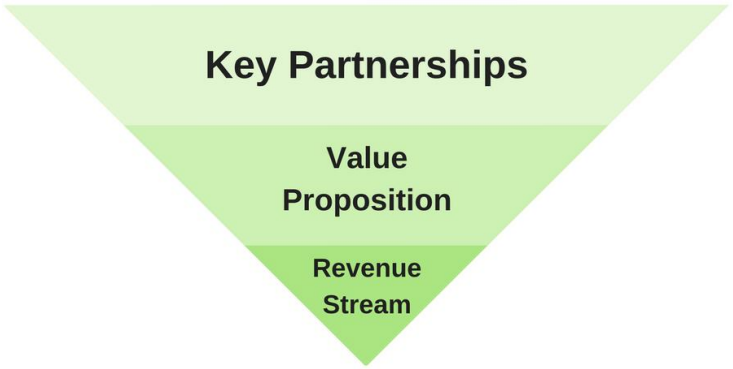


Figure 27. The three Key Building Blocks of a circular business model

9.3.1. Key Partners

The largest, most valuable, source of disruption is the key partnerships building block. This block outlines the partnerships that are required for a business model to achieve the value proposition and to deliver this value proposition to consumers. Four out of the six case studies show key partnerships as the major source of differentiation from the more traditional linear business models. These cases incorporate key

partners in order to focus on their core competencies, often allowing more rigid firms to adapt their business model without hindering key activities and key resources. Partners allow firms to create a value proposition that is suitable for a circular economy, while retaining their points of expertise and the brands points of difference. Partnerships are designed to be beneficial for both partners, and often the equity of new firms, or splits in revenue have to be negotiated before the creation of a successful partnership.

Of the two case studies which do not (specifically) disrupt their key partnerships one (Project ARA) was unsuccessful in the brining to market of its value proposition, and the other (Miele) has been operating with a design for durability CBM for over 110 years. This reveals the importance of partnerships, especially for the creation of innovative value propositions. BMW, Philips, Renault, and Mars, have each needed to create specific partnerships with firms that bring unique competencies into the circular business model. For each of these cases key partners have been used to oversee operations, aid in supply chain management, and to lend expertise in new customer segments and revenue streams. The importance of key partners is outlined by the success of each of these case studies.

BMW and SIXT created the joint venture in the form of DriveNow to provide urban mobility to consumers. The partnership allows BMW to focus on the manufacturing of its vehicles, and the improvement of fuel efficiency, durability, reliability, serviceability, and on other innovations for its products (core competencies). DriveNow creates a situation where BMW's vehicles are combined with SIXT's leasing experience to create a profitable service for urban mobility consumers. The partnership disrupts BMW's traditional model, and allows focus on an improved value proposition and the new form of revenue stream. Philips employs a similar service oriented model to provide its products as a service, the firm also created new partnerships with innovative firms such as TurnToo, SESCO, Cisco, and Vodafone. These partnerships effect the Philips business model in a similar way, by allowing the firm to focus on its core competencies while partners help create the value propositions needed for the circular business model.

9.3.2. Value Proposition

The value proposition that a firm offers is often the second point of disruption. Innovative value propositions can disrupt the way a firm designs its infrastructure, customer interface, and financial aspects. Disruption to a value proposition often results in a disruptive product being brought to market, this creates new market segments and can be a valuable source of competitive advantage. Each case study has developed unique value propositions to achieve the circular business model and to bring value to specific customer segments. This is at the center of the BM canvas design, and is the major source of value for a firm, due attention should be given to this building block during the conception of a circular business model canvas.

The value proposition of each of the case studies analysed is unique. The new circular business models being employed often add new value propositions to firms existing products, as is the case with BMW, Philips, and Project ARA. Otherwise value propositions are broadened to include sustainable features, create a product from waste materials, or create value in the recapture of EoLs, as is the case with Mars, Miele, and Renault. For each case study, the value proposition is the focal point for the design of infrastructure and

customer interface. This makes the value proposition a source of disruption for firms, acting as the seed from which a firm grows and designs its roots. Each root drawing nutrients to provide for the realization of the value proposition, thus this is an integral building block in the design of a circular business model.

