Assessing the strengths and limitations of Business Model Frameworks for Product Service Systems in the Circular Economy: Why Canvas and co. are not enough

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Abstract

Today's value chains rely strongly on a virgin material to 'take-make-dispose' products. One way to reduce that dependency on finite resources is a circular economy (CE). Different pillars form the concept, this research paper focuses on Product-Service Systems (PSS) in which a customer instead of buying a product for example only pays for the use of one.

Companies who want to transfer towards a circular business model (BM) face tremendous organisational challenges. They cannot just modify some parts of their operations, they have to change the entire BM. Much of the literature and t on BM is a result of e-business and therefore not necessarily suitable for circular BM.

To investigate if the current tools are suitable, the aim of the research is to answer the question: Do existing BM Frameworks cover the information requirements for PSS BMs within the CE.

The paper provides a literature review on two bodies of knowledge. First it explains the characteristics of PSSs in the context of a CE; secondly, it describes the different BM frameworks which are assessed in this research.

To answer the research question, three sub-questions are formed on values, activities and stakeholders of a BM to be applied on the BM frameworks. The research follows a two-step approach to answer these sub-questions, in a first step 9 experts from academia, consultancy and business were interviewed on characteristics of PSSs. Based on these characteristics, 26 questions were defined to assess the strength and limitations of the 9 BM frameworks.

As the analysis of this assessment shows, future work is necessary to develop suitable BM frameworks for PSSs and scaled up to the entire CE. The research does not propose a new BM framework but rather points on lacks in current ones and suggests possible further research to locate these lacks. Further, the two-step approach as a research methodology can be used to connect and assess any kind of expert-knowledge with existing literature or frameworks.

Key-words: Circular economy, product-service systems, business model framework

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Abstract

Today's linear approach of how value chains are designed relies strongly on virgin material streams to 'take-make-dispose' products. One way to reduce that dependency on finite virgin materials is the transaction towards a circular economy (CE), in which products are designed to generate no waste.

Different pillars like Cradle to cradle, Biomimicry and Servitization are influencing and shaping the concept. This research paper focuses on Product-Service Systems (PSS), a type of Servitization in which a customer instead of buying a product for example only pays for the use of one.

Companies who want to change their value chain taking CE approaches into consideration face tremendous organisational challenges. Hence, they cannot just modify some parts of their operations, they have to change the entire Business Model (BM).

Research on BM is a rather new topic and much of the literature and research is a result of e-business and therefore not necessarily suitable for BMs within the CE. As a subcategory of the wider term BM, the research focuses on BM frameworks, tools to model and visualize a company's BM. To investigate if the current tools are suitable, the aim of the research is to answer the question: Do existing BM Frameworks cover the information requirements for PSS BMs within the CE.

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Keywords: Circular economy, product-service systems, business model framework

It's not bringing in the new ideas that's so hard; it's getting rid of the old ones. [1]

John Maynard Keynes, English Economist

Acknowledgment

My special thank goes to the interview partners who are working every day to make the transformation towards a Circular Economy reality to enable future generations to live in an intact and economic and environmental ecosystem.

On this occasion, I am happy to express my gratitude to my supervisor Andres Ramirez Portilla for the support and the great inputs during the research project.

Tobias Widmer, Stockholm May 2016

[1] Source: http://www.azquotes.com/quote/1407284 accessed 17.05.2016

Table of content

List of figures

List of tables

Terms and Abbreviations[2]

Downcycling is the process of converting waste materials or useless products into new materials or products of lesser quality and reduced functionality.

Upcycling is the process of transforming by-products, waste materials, useless and/or unwanted products into new materials or products of better quality or for better environmental value.

Servitization is a relatively recent concept adopted by manufacturers to deliver a service component in tandem with their traditional product - providing added value to customers, securing orders and boosting profitability.

Cradle to Cradle design (also referred to as Cradle to Cradle, C2C, cradle 2 cradle, or regenerative design) is a biomimetic approach to the design of products and systems. It models human industry on nature's processes viewing materials as nutrients circulating in healthy, safe metabolisms.

BMF: Business Model Framework

BM: Business Model

SC: Supply Cain

PSS: Product Service System

CE: Circular Economy

GDP: Gross Domestic Product

PE: Performance Economy

B2B: Business to Business

B2C: Business to Customer

P2P: Peer to Peer (a term for Customer to Customer)

[2] Source: https://en.wikipedia.org accessed 18.05.2016

1. Introduction[1]

1.1. Necessity of research

As stated in the United Nations report on the world population prospects, the global population is about to grow from 7.25 Billion in the year 2015 to 8.50 and 9.73 Billion in 2030 and 2050 respectively (U.N., 2015). Further, the EPSRC Centre for Industrial Sustainability forecasts, that by 2050 the global industrial system is targeted by international agreements and governments to double its output while only using half of the current resources and generating one-fifth of current CO2 emissions. To make this change happen, a new industrial revolution is required (EPSRC, 2016).

No doubt the industrial revolutions humanity experienced so far brought many advantages, although out of a sustainable point of view they lack in many ways. Just to name the concept of planned obsolesce as one example which was first introduced in the 1930's as a means to stimulate the markets and end the great depression. The purpose of this concept is that goods are designed and produced in a way to have a short technical life and customers are forced to replace the product (Andrews, 2015).

This 'take-make-dispose' model of consumption which is one of the main characteristics of a 'linear economy' is still applied in many consumer goods nowadays. The model is simple: companies extract materials, apply energy to them and manufacture a product and sell it to a consumer who discards it when it no longer works or serves the purpose (EMF, 2012).

One way to overcome the future resource scarcity is the transformation from a 'linear economy' to a 'circular economy'. A circular economy is an economic system which is restorative or regenerative by intention and design. In this system, waste does not exist because products are designed not to generate any. In these products, components are strictly differentiated between consumables which are made of biological ingredients and durables which are designed from the start to be reused (EMF, 2012).

In the Business to Business sector, some form of a circular economy already exists since the 1920's, investment goods like e.g. trains were and are made to have a long lifetime and to generate revenue after sales for maintenance and spare parts. Companies, however, won't just become 'greener' and 'save the world' voluntary. Legislation can force businesses to be more sustainable what unfortunately often harms the company's performance (Guide, Harrison, & Wassenhove, 2003).

[1] Outtakes of this chapter were part of the research project in the KTH course ME2093 Technological and Industrial Change, Spring term 2016

The trillion-dollar question is: How can companies capture the most value and be sustainable? To achieve these two goals, companies often have to change their entire Business Model to be competitive. As the literature review shows, scientific research in this area is far from satisfying, especially in the field of Business Model Innovation.

1.2. Origin of the Circular Economy

Today's concept of the circular economy is not accountable to one person but an anthology of different holistic views of achieving a more sustainable, waste-free society. Hence it is a holistic concept, many of the approaches are related to a closed system way of thinking, first traceable back to Kenneth E. Boulding's 1966 book "The economics of the coming spaceship earth." Boulding describes the earth as a spaceship on a long journey in possession of limited resources(Boulding, 1966).

The popular term 'Cradle to Cradle' was coined by Walter R. Stahel, a Swiss architect who in the 1970's as first advocated a 'service-life extension of goods - reuse, repair, remanufacture, upgrade technologically' philosophy to apply to our industrialised economy.

In 1976 Walter Stahel and Genevieve Reday presented a research report to the European Commission in with the title 'The Potential for Substituting Manpower for Energy'. Key points of that report were the positive impact of an economy in loops, or CE, on waste prevention, resource savings, economic competitiveness and job creation (Product-Life Institute, 2013).

36 years later, in 2002 the thinking in loops got a new push when German chemist Michael Braungart and U.S. architect William McDonough published their bestseller "Cradle to Cradle: Remaking the Way We Make Things." In their publication they described in detail how a Cradle to Cradle Design model has to look like and which characteristics a valid lifecycle development has to have (McDonough & Braungart, 2010) .

In their book, Braungart and McDonough describe two different circles for materials. They classify them as nutrients for products and separate them into biological and technical nutrients and products have to be designed to separate them easily after use. The non-toxic biological nutrients have to be simply compostable, whereas the technical ones are designed to be reused again with a minimum input of energy. These nutrients have to be strictly separated in what the authors call biosphere and technosphere; these spheres are shown in figure 1 that shows these principles visualized by the Ellen MacArthur Foundation (McDonough & Braungart, 2010) .