9.3.3. Revenue Stream

The revenue stream is the only channel by which the firm receives its monetary value for the services or products it creates. This makes it an important building block for the service oriented CBM, since a service orientation means the leasing of products, and the reduced ownership for consumers. This disrupts the traditional pay-per-product route that is a staple model for most industries, including those examined in the case study analysis. The building block is also important for the extended value CBM, due to the extension of value often creating new logistical and reverse supply chain costs for firms. The design of a viable revenue stream from the recapturing or extending of value in products should be considered. For example Renaults' ICARRE95 initiative generates a profitable circular economy from product value recapture through the utilization of previously unused revenue streams from new customer segments.

9.4. The Limitations of the 'Business Model Canvas' for the Circular Economy

The business model canvas as designed by Osterwalder (2006) creates a canvas for businesses to outline their business models on the basis of 9 different building blocks. This canvas segments a business model into four distinct pillars, infrastructure, value proposition, customer interface, and the financial aspects. For the purpose of this thesis, the business model canvas is used to compare traditional LBMs with their CBM counterparts operating within specific industries. From the results of the case study analysis there can be determined to be three key building blocks outlined in section 8.2. Osterwalder may have created a popular canvas that fits a multitude of different business models, however the canvas may not be as suitable for many circular business models.

CBMs often differ from LBMs due to the extended interaction firms have with their own products. These interactions stem from the need for reverse supply chains, recapturing of value, and for the re-procurement of marketed products. Philips, Renault (ICARRE95) and BMW (DriveNow) each integrate distinct reverse supply chains to realize their value propositions, and to further recapture the intrinsic value of the firm's products. For cases like these, Osterwalder's business model canvas does not cover aspects such as, environmental impact and stakeholder management (Joyce & Paquin, 2016). The same fact is stipulated by Alexandre Joyce (2016) with a paper that explores the need for a triple layered business model canvas that incorporates all these factors into one tool. The paper focuses on the design of a tool to explore 'sustainability-oriented business model innovation'. This is achieved by extending the Osterwalder business model canvas out and adding two layers, an environmental layer based on lifecycle perspective, and a social layer based on stakeholder perspective.

9.4.1. Disadvantages

The circular economy is a concept which incorporates both material and value cycles into its business models. Unfortunately the business model canvas is focused on more linear business model cycles, the linear style of the canvas thus hinders the full exploration and disruption that a circular business model potentially creates. Osterwalder's (2006) canvas is linear by design, starting with raw material, and ending with customer segments, from left to right. This creates a canvas which ignores many features that a CBM adds to a firm. Many of these features can be argued into certain building blocks, but often certain aspects are not examined in the canvas.

The lack of certain building blocks really hinders the overview of a circular business model, and can hinder firms who want to transition to a CBM. If a firm is experimenting with certain configurations of their business model canvas to explore the possibilities of a CBM, these firms cannot generate the full picture of their canvas. The case to be argued is the suitability of Osterwalder's canvas as a tool for the conceptualization of CBM. From the case study analysis and previous research such as (Joyce & Paquin, 2016) it can be concluded that certain features are lacking from the canvas to perform well as a tool for outlining and evaluating a circular economy.

The issue with Osterwalder's canvas is that the product life cycle is not considered past the point of consumers. Before concepts such as 'cradle to cradle', design for sustainability, and the circular economy, linear business models where considered as the only viable option for commercially successful businesses. For linear business models it is clear that the consumers are more often than not the last stage of a firm's stake in their product (other than after sales services). This leaves governments and/or consumers to bear the burden of appropriate waste management. The strengths of circular economies lie in the increased utilization of their products through, service and leasing schemes to increase utilization, the recapture of underutilized products, or the recycling of the intrinsic material value of the product. These activities and actions must be considered during the design of a circular business model, and for this reason the Osterwalder canvas is not suitable for the circular economy.