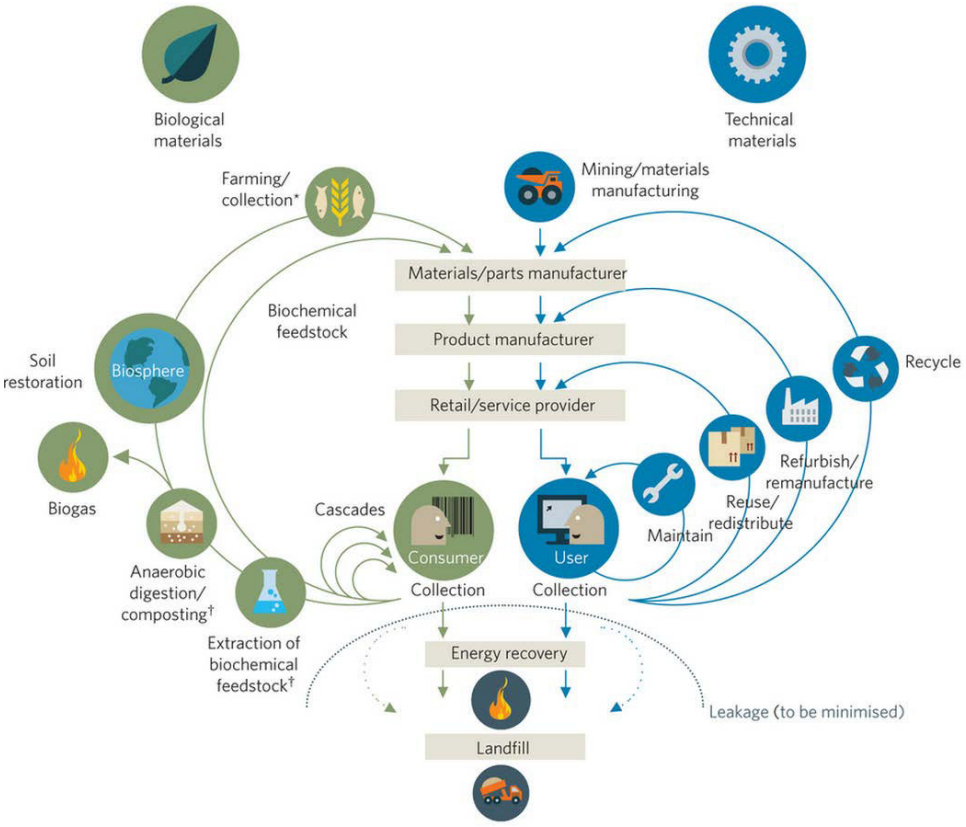


Figure 1. Circular Economy System Diagram basing on McDonough & Braungart (EMF, 2012)

Most of the approaches of the CE follow the idea of biomimicry, the idea of imitating nature to solve modern engineering problems for products and architecture. CE approaches can be on a macro level of looking at the economy as an organic system or in a micro perspective to design a product by mimicking its form and movement (Pitt & Heinemeyer, 2015) .

1.3. The example of ResCoM

To get a better understanding on how a BM in the CE can be executed, the approach of Resource Conservative Manufacturing[2] (ff. ResCoM) is used to explain how waste can be reduced by extending a product's lifecycle(Rashid, Asif, Krajnik, & Nicolescu, 2013).

In a linear economy, the product lifecycle of goods is an 'open-loop' which means that the goods after one lifecycle end on the landfill. This implies that a company's major activities focus on the 'forward supply chain' (bringing the product to the customer). The ResCoM concept aims to integrate the return of a good to the producer which is called a 'reverse supply chain' whereby a recovered product re-enters the traditional forward chain.

[2] ResCoM is an international consortium of research partners, OEM and technology partners with the aim to develop a system to enable closed loop supply chains. It serves as an example because of both its academic achievements and KTH's participation as a knowledge provider.

By having both forward and reverse supply chain, the supply chain is closed or so called a 'closed loop supply chain' and is considered as one of the most feasible solutions for sustainable supply chains, although very complicated to implement.

Many companies already have some sort of reverse supply chains, e.g. take back processes of products if they do not work properly. The aim of ResCoM is to close the loop by design. Features of such a closed loop supply chain are products that are designed for multiple lifecycles, well-defined loop closing strategies and a deeper customer integration in the company's processes itself.

Traditional goods normally have one lifecycle before the 'End of Life' (ff. EoL) is reached. Resource conservative goods are designed to have several lifecycles before they reach their EoL. These lifecycles are an integrated part of the business model and a vital part of a company's revenue and activities. In an open loop, the aim is to have a profit maximisation, whereas in a closed loop the sustainable aspect has to be taken into account as well.

The different lifecycles in figure 2 are called 'Resource Conservation Levels' (RCL), after reaching the 'End of Resource Conservation Level 0' ($EoRCL_0$), the product has to be upgraded by the producer and enable the next lifecycle for the same or another customer. Having a closed loop supply chain like this requires to have the customer as an integrated part of business activities and not as another island as in the linear economy. This kind of producer-customer relationship is essential to improve visibility and control over the entire lifecycle of a product and has both advantages and disadvantages.

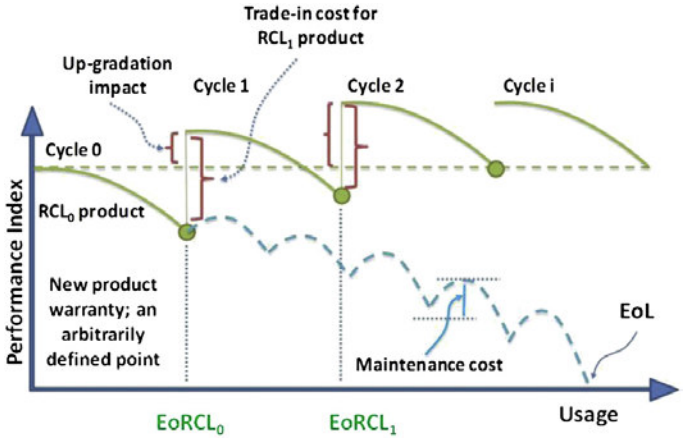


Figure 2. Comparison of the conventional lifecycle (blue- dotted curves) and the ResCoM lifecycle (green-solid curves) (Rashid et al., 2013)

1.4. Aim of the research

As the example of ResCoM shows, many researchers are working on solving the problems to change towards a CE. Although valuable on an operational level, the general knowledge on CE is still in its early stages. An earlier review of online sources showed that the tools to visualize BM for the CE and in special PSS are defective.

It does not matter if it is just a business idea or a well-established company, is not easy to become sustainable if one is used not to care about it. Especially companies using a system of Linear Supply chains face tremendous problem making their products more sustainable. One reason therefor often is the existing BM, which is established over decades and are stable systems of revenue, cost and profit.

If they want to pivot their business towards a circular economy, they not only have to change their supply chain but redesign their products and relationships to many different stakeholders. To visualize this demands many aspects have to be considered, and as for most things in life and business, there is no perfect one-size-fits-all solution.

In the case of a framework, it is necessary to make compromises and detect the balance to fit the widest range without losing too much information. To find out what's the best framework for business models in the circular economy these compromises have to be made on:

- Standardisation vs. Flexibility (level of abstraction)
- Start-up idea vs. Mature company (level of knowledge)
- Operational vs. Strategy (level of complexity)

The main research question this thesis aims to answer to address this problem is:

Do existing Business Model Frameworks cover the information requirements for Product Service System Business Models within the Circular Economy.

The thesis not only aims to contribute to solutions for a more sustainable industry and investigates baselines for future research, it as well discusses basic ethical issues on how we think about values in our growth driven society.

1.5. Disposition

The 2nd chapter of this report sets the theoretical boundaries of the research. It starts generic on the topic of BM, followed by definitions of the CE and then sets the focus on different PSS in the first part. In the second part of the chapter the theoretical background is explained and the analysed BMF are presented.

In the 3rd chapter, the research methodology is explained, and the two-step approach of interviews followed by analysis is presented. In this chapter, the limitations and delimitations are defined as well.

The 4th chapter presents the interview structure and the interview partners in the first part. In the second part, the findings of the interviews are summarized.

In the 5th chapter, the BMF are assessed on the findings of the interviews, and the strength and limitations are summarized.

The 6th chapter answers the research question and shows up possible further research possibilities as well as the implications of the investigation.

2. Theoretical background

2.1. Definition of Business Models

To understand what features a BMF has to display at least, a brief definition of the term 'business model' itself is required. Popular research, as well as thought leaders, came up with various definitions of what a business model is and what it contains.

- "A framework or recipe for making money (by creating and capturing value)" (Afuah, 2014)
- "The rationale for how an organization creates, delivers, and captures value" (Osterwalder, Pigneur, & Tucci, n.d.)
- "Combination of resources which through transactions generate value for the company and its customers" (DaSilva & Trkman, 2014)
- "The content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities" (Amit & Zott, 2001)

Using these and other definitions, Gronum et al define the business model as an abstraction of strategy of 'how a firm does business', capturing the heuristic logic of how a firm creates, delivers, and captures value through its activity and transaction system architectures, in concert with its boundary-spanning relationship network (Gronum, Steen, & Verreynne, 2015) . For the purpose of this thesis, this is the definition of a BM the researcher uses.