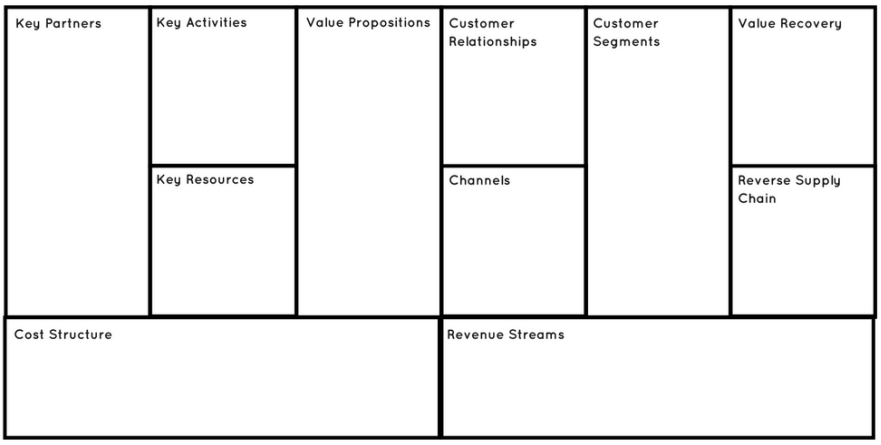
9.4.2. The Addition of New Building Blocks

From the analysis that has been carried out on the six case studies, and the lack of building blocks to involve circular business model components, this paper suggests two building blocks be added to enhance the circularity of the Osterwalder canvas. The building blocks will make up the new business model canvas pillar named 'Product Interface'. This pillar aims to involve EoL product management cycles into the business model canvas. This means that firms which intend to have any interaction with products after they reach consumers (applicable for service orientation too) can include this in the decision making process. The traditional canvas model is designed to allow businesses to make trade-offs between various factors, the addition of the product interface pillar allows circular business models the ability to design, make trade-offs, and innovate on more holistic business model canvas.

The product interface pillar will include two new building blocks. The first addition to the canvas is 'value recovery', this building block aims to include any activities relating to the recovery and exploitation of intrinsic value in a firms products. This can be for both material and monetary value, for example including the return of a vehicle which is only half way through its predicted life cycle (BMW DriveNow), or a light bulb and fixture which need servicing or refurbishing (Philips). The building block should describe when products can be recaptured for value recovery, and in what ways this value recovery will happen. The block can further be used to describe the areas where the value recovered will end up, which has the added effect of creating a more circular business model canvas. The circularity is achieved by being able to specifically indicate what areas of the forward supply chain will receive the product value, and in what form that value will arrive.

The value recovery building block should be used as an area where a firm can outline the resources it aims to recover as well as the way in which value recovery can be achieved. Due to the flexibility and unpredictability of circular business models, with new CBMs still being tested and explored, this building block is left intentionally ambiguous. The need for a less rigid canvas structure was already apparent with the six case studies examined in this paper, each case studies BM has unique attributes which often lacked a proper location in the traditional BM canvas framework. This reduces the holistic overview that the business model canvas should provide, and can often create situations where resource and financial gains from value recovery are overlooked. Canvas creators are often forced to not include certain aspects of the business model due to the rigidity of the canvas. The addition of the product interface pillar should allow more flexibility to create trade-offs in EoL management cycles, and create an improved, holistic CLSC based on popular circular business model.

The second building block being proposed is entitled 'Reverse supply chain'. This block is focused on the types of channels, partnerships, and logistical needs that are necessary to retrieve the value, and recapture the value to be put into the forward supply chain. Renault would use this building block to specify which partners are used for the reverse supply chain of EVLs, and consequently what activities would need to be taken to achieve the reverse supply chain. Case study evidence has shown that the traditional business model canvas lacks in this respect, for Philips it would be useful to be able to specifically outline its reverse supply chain needs. This would help incorporate the recycling, reuse, refurbishing and servicing of its products under



the business model canvas, which is currently not the case. The only evidence of these actions being taken is in the overview that this paper created to represent the flow of materials through the firm (Figure 17).

Figure 28 Proposed Circular Business Model Canvas

9.5. Opportunities for sustainable product design principles

Using the cross-case analysis has generated an overview of the design principles being employed by the case studies. This overview reveals many similarities in design principles that overlap throughout the case studies. It can be stated that each CBM has an inherent suitability towards a certain design principle, or in the case of a service orientation a combination of design principles being used. The design strategies for each case study do differ, due to the differences between the firms chosen and the products and value propositions being created. A service oriented BM is revealed to employ a combination of both product life-extension and long-life products for the design principles of the products. The extended value BM shows a strong coherence with product life-extension, as being used by both ICARRE95 and Project ARA to achieve the creation of value loops to extend a products lifecycle, often being designed for the recovery of intrinsic value. Designing for Durability aligns perfectly with the strategies behind the principle for long-life products. 'Design for a cycle' is being used by one case study to achieve a neutral bio-material cycle, this is the case for Mars. A cycle design allows for a more closed loop situation where product value is recovered, in this case reabsorbed by the earth as a source of nutrients.

Table 3 outlines the commonalities found between the case studies. The grouping of design principles to CBMs reveals the alignment between a CBM and its suitability towards a distinct design principle or set of design principles. The table does not show coherence in design principles, within an industry. This can be due to the distinct approach each case study has used to transition and operate within a circular economy. This distinct approach is often the CBM being utilized by the firm, this underlines the statement that design principles align with the circular business models rather than the industry being operated in. This means that these sustainable design principles can be used for multiple industries and are more dependent on the choices a firm makes during their CBM development.

The connection between a CBM and its set of design principles can help simplify the transition to a circular economy for a business. This study can help a business make trade-offs within their CBM in order to facilitate product designs that fall under the design principle that belongs with that CBM. Flexibility is offered to a business by the way of design strategies, under which a business can deviate from other businesses which may be operating with a similar business model. The strategies therefore may become a unique selling point (USP) and can create a value addition to a firm's product. By becoming a USP design strategies further create a source of competitive advantage as they differentiate a business's designs from competing offers on the market.

Industry	*Cases*	*CBM Employed*	*Design Principles Employed*	*Design Strategies*
Automotive	BMW DriveNow	Service Oriented	Product Life-Extension & Long-Life Products	ease of service / design for durability & reliability
Automotive	ICARRE95	Extended Value	Product Life-Extension	dis and re-assembly / ease of service / design for recyclability
Electronics	Project ARA	Extended Value	Product Life-Extension	Modularity / Upgradability
Manufacturing	Philips	Service Oriented	Long-Life Products & Product Life-Extension	Durability & Reliability / Ease of service / dis and re-assembly
Manufacturing	Miele	Design for Durability	Long-Life Products	Durability & Reliability / Functionality and Usability
Packaging	Mars	Industrial Symbiosis / Extended Value	Design for a cycle	Biological Cycle / Material Choices

Table 3 Cross-Case Analysis of each case's CBM and corresponding design principles

9.5.1. Long-Life Products

Aligning well with a design for durability and service orientation, the design principle of long-life products focuses on innovative strategies to achieve durable, reliable, functional and useable products. It can be stated from this papers research and analysis that the principle of long-life products is a key sustainable design principle that is applicable for a 'design for durability' CBM. Miele shows us that durable design is a long term strategy that brings with it many advantages, ranging from enhanced value propositions to fully recyclable high quality materials. This design principle creates longer product lifecycles by increasing the products utilization period. Durable and reliable designs can decrease the need for service, and reduce the demand for new products, this is what makes the design principle sustainable.