In nowadays business, people have the possibility to profit from a variety of tools and assessments for many different challenges. They reach from very generic strategic to a specific operational level of business, and many of them have specialized iterations. They all have in common that they offer a framework, a conceptual structure intended to serve as a support and they offer a guideline on how to model and visualize processes and structures. To even describe it more abstract, these tools only show the way, but the person has to walk there on his own.

2.2. Definition of sustainability

As the understanding of sustainability and its impacts changed over time, after being first framed by the WCED[3] as 'meeting the needs of the present generation while not compromising the ability of future generations to meet their needs' (Brundtland, 1987), it is, although discussed and extended in many ways, still accurate and not outdated in the basic means even after almost three decades.

Today's literature usually refers to three dimensions of sustainability: environmental, social and economic. In their extensive literature review on state-of-the-art definitions, Arena and colleagues outline that companies have to answer

[3] World's Commission on Environment and Development

three questions if they want to become more sustainable (Arena, Ciceri, Terzi, & Bengo, 2009).

- **What is sustainability?** Which are the meanings, the goal and the scope of a sustainability-based strategy for a due company?
- **How can sustainability be achieved?** Which are the current means of a sustainability based strategy in the company? Which are the methods and tools that can be applied?
- **How can sustainability be measured?** Which are the available indicators that can explicit to the stakeholders the actual result of a sustainability-based strategy?

To clarify the three broad dimensions of sustainability, Arena et al. extracted the characteristics from their literature review in table 1 to understand these:

Table 1. Dimensions of sustainability (Arena et al., 2009)

Environmental	Social	Economic
Materials	Work practices and adequate working conditions	Economic performance
Energy	Diversity and equal opportunities	Market presence
Water	Relations with the community	Indirect economic impacts
Biodiversity	Social policy compliance	
Emissions	Consumer health and safety	
Waste	Human rights	
Product & Service		
Compliance		
Transport		

Van Marrewijk and Werre argue that "all kind of standardized corporate sustainability tools should be abandoned hence each company is unique" (Marrewijk & Werre, 2003) which goes in line what many researchers say, that there is no "one-size-fits-all" solution. Every single organisation has to choose its unique approach to matching the ambitions and intentions aligned with their strategy (Marrewijk & Werre, 2003).

2.3. The Performance Economy

CE thinker Walter Stahel states the problem for economists "who work with GDP, creating wealth by making things last is the opposite of what they learned in school" (Stahel, 2016). He reasons that because GDP measures a financial flow during a certain time and selling more results in higher profit and economies of scale, whereas CE preserves physical stocks and reduces flow. He takes it one step further and extends the definition of different ways of how the economy can be shaped

and adds the term 'Performance Economy' (in addition to Linear and Circular Economy) (Stahel, 2016) .

The way on how we do business and how the economy has to be shaped is as well crucial for a global development. Key factors that define industrial countries show up the difficulties for developed countries to serve their needs and resource requirements. The population of the industrial countries on our planet only accounts for 20%, but this 20% are responsible for 80% of the world's resource consumption. The markets in these countries are saturated and the warehouses full with a huge storage of resources. In these markets, the economy suffers from oversupply because the companies follow the old approaches of economies of scale to produce goods as cheap as possible. The goods developed, sold and used in the industrialized countries are substituted by newer generations instead of upgraded, these and other factors are not solving the sustainability issues our society faces (Stahel, 2008) .

In a PE, companies do not sell goods in a traditional way but as services as for example through rent. The main difference is that the producer of a good retains ownership over the tangible object and carries that risk and cost of its waste, following the Cradle to Cradle approach. In such a PE, the company not only focuses on design and reuse but further focuses on delivering solutions rather than products and generates profit from sufficiency strategies like waste prevention (Stahel, 2016).

To overcome this current situation of overproduction, the economy has to change from an 'efficiency strategy' to a 'sufficiency strategy'. With such a sufficiency strategy, long-term ownership of physical assets becomes the key to the long-term income of successful companies. As a result of the company being the owner of the product, unlimited product responsibility that includes the cost of risk and cost of waste transfers from the customer to the producer. Stahel summarizes four strategies to reduce oversupply (Stahel, 2008) :

Stahel defines four main strategies on how to reduce the oversupply of products and the associated consumption of raw materials. The first strategy tackles the accelerated flow of matter in the economy which should be slowed down. The matter flow can be achieved by increasing the lifetime of the goods by design, for example lamps and printers that last longer and are not designed for a planned obsolesce. Another way to do so can be a product-life extension to either increase the life-cycle itself or add more life-cycles. This product life extension can either be made on a component or the good as an entire. The four sub-strategies include reuse (e.g. glass-bottle or printer cartages), repair (e.g. broken windscreen or re-welding of broken machine parts), remanufacturing (e.g. re-treaded tires or remanufactured engines) and technology upgrading to new standards or higher energy efficiency. To slow the flow of matter through the whole economy, waste of one system can be sold into a new system as a resource input which is named as product life-life extension into a new field (Stahel, 2008) .

In addition to the main strategy of slowing down the flow of matter volume in the economy, Stahel as a second strategy suggest to reduce the flow of matter in the economy. Reducing the flow can be achieved by having multifunctional and therefore fewer goods to execute a job. Having, for example, a combined copy-print-fax machine allows using many of the components like power-supply and displays which in other case are used for each single product. Matter reduction or in a similar case energy reduction can as well be achieved by having a system solution when for example using a cogeneration plant in which the burning of fuel can produce electricity, heat and cold at the same time (Stahel, 2008) .

The third strategy Stahel suggest is focusing on the Cradle to Cradle responsibility for companies producing goods. The company then takes the responsibility to design and manufacture goods following a systems approach that within the system the goods produce no waste (Stahel, 2008) .

As a fourth strategy, Stahel sets the focus on the more marketing and commercial aspects which most relate to PSS. Material consumption can be reduced in selling the use or the service of a good, for example, construction machined can be just rented instead of sold or a company sells customized greasing solutions to solve a problem instead of just a barrel of oil. Fewer resources are as well required when sharing goods for example laundry services or car sharing. To motivate customers to decide for eco-friendlier products, the company, for instance, can offer monetary bring back rewards and cash back guaranties (Stahel, 2008) .

According to Stahel, the highest economic rewards result from reducing or optimizing activities needed to transfer products from one user to the next to prevent unnecessary material flow. That leads to the conclusion that the local reuse after refurbishing and quality check is the smallest possible product-cycle and therefore the most profitable strategy. Various economic and organisational changes, as well as changes in the mind-set, have to be achieved in several areas. The industrial infrastructure has to be organised to have regional manufacturing and remanufacturing facilities in order to be closer to the marked. These facilities are smaller than traditional ones and can handle lower volumes with still being efficient. Products have to be designed to facilitate the ease of maintenance and upgrading. The product in addition to that should as well be modular and have interchangeable, standardized components. Unlike traditional products, they are made for longevity and are designed to be maintenance free and fault tolerant. New technologies enable companies to monitor the products and have the best possible maintenance options. In this new economy not only the product will change, but as well new professions and qualifications will be required to maintain the products. The traditional salesperson will be obsolete and instead the customer solution advisor will be necessary to satisfy the needs. As the companies decentralise, the jobs will become more flexible and unlike the classic work where the employee commutes to the company, he will be working on his own or in situ at the customer's site. (Stahel, 2008)

By changing from an efficiency to a sufficiency strategy, not only the organisation but as well customer gets influenced in different ways, figure 3 compares some key features of that change which might apply for the customer (Stahel, 2008) .