Lengthening the utilization period of goods and services does not close the CE resource loops, however research shows (Nancy M. P. Bocken et al., 2016) that it aids in the slowing of resource loops by decreasing the need for new raw material consumption, and reducing the cyclical demand for new products as the older ones reach their EoL. The long-life products principle also aligns with service oriented business models. Firms which wish to lease their products will be incentivised to increase the durability and reliability of the products they manufacture. BMW DriveNow has created a need for BMW vehicles to become longer lasting, due to the cost structure of DriveNow it is favourable for the firm to use a more durable product where servicing needs are minimized. Where today's market often favours lower prices, due to the economic crisis and reduced consumer spending, the 'long-life products' design principle allows firms to operate sustainably

and create positive brand associations aligning with durability and reliability, all of which leads to an increase in the products value perception in the eyes of consumers

9.5.2. Product Life-Extension

The principle of 'product life-extension' is being used by four out of the six case studies examined in this paper, making it the most popular principle for these CBMs. Life-extension differs from long-life by the way in which it approaches sustainability, rather than creating longer utilized products, it aims at designing products which fit better into the resource loops of the circular economy. For example the strategy for 'design for ease of service' increases the efficiency of products that go through the service loop. This often extends the products life-cycle, hence the name product life-extension. A further example of this would be the 'design for dis and re-assembly' which focuses on the designing of a product which can easily be recycled, refurbished, and reused. By increasing the ability for a product to be dis and re-assembled a firm can profit from more efficient cycles of recycling and refurbishment due to the ease at which the products can be disassembled. Renaults ICARRE95 scheme would greatly benefit from vehicle designs which are holistic and use the strategy for easy dismantling to aid in the ELV recapture and dismantling process that the CBM in the case study focuses on.

Product life-extension also includes strategies for modularity and upgradability both of which are techniques to extend the utilization periods of existing products by adding new components or replacing older ones, without the need for disposal and re-purchase of the full product. These techniques achieve a more sustainable product life-cycle by extending usability, reducing volume of waste, and allowing for consumer customization which may lead to better consumer attachment and in turn a reduction in waste. For a better idea of this principle a similar name may be given to it, 'product value-extension' this differentiates the principle more from long-life products and can broaden designers minds to begin thinking about, not only the products life cycle but also, the intrinsic value of the product. The term value in this case refers to the materials, and energy held within the product, and so product value-extension also carries towards ease of recycling and more EoL focused design strategies. This renaming also separates the principle from its counterparts and better explains the goals of the principle.

9.5.3. Design for a cycle

Design for a cycle is more uncommon than the other two principles for sustainable product design, however it aims at achieving the highest level of sustainability and fully closing the resource loops for both technological and/or biological product cycles. Design for a cycle is used by one case study, Mars, due to a material innovation that allows for Mars to use a fully bio-degradable packaging material. The material innovation comes from Rodenburg Biopolymers, a partnership that was instigated four years previous to the perfection of the Solanyl polymer. The primary reason Mars is able to use this principle is through the partnership, which facilitated the innovation in material to allow for a full biological cycle. This makes it a

difficult design principle for designers to tackle without a disruptive innovation taking place that allows for full loops to be made to re-integrate product value back into the forward supply chain of firms.

This principle, design for a cycle, should be used for firms which want to create a fully closed loop supply chain, and/or fully close the loops for their resource usage. The principle focuses on technological or biological material innovations to initiate the transition to a circular economy. Often taking time, these innovations may not come about by themselves and must be a focus for R&D costs, creating such a cyclical material loop comes with a set of advantages that Mars is able to exploit. The case study reveals that the design for a cycle is a principle which is appropriate for disruptive innovations in the field of sustainability, and is a time consuming and costly principle to implement, however if accomplished a business can create stable sustainability and offer this as added value for consumers.