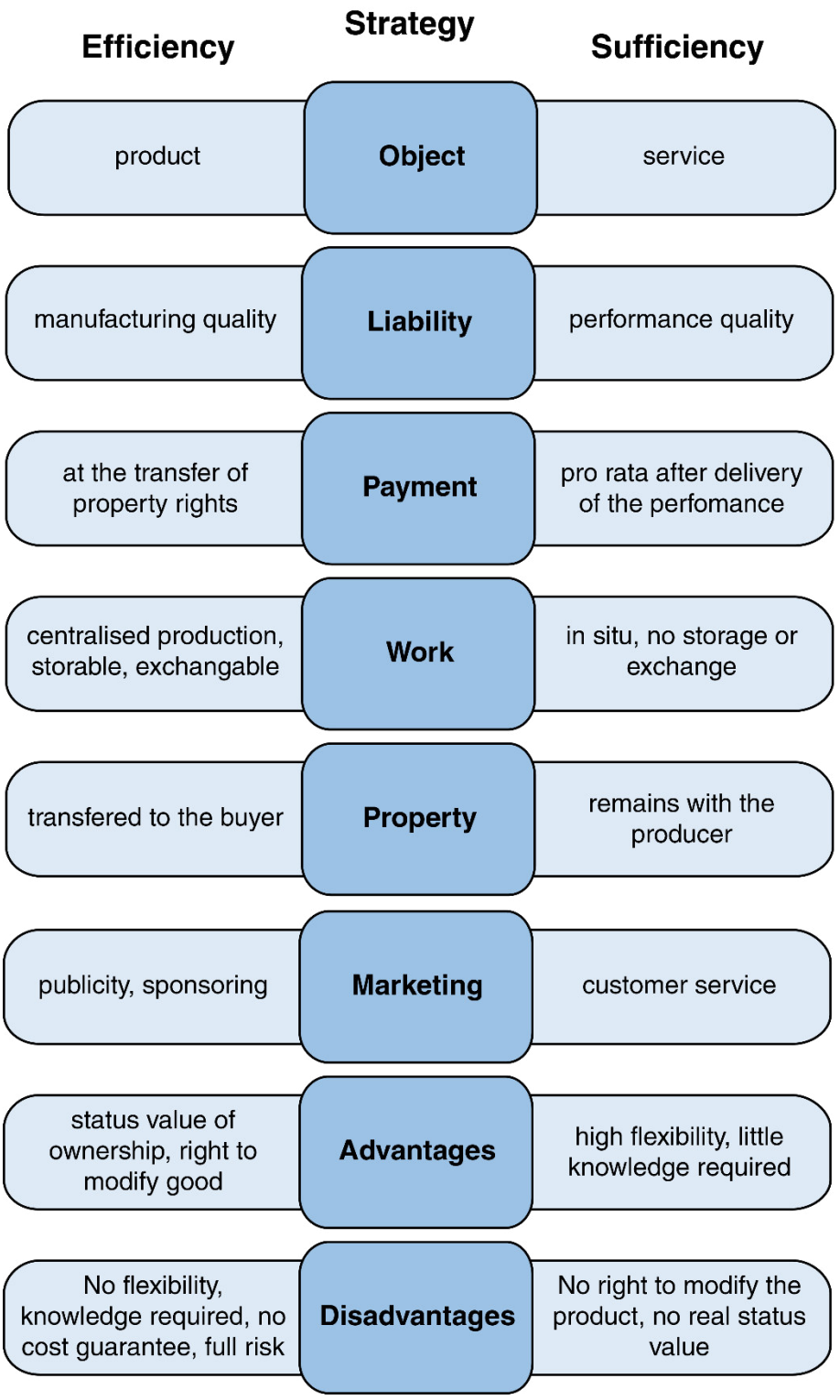


Figure 3. Selling product versus selling performance (own, based on Stahel, 2008)

As Stahel points out, many of the challenges to master the transformation towards a CE including life-cycle and service thinking are already existing in the way of the linear economy but have to be intensified. He focuses on the quality of goods to ensure longevity of products, which in a PE consists of three interdependent dimensions (Stahel, 2008) :

- technology management (efficiency)
- risk management (preventive engineering)
- sustainability management (the factor time)

He further states that a PE will consume fewer resources and be more efficient hence the volume of goods to be transported decreases. In addition to that, jobs are more regionalized and offer a higher variation for different skills and offers new opportunities for decentralized workshops and remanufacturing facilities (Stahel, 2008) .

2.4. Value creation in the Circular Economy

2.4.1. Sources of value creation

The Ellen MacArthur Foundation defines the four following fundamental types of value creation in the CE, which are depicted in figure 4 (EMF, 2015).

The upper left quadrant describes the power of the inner circle. The idea of the inner circle is that goods are most efficiently used when not diverted from its intentional use. A product has to be designed to be able to serve its original purpose the longest possible. In this case, a car for example should be designed to be easily repairable and maintainable and even if the car as a whole doesn't work any longer, the components can be used within another vehicle.

The second source of value creation relates to circling products longer in terms of maximising the lifecycles, which is depicted in the upper right quadrant. By circling longer, less raw-material and energy is required to produce new goods. This again can, for example, be achieved by design for longevity.

Cascaded use of goods is depicted in the lower left quadrant and describes the use of goods across different value chains. Clothing, for example, can be used for upholstery after wearing them, and when the life of the furniture comes to an end, the filling can be utilized for insulation purpose. By doing so, it is crucial to make sure that the reuse doesn't require even more energy that new ones.

The last quadrant in the lower left again strongly refers to the design in terms of having easily separable products made out of uncontaminated materials.

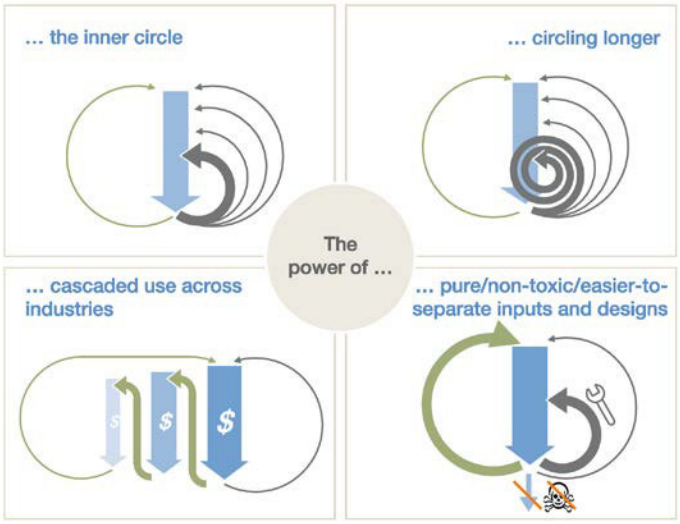


Figure 4. Sources of value creation for the circular economy (EMF, 2015)

2.4.2. Five types of Business Models

Hence the concept of the CE is not set in stone, and different authors and researcher are working in that field, various categorizations exist. In its 2014 publication "Circular Advantage", the consultancy Accenture defined five BM for the CE shown in figure 5, basing on dozens of case studies and interviews (Lacy & McNamara, 2014):

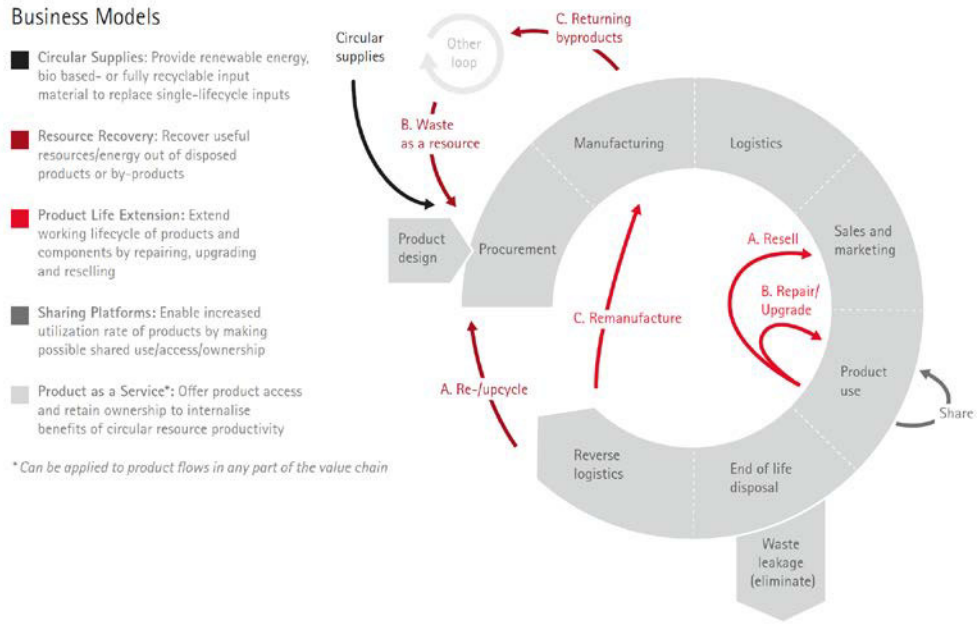


Figure 5. The five Business Models for the Circular Economy(Lacy et al., 2014)

1. **Circular Supplies** refer to BM which supply fully renewable and can clean resource inputs to productions and consumption systems. This BM concentrates on the ingredients a good is made of and refers to the use of pure inputs described in the previous chapter.

2. **Resource Recovery** BM focus on collecting and goods and close the supply chain loop to transfer waste into value through recycling or upcycling and as well refers to the use of pure inputs.
3. **Product Life Extension** aims to extend the lifecycles of a good through repairing, upgrading, remanufacturing or remarketing. By doing so, a company ensures that a product can be used as long as possible, and revenue can be generated over a longer period of times. Connecting this BM to the four sources of value creation, this refers to the power of circling longer.
4. **Sharing Platforms** offer a place for companies and individuals to share assets among other users which is decreases the overcapacity of a good.
5. **Product as a Service** is the alternative to traditional 'buy-and-own' BM. Instead of selling a product, a company sells a service which is satisfying the customers need. This research focuses on this kind of BM which will be explained extensively in the next chapters.