10. Conclusion

Becoming sustainable is one of the most challenging endeavours that the world's economy must meet in order for humans to survive long term on our beautiful, green and blue, planet. The consumption of scarce resources and finite energy sources is straining the global economy, this technological age has allowed for renewable energy sources to become present in everyday life both as a consumer and as an organization. However the lagging behind of renewables in the form of raw materials is constricting the advancements made towards sustainable industries. This has created the 'circular economy' movement which is driving the full use of value from products being produced and brought to market. This paper set out to aid businesses in overcoming the barriers of uncertainty being faced when dealing with the transition to a circular economy. The thesis has been able to identify firmer avenues for firms to traverse while transitioning to a circular business model, and has linked a set of design principles which have proven successful for certain circular business model archetypes.

The in-depth analysis of six case studies, which each implement a distinct style of a circular business model, has allowed this paper to identify three key building blocks which see major disruption and need to be a focal point for firms entering the circular economy. These key building blocks should be used to weigh choices made during the conception of a CBM, becoming especially useful when used in conjunction with the popular business model canvas method. The most important key building block is 'partnerships', the act of creating partnerships that benefit both parties has enabled BMW, Renault, Philips and Mars' to achieve a successful circular economy in their respective industries. The second key building block is the value proposition, this is key to any business model, however to achieve circularity firms have disrupted the industry standard value propositions in each and every case analysed. This disruption identified is not large, often it creates a situation where the core competencies of a firm can still exists, however innovative additions to the value proposition are being implemented acting as a source of competitive advantage or altering the customer interface which a firm utilizes. The final key building block identified in this paper is the revenue stream, this is of strong importance for a transition to a service oriented archetype. The revenue stream is the only source of

income for a firm and the transition to a CBM disrupts the stream of revenue therefore the increasing the risk of a valid revenue stream for firms which transition to the circular economy.

Out of the six case studies, five of which recently transitioned to a circular economy, opportunities have been created for the implementation of sustainable product design principles. These principles have been identified by previous research and this paper has argued that distinct links can be made between a CBM archetype and the adequate design principles that aid in its implementation. These links are made clear through the analysis of the case study and during the discussion chapter this paper has argued that these links can aid in forming a clear approach to product design for firms to utilize. Table 3 reveals that an 'extended value' BM has shown success by implementing the design principle of 'product life-extension'. The cross-case analysis has also shown evidence that suggests a service oriented BM should incorporate the combination of 'long-life products' and 'product life-extension'. The combination of these two principles is inherently advantageous to a product leasing firm due to their focus on durability and reliability, as well as incorporating design for EoL product management through the 'product life-extension' design principle. The 'design for durability' BM is used by Miele and shows strong singular connection to the 'long-life product' sustainable design principle, and the strategies that this principle exploits. Industrial Symbiosis has shown a strong relationship with the 'design for a cycle' principle, however it should be noted that a singular case study does not show enough evidence for this paper to argue as to the strength and validity of this relationship.

To conclude, firms which are looking to transition to a circular economy should take into account the disruption that takes place in the three key building blocks that are outlined in this thesis. By acknowledging the importance of these building blocks a firm can profit from a more in-depth and the specific outlining of actions to be taken and a more focused business model configuration with regards to these key areas. These key building blocks are not limited to firms but also should be considered by organizations and governments, and a strong focus in these areas will limit the uncertainties that arise when conceptualizing, transitioning and implementing a circular business model with the goal of achieving a circular economy. This paper stresses the importance of these building blocks as a main source of disruption and uncertainty for many firms, they also create a fundamental base from which a firm can design its CBM. It should be noted that this paper has identified weaknesses with the standard business model canvas, and has therefor recommended the addition of two new building blocks. This allows firms and organizations to create a more holistic overview of their current or future BM, and is designed in such a way to account for the EoL management of a product, being especially useful when value re-acquisition is a key activity for the firm. The link between sustainable product design principles and the CBM archetypes creates a solid base from which firms can choose and implement specific design strategies to meet the demands of the CBM being employed.