It is important to understand that any company can apply hybrids of these five business models and that they are not only applicable as a single unit. Literature Review

2.5. Eight types of Product Service Systems

In his 2004 publication "Eight types of product-service system: eight ways to sustainability" Tukker defined and evaluated eight business models with different levels of servitization which are visualised in figure 6. In his writing, a PSS is defined as "tangible products and intangible services designed and combined so that they jointly are capable of fulfilling specific customer needs" (Tukker, 2004).

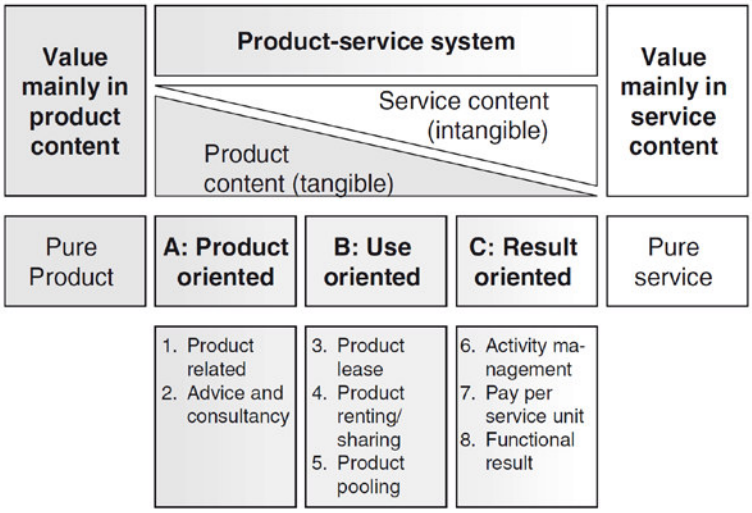


Figure 6. Main and subcategories of PSS(Tukker, 2004)

He argues that a PSS model allows firms to create new sources of added value and competitiveness, since they (Tukker, 2004):

- fulfil client needs in an integrated and customized way, hence allowing clients to concentrate on core activities,
- can build unique relationships with clients, enhancing customer loyalty, and
- can probably innovate faster since they follow their client needs better

Tukker aligns his eight archetypal models within three predefined categories of PSS which are further defined in table 2 (Tukker, 2004) :

- **product-oriented services**, where the business model is still mainly geared towards sales of products, but some extra services are added
- **use-oriented services**, where the traditional product still plays a central role, but the business model is not geared towards selling products. The product stays in ownership with the provider, and is made available in a different form, and sometimes shared by a number of users
- **result-oriented services**, where the client and provider in principle agree on a result, and there is no pre-determined product involved

Table 2. Eight types of PSS (own, adapted from Tukker,2004)

Product-oriented services	
1. Product-related service	
Characteristics: The service provider not only sells a product but as well other products and services required during the operation of a product.	Example: The producer of a good, e.g. a processing machine, does not only sell the machine but in addition to that as well a maintenance contract over a certain amount of time or the supply of consumables to operate the machine. These services can be as well less tangible like a take-back option when the machine reaches the end of life or a financing scheme to buy the machine.
2. Advice and consultancy	
Characteristics: The seller of a good not only sells the good, but in addition to that as well he gives advice in relation to the good and how it can be user the most efficient way.	Example: The consultancy options a company can offer don't necessarily have to be close related to the good like instruction of the operator of a machine. The service can, for example, be advice on how a customer's organisational structure can be optimized to use a product or how they can make their logistic more efficient.

Table 2. (continued)

Use-oriented services	
3. Product lease	
Characteristics: In a product lease, the producer or a third party has the ownership of the good and often is as well responsible for repairs and maintenance.	Example: The most popular example of a product least is the car lease. The lessee pays a regular, e.g. monthly fee to use a product. The customer normally has unlimited access to the leased good and can use it individually.
4. Product renting or sharing	
Characteristics: Like in the leasing, the producer or a third party keeps the ownership of the good and has responsibility for repair and maintenance. Unlike leasing, the customer doesn't have unlimited access to the good and has to share it with other users.	Example: Continuing the car example, by renting a car the customer doesn't have unlimited access to the good and has to share it. It can be either a car sharing platform or a traditional rental service.
5. Product pooling	
Characteristics: Product pooling is very similar to renting and sharing, but unlike these, in a product pooling service system the customers use the product simultaneously.	Example: An example for product pooling can be the sharing of a rented flat where some rooms are shared and simultaneously rented from more parties.
Result-oriented services	
6. Activity management/outsourcing	
Characteristics: In this PSS, an entire or a part of an activity is outsourced to an external partner. Most of this kind of services have performance indicator component to control the quality of the service. Having outsourced these activities normally doesn't really affect the company's other activities and the BM.	Example: Typical examples for outsourcing are for example office cleaning, web hosting or accounting services. By outsourcing such activities, the company can concentrate on its core business and is common practice in most companies.

Table 2. (continued)

7. Pay per service unit	
Characteristics: The 'pay per service unit' category contains many of the classical PSS. The product is still a vital component of the BM and is the basis of the PSS. The user doesn't have the ownership over the product and only pays for the use or output of the good. By doing so, the producer has the chance to optimal monitor the use of a product and can schedule maintenance in the best way.	Example: This category probably contains the most well-known PSS. It includes print per copy solutions in which the producer retains ownership over a product and the customer only pays for the copies. Similar to this, companies offer 'scans' of magnetic resonance imaging instead of selling the machine. Another often used example is the Rolls Royce's 'power by the hour' in which the company sells the hours their plane turbines are in the air.
8. Functional result	
Characteristics: A 'functional result' PSS gives the service provider the highest level of freedom on how he executes the job. The customer and the provider agree on a result which is not bound to a technological system and in theory, the provider is free on how he delivers the result.	Example: Popular examples of this kind of PSS are companies who don't sell pesticides, but rather the promise for a minimum harvest loss or instead of selling air conditioners; they sell specified solutions for a pleasant climate in the entire office.

As these examples show, by going from the first to the last of these PSS the reliance and focus on the product decreases. The more freedom the service provider has to execute a job, the more abstract the contracts become and the harder it gets to make sure the customer gets what he signed for (Tukker, 2004).

In his research, Tukker then defined four main common key elements for PSS.

The market value of a PSS can either be tangible or intangible for the consumer. If the PSS is designed to save money, time or resources for the customer, the objective value is highly tangible. To be successful in developed markets, PSS must not only offer tangible values but as well add subjective value like an extraordinary experience while using the good or a higher level of convenience. In the traditional way of producing goods, the costs of resources, time and capital are easier tangible than in a PSS. In a PSS a provider faces new uncertain costs when he for example in a result oriented PSS promises an outcome which is hard to predict. Another characteristic many PSS share is the higher capital needs and investments for a company. The provider as to produce the solution on his own expense before having the possibility to offer it. An example, therefore, is Rolls Royce's "power-by-the-hour" service in which they had to buy all the engines on the market before servicing them and almost got bankrupted by doing so. By strategically positioning themselves in the value network, the companies have the ability to catch not only the value in the present but as well in the future because the accessibility for the customer to the service is easier and the can contribute the customer's client loyalty (Tukker, 2004).

Tukker observes that the in an overall picture product-oriented services are the least radical ones and probably easily applicable by traditional product oriented firms. Use-oriented services are now also common business models, whereas product-renting, pooling, and sharing seem to have a relatively high chance of creating tangible and intangible client sacrifices. Within result-oriented services, activity management and pay per use are becoming more common (Tukker, 2004).

The key problem with these PSSs is the difficulty of agreeing with the user a set of good performance criteria, and the prediction of, or influence on, the behaviour of the user within reasonable margins. This risk element is particularly relevant for the functional result type of PSS, since the provider takes over all the liabilities that in a product-based system were with the user (Tukker, 2004).

Assessing the eight PSS on environmental impact, Tukker describes different sustainability characteristics as shown in figure 7. Generalized described, the higher the level of servitization, the higher the positive environmental impact (Tukker, 2004).

PSS type	Impacts compared to reference situation (product)				
	Worse	Equal	Incremental reduction (<20%)	Considerable reduction (<50%)	Radical reduction (<90%)
1. Product-related service		←----------→			
2. Advice and consultancy		←----------→			
3. Product lease	←----------→				
4. Product renting and sharing		←----------→			
5. Product pooling		←----------→			
6. Activity management		←----------→			
7. Pay per unit use		←----------→			
8. Functional result		←----------→			

Notes:
- Renting, sharing: radically better if impact related to product production.
- Pooling: additional reductions compared with sharing/renting if impacts related to the use phase.
- Renting, sharing, pooling: even higher if the system leads to no-use behaviour.

Figure 7. Tentative (environmental) sustainability characteristics of different PSS types (Tukker, 2004)

He concludes that although all PSS can have a positive environmental impact, they are not all suiting to serve radical solutions and the simple thinking that a PSS development will automatically result in an environmental–economic win–win situation also seems to be a myth. Further, he argues that although the environmental impact is not the highest, product-related services are the easiest for a company to implement. As well he states that PSS (i.e. product lease) can have an even worse environmental impact than traditional product sales (Tukker, 2004).

2.6. Review of Business Model Frameworks

The literature review on BMF is predominantly basing on online research and books, less on research papers. The reason therefor is that a significant amount on knowledge generated is gathered on experience less than academic research. Online search terms in English are “business model, business model mapping, business model framework, business model visualisation, business model canvas, business model canvas alternatives”.

To understand BMF as a term, first, a brief review of the term and characteristics of 'framework' is made. In a second step, the different BMF are differentiated by the researcher's definition of 'rigid' and 'flexible' BMF.

A rigid business model consists of a predefined amount of features, boxes or tasks that serve to visualize and conceptualize a BM. In opposite to that, a flexible BMF suggests a number of actors and actions that can be arranged as it pleases the user to visualize not only the characteristics but as well the value chain and flow.

2.6.1. Literature review on framework development

A BMF can be considered as a conceptual framework that assists as an analytical tool to make conceptual differentiations and help to organize ideas. Valid conceptual frameworks are basing on empirical, most often qualitative data. Maxwell defines it as a theory or model of phenomena under analysis that described how these phenomena work and why. He defines it in a broader sense as a system of assumptions, expectations, beliefs, theories, and concepts that support and inform research (Maxwell, 2012) .

As a tool, Shields and Tajalli argue that a conceptual framework can be used to organize the exploration of the problem at hand (Shields & Tajalli, 2006). Kumar and Antonenko point out, that one important feature of a conceptual framework from an instrumental point of view is that it is "something that is carefully assembled piece by piece by the researcher rather than identified as one, ready-to-use theory or model in the literature" (Kumar & Antonenko, 2014)

Jabareen goes one step further and argues that a conceptual framework possesses three dimensions of assumptions, the knowledge of how things are, how they really are and what they can tell us about the real world[4]. He depicts a conceptual framework as a network of interlinked concepts that together provide a comprehensive understanding of a phenomenon or phenomena.

Subsequent the seven features that define a conceptual framework according to Jabareen (Jabareen, 2009)are applied on the Business Model Canvas (BMC):

1. It shouldn't be a collection of concepts but a construct in which the applied concepts play an integral role in the business interaction between customers and partners in BMC.
2. It shouldn't be analytical but interpretative to reality which the BMC is hence it depicts the process of value delivery in an easy way.
3. It shouldn't offer a theoretical explanation but provide an understanding of something like the BMC offers the explanation of how a company creates, delivers and captures value.

[4] Conceptual frameworks possess ontological, epistemological, and methodological assumptions, and each concept within a conceptual framework plays an ontological or epistemological role (Jabareen, 2009) .

4. It shouldn't provide hard facts, but soft interpretations like the BMC, for example, shows revenue streams but not KPI.
5. It shouldn't try to predict the outcome like the BMC doesn't predict the outcome of the success or failure of a BM.
6. It should be constructed through a process of qualitative analysis like the BMC is the result of Osterwalder's dissertation.
7. It should consist of many theories that provide data like the BMC that is basing on many business strategies and case studies.

Basing on that non-exhaustive list of definitions of conceptual frameworks and the previous definition of business model the researcher defines a BMF as:

A tool developed and assembled based on qualitative data to help to organize the idea of how a firm does business. It enables the understanding of the interaction within the relationship network. Thereforee it interlinks the logic of creating, delivering and capturing value as it is in reality without trying to predict the outcome.

Based on that definition, the researcher decided for 9 different business models which are presented in the following two chapters in the tables 3-11. The decision to assess exactly these 9 BMF was based on different factors. First, they needed to be based on real cases and have validity or a track record. The BMF were chosen from different authors and different development approaches. They are aimed to depict BM from a very abstract level to a very detailed to show up the differences of possible ways to visualize a BM.

2.6.2. Rigid Business Model Frameworks

The description of the BMF show a thumbnail of the visualisation; a larger picture can be found in appendix 1.

Table 3. Description of the Business Model Canvas

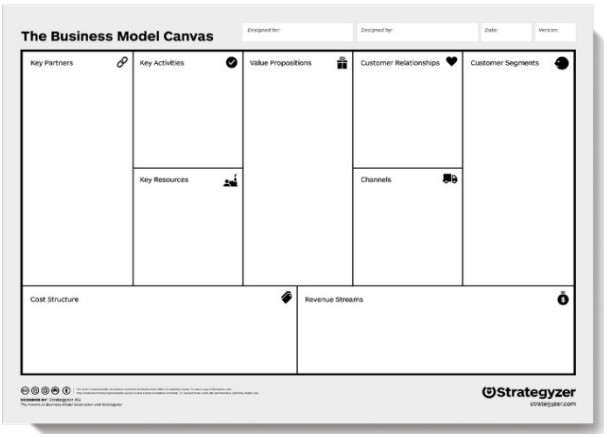
Business Model Canvas	
Origin	
Basing on his Ph.D. dissertation, Osterwalder and Pigneur designed the probably best known BMF. The template is built on similarities of a wide range of business model conceptualizations and characteristics. (Osterwalder & Pigneur, 2013)	
Description	
The BMF is made of 9 building blocks to describe how an organisation creates, delivers and captures value. These building blocks are organized in the categories infrastructure (key activities, key resources, key partners), offering (the value proposition), customers (customer segments, channels, relationship) and financial (cost structure, revenue stream).	

Table 4. Description of the Flourishing Business Canvas

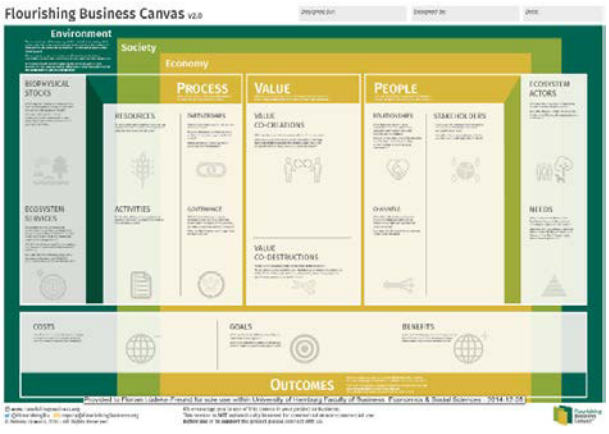
Flourishing Business Canvas	
Origin	
The Canadian researchers deconstructed the Business Model Canvas and re-assembled it by adding dimensions of sustainability thinking. They argue that the 9 building blocks of the Business Model Canvas help a company to “do well” but in order to “do good”, 5 more questions are required. (Upward, 2016)	
Description	
In order for a company to do “well” and “good”, only five more questions were added to the existing 9 of the business model canvas which resulted in the 16 new building blocks of the Flourishing Business Model Canvas that takes respect of economy, society and environment. The building blocks are valued co- creation and co-destruction, relationships, channels, stakeholders, ecosystem actors, needs, partnerships, governance, resources, activities, biophysical stocks, ecosystem services, goals, benefits and costs.	

Table 5. Description of the IBM's Component Business Model

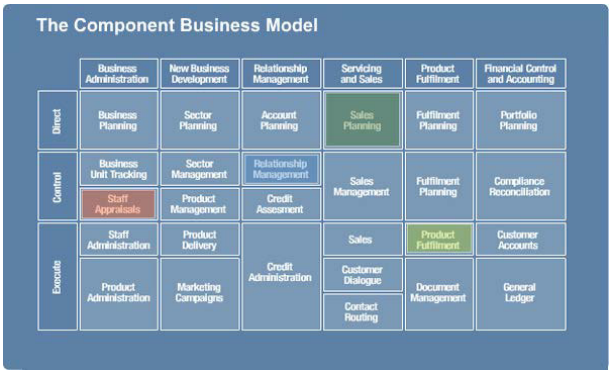
IBM's Component Business Model (CBM)	
Origin	
As part of its consultancy services, IBM developed the CBM to focus on the critical activities of business operations as a key to surviving against ever growing competition. (IBM, 2006)	
Description	
The BMF depicts the activities of the company on an operational level. Each of the 25 building blocks of the CMB is defined in five dimensions: business purpose, activities, resources, governance model and business services. It is very much technologically oriented and doesn't depict the values other BMF normally set the focus on.	

Table 6. Description of the Fluidmind framework for a successful business

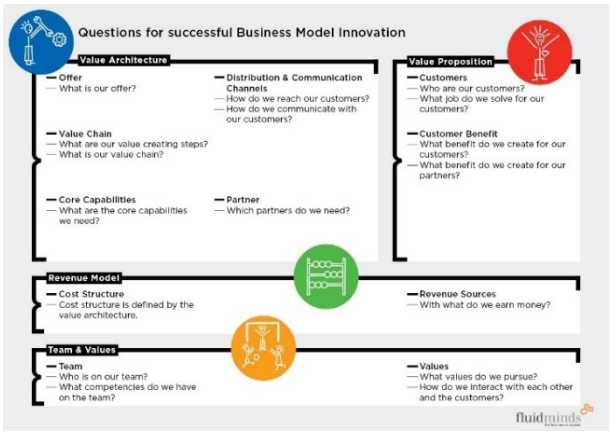
Fluidminds framework for a successful business	
Origin	
Patrick Stähler, a Switzerland-based business model innovation consultant and author developed the framework basing on his Ph.D. studies to define the value a company delivers. (Stähler & Hobcraft, 2013)	
Description	
The BMF sets the focus on a company's values, therfore it depicts the value proposition for the customer, but as well the architecture and the value chain. Unlike other BMF it as well shows the internal values of the company. In each building block except the revenue model, the BMF explores different aspects of the value creation.	

Table 7. Description of the VARIM model

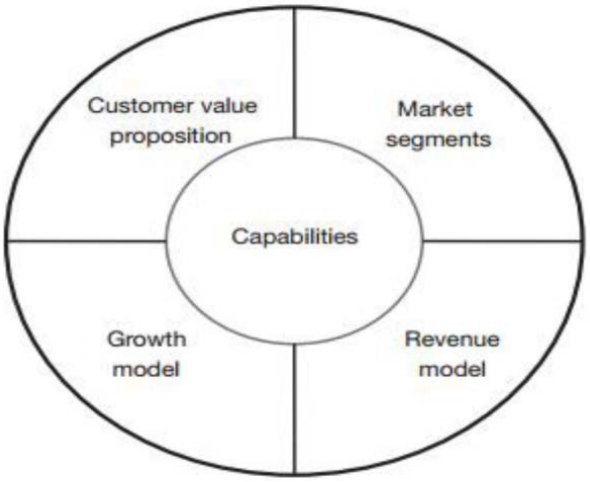
VARIM model	
Origin	
US-based author Allan Afuah focuses his research on case studies of business model innovation. In this context, he bases the success of a BM on a few components and states that a business model innovation is a recipe for creating and capturing value by doing things differently. (Afuah, 2014)	
Description	
Afuah argues that a BM is about making money, and the money comes from the customer, so in order to sell so the customer the company needs a good value proposition. To target that, the company needs to know the target market and how to structure the monetisation of these markets. To grow against competitors, the company needs to have a growth strategy. To execute all that, the company requires certain capabilities in for of resources and assets.	

Table 8. Description of the Business Model Navigator

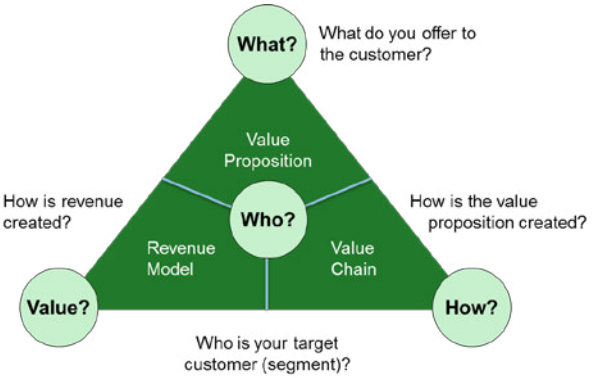
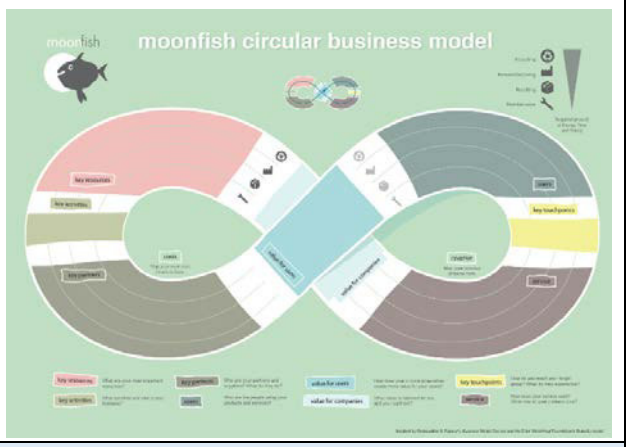
Business Model Navigator	
Origin	
The Business Model Navigator was developed at the University of St. Gallen, Switzerland. Basing on analysis of 250 BM, the researchers defined 55 BM patterns. These patterns all affect the BM components that are depicted in the very abstracted triangle different. (Gassmann & Frankenberger, 2014)	
Description	
The BMF focuses on answering four associated questions: explicating the target customer, the value proposition towards the customer, the value chain behind the creation of this value, and the revenue model that captures the value. By doing so, the business model of a company becomes tangible and easy understandable.	

Table 9. Description of the Moonfish circular business model

Moonfish Circular Business Model	
Origin	
Result of a master course at the Technical University Delft where students were set into the position of a design consultancy to develop a BMF for a BM following characteristics of the CE. (van Dort, 2014)	
Description	
The tool is based on Osterwalder & Pigneur's Business Model Canvas and the Ellen MacArthur Foundation's Circular Economy System Diagram showing thee different cycles of maintenance, reselling, remanufacturing and recycling. The model takes after the infinity symbol, in order to emphasize the ongoing process of circular business (it never ends). The smaller cycles require less time, money and energy. The value of the Circular Economy is embedded in each of the four cycles.	

Not assessed in this research is the Value Proposition Canvas, it is an addition to the Business Model Canvas and help precisely to define the product market fit of a BM. Besides the assessed alteration of the Business Model Canvas in tables 4 and 9, some Authors modified the Business Model Canvas in a different way. For the purpose of this research, they are not taken into consideration because they are either not concentrating on the circular economy or not distinct enough from the original Business Model Canvas. Osterwalder and Pigneur designed the Lean Canvas, as well basing on the 9 building blocks it is more focusing on action instead of resources. Nancy Bocken added the dimensions society, environment and economy to the value proposition to depict the different levels of sustainability within the Business Model Canvas. In the Value Model Canvas, Jeroen Krajjenbrink added the strategic values of a company and the key rivals to make it more market-related. Other authors added components to enhance supply chains, strategies and company values.

2.6.3. Flexible Business Model Frameworks

Table 10. Description of the Causal Loop Diagram

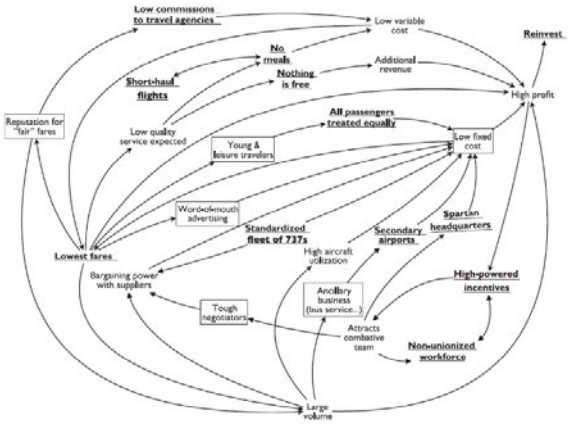
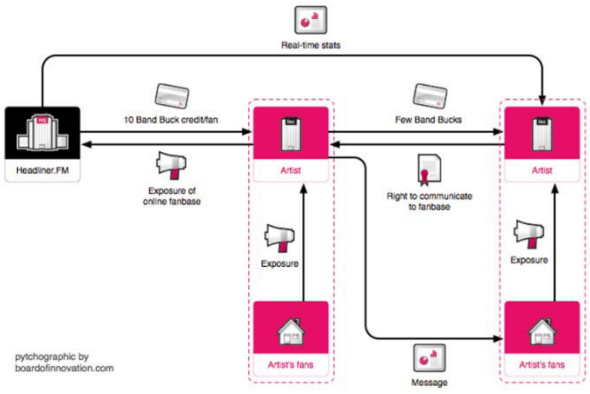
Causal Loop Diagram	
Origin	
Origin Causal loops have their origin in computer science to describe feedback loops for the result of output. They were later used to depict the outcome of an activity within a BM. Above all, successful business models generate virtuous cycles, or feedback loops, that are self-reinforcing. This is the most powerful and neglected aspect of BM. (Casadesus-Masanell & Ricart, 2011)	
Description	
The different variables in the BM are visualized as a set of nodes and edges. The nodes in that system represent the variables (e.g. the stakeholders or activities) and the edges represent the relation between those nodes.	

Table 11. Description of the Board of Innovation business model mapping tool

Board of Innovation business model mapping tool	
Origin	
Origin The Antwerp-based innovation consultancy developed a system of building blocks to visualize a company's BM in an appealing way. (BOI, 2016)	
Description	
The building blocks of this BMF are divided into 6 players and 10 objects of exchange. The players (or stakeholders) are the own company, any other company, consumers, suppliers, non-profit organisations and the government. Within these stakeholders, it is possible to exchange products, services, experience, exposure, reputation, money, discounts, data, rights and credits. The players are interlinked with arrows to show the flow of exchanged objects.	

3. Methodology

3.1. Research objectives and research questions

The initial position to carry out the research is basing on the following hypothesis statement:

Because current Business Model Frameworks are the result of e-business and direct selling business, they are not suitable for a Circular Economy and circular supply chains which show the need for new tools to visualize them.

The aim of this thesis is to evaluate whether current mapping tools for BM are suitable for PSS with closed loop supply chains or not and if not, which characteristics are not imaged in the existing frameworks. The assumption is that the existing frameworks are not suitable and if so, the result of the thesis is to define components for a new framework to map BM for PSS with closed loop supply chains and help new or existing companies to map their BM.

The main question the researcher seeks to answer in this thesis is:

Do existing BMF cover the information requirements for PSS BM within the CE?

To reduce the complexity of that one question, it can be analysed as two independent components. The first component is the BMF; the second component is the information requirement.

Using the definition of a BM mentioned earlier allows extracting the required components for a suitable framework. The researcher defined the term BM as an abstraction of the strategy of 'how a firm does business', capturing the heuristic logic of how a firm creates, delivers, and captures value through its activity and transaction system architectures, in concert with its boundary-spanning relationship network. This definition can as well be formulated in a few easy questions:

What does the company do (value), how does it do it (creates, delivers, and captures) and who is involved (boundary-spanning relationship network)?

To answer the main research question, the component "information requirement" it is broken down into three sub-questions investigating the "what, how and who" of the BM.

***Sub question 1**: Do existing BMF display the value delivered by a PSS?*

To investigate this question, data has to be gathered on what dimensions BM add value. These dimensions have to take sustainable aspects into concern as well. Answering this question helps find out shortcomings in "what does the company do." It is related to both the product and the service as well as tangible and intangible values.

Sub question 2: *Are existing BMF suitable to depict activities of a PSS?*

By answering this questions, the main challenges on activities of companies having closed loop supply chains are defined. It answers the question of "how does the company do business."

Sub question 3: *Do existing BMF cover the critical stakeholders for a PSS?*

The aim of this question is addressing the key partners in the value chain which characterise closed loop supply chains. It answers the questions on "who is involved in the business."

3.2. Research design

Collins and Hussey define different types and classification of research as shown in table 12 (Collis & Hussey, 2013) .

Table 12. Classification of research(Collis & Hussey, 2013)

Type of research	Basis of classification
Exploratory, descriptive, analytical or predictive research	Purpose of the research
Quantitative or qualitative research	Process of the research
Applied or basic research	Outcome of the research
Deductive or inductive research	logic of the research

According to their definition, "exploratory research is conducted into a research problem or issue when there are very few or no earlier studies to which we can refer for information about the issue or problem" (Collis & Hussey, 2013) . That is the case and purpose in this research hence both BMF and the CE are rather new fields of research. Further they explain, that "the aim of this type of research is to look for patterns and ideas and develop rather than test a hypothesis" (Collis & Hussey, 2013) which is the case for having a hypothesis statement as a starting point for the research

To assess the BMF, the empirical evidence is as they describe it based on "evidence or experience" which in this case is made by triangulating the literature and the expert's opinions. They outline that in this kind of research the researcher "will assess which existing theories and concepts can be applied to the problem or whether new ones should be developed" (Collis & Hussey, 2013).

As Collins and Hussey describe the process further, "the approach to the research is usually very open and concentrates on gathering a broad range of data and impressions and on gaining insights and familiarity with the subject area for more rigorous investigation at a later stage" (Collis & Hussey, 2013). Based on that statement, the exploratory research rarely provides precise answers to a problem as for this case it is a proposal for new components of a BMF.

The research approach is a quantitative process, basing on literature review, online search and interviews. To get the highest possible quality in data, the Triangulation[5] approach of using multiple sources of evidence is used. This approach allows to have a broader range of sources and decreases the risk of being biased and increase the chance of having convincing results. Of the four possibilities of triangulation, data triangulation, investigator triangulation, theory triangulation and methodological triangulation, only the first one is used as shown in figure 8 (Yin, 2013) .

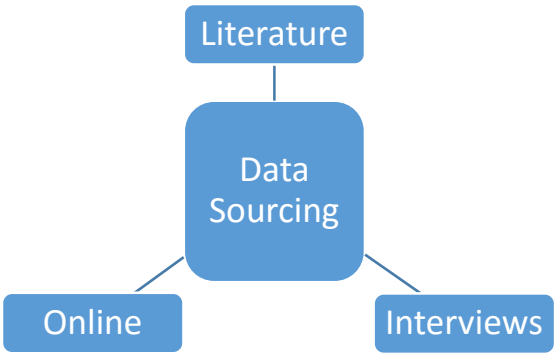


Figure 8. Triangulation of sources

It is an applied research studying and assessing what has been done so far and try to find the specific problem of missing components in BMF.

3.3. Procedure

The research is designed in a two-step approach to conclude findings to answer the research questions.

In a first step, based on the literature review on BM for the CE and PSS a set of questions is designed. These questions are to be answered by experts who are working or researching in the field of CE. The findings of these interviews are summarized in terms of values, activities and stakeholders.

In the second step of the research, the findings of the interviews serve as a basis for the analysis of the BMF. Therefore the main findings are transferred into a set of questions that help assess the BMF by scoring them with a numeric value. By summarizing the score of the individual questions, the BMF can be compared with each other and conclusions on their strength and limitations can be drawn.

Basing on these conclusions, the sub-questions and so the main research question can be answered, and further implications can be made as well as suggestions for further research can be given.

[5] The term triangulation does not mean that there have to be three components, it just has to be more than one source

3.4. Limitations and Delimitations

The **limitations** are the parameters within the research that can't be controlled by the researcher.

Hence, both the concept of BM, BMF as well as CE are rather new and fragmented, sources in these fields have to be interpreted with caution.

Many of the BMF are results of applied experience, rather than scientific research. That makes it difficult to rate them in terms of quality because they can be very valuable although they don't have a scientifically founded origin.

The CE is an entire concept, and the BM can vary, the research conducted is very generic. There is no such thing as "the Circular Economy Business Model", they vary from case to case and have to be assessed individual. Even if the BM are viable in theory, this is no surety for the operational and financial success.

The completeness of the research further is limited because of the limited time is given for such a comprehensive topic.

The **delimitations** are boundaries set by the researcher to define the objectives of the study. In contrary to the limitations, they can be controlled.

The focus of this research is laid on BM for companies providing services for either the B2B or B2C market. Therefor delimitation of the research is set to PSS. This includes either companies manufacturing and servitizing as well as BM for only servitizing.

The timeframe for the research is set on the last forty years for the CE and to the past 20 years of research on BM respectively. Obviously, hence new technological possibilities occurred within the past 10 years, the focus is set on the present and future, rather than the past.

To source the required information, the researcher follows a triangulation approach and gathers information from academic publications, online sources and interviews.

The focus of the academic publications is set on the works of Stahel and Tukker. CE thought leader Stahel pioneered in the 1970' with his work on cradle to cradle and is still one of the most respected researchers in the circular economy. Tukker's 2004 published work "Eight types of product-service system" is one of the most cited and general works on PSS and is used to categorise BM in this research. By focusing on these two authors, the researcher decides to concentrate on the most generic, although non-exhaustive sources.

To find and decide for the right interview partners, the researcher decides to set the geographical delimitations on central and northern Europe. The reason therefor is on one hand the fact that this region is the cradle of CE, on the contrary the

cultural behaviour is homogeny and leads to comparable results. To achieve different perspectives on the research topic, the interviewees are chosen from academia, consultancy and business.

BM can be described in various level of details. To generalise PSS, the researcher decides to take a very simplified description of value, activities and stakeholders.

The described delimitations lead to the preliminary conclusions that the expected findings will be highly generic and only to a certain