10.1. The Three Key Building Blocks of the Business Model Canvas

"In order to overcome the barrier of uncertainty businesses face, are there any identifiable key building blocks that remain common between different business model archetypes operating in various industries?"

This paper has argued towards the integral importance of three key building blocks, partnerships, value proposition, and revenue stream. These building blocks are keys to helping organizations overcome the barriers of uncertainty when conceptualizing their circular economy. These blocks are repetitive sources for disruption over the six cases analyzed, this fact suggests the overarching importance of these key building blocks over each of the circular business model archetypes and across the four different industries. This allows for the statement that partnerships, value proposition, and revenue stream are common sources of uncertainty and disruption for businesses that wish to operate in a circular economy. These three building blocks should be used as focal points for a business model canvas to be built around. Thus allowing firms to reduce the uncertainties and risks they may face during a transition to an innovative CBM.

10.2. The Circular Business Model Canvas Concept

During the analysis phase of each case study, the author of this paper saw the need for a more holistic 'circular' business model canvas. The current business model canvas ends abruptly with the customer interface section, revealing a short sighted model that aligns with the linear business models for the 'take-make-dispose' value chain. The addition of 'Value recovery' and 'reverse supply chain' increases the utility of the business model canvas, and makes it more suitable for circular business models. These building blocks allow firms to evaluate the actions they take after the customer has interacted with, disposed of, or returned their products. This concept does not aim to answer one of the research questions, however with the aim of aiding firms in a less uncertain transition to a circular business model, it is important to note the suitability of the current business model canvas.

To suggest this conceptual circular business model canvas as an area for further research may be a little farfetched. However this paper has certainly identified the need for an extended business model canvas that includes a more holistic point of view for a products life cycle. For this point of view recommendations could be made towards cradle-to-cradle ideology and the circular economy. Research has been done on an extended canvas model that integrates both social and environmental factors into the business model canvas (Joyce & Paquin, 2016). However this ultimately pulls away from the overview of the economic business model canvas, which is of integral importance to most firms. As such this paper recommends further research in the functionality of the business model canvas for circular business models, and has conceptualized a new circular business model canvas which could be used to test the advantages or disadvantages of this, more holistic, approach.

10.3. The Principles for Sustainable Product Design

"During the transition to a circular business model, are there opportunities for firms to incorporate desirable sustainable product design principles to more fully create value in a circular economy?"

The process of value creation in a circular economy becomes one which involves increasing the usable lifetime of value that enters the circular economy. By exploiting a number of sustainable product design

principles firms have benefited from easier and more successful transitions into a circular business model. This paper has identified and argued towards the links made between the design principles and the circular business model archetypes. These links should aid in a firms decision making behind which, more specific, design strategies will add value with their often unique business model. The sustainable product design principles should align a firms design strategies with their circular business model, thus aiding in a smoother, less uncertain, transition to the circular economy.

10.4. Creating a Stronger Position for Firms to Achieve a Circular Economy

Many firms and organizations are still sceptical on how sustainability can create tangible benefits for their operations. This point of view is restraining the innovative sustainable advantages of a circular economy, this is even further restrained by the challenges firms and organizations face when conceptualizing their circular business models. This paper has argued towards the importance of three key building blocks which will decrease the uncertainties that are being faced. Uncertainties are also reduced by the grouping of CBM archetypes with their sustainable product design principle counterparts. Together these results aid a firm in the planning, and implementation of their circular economy. This paper facilitates the global economy and all its stakeholders to take one transitional step forward by reducing the feared gap of uncertainties between the linear economy and the circular economy. Taking us one step closer to making today's products become tomorrow's resources.

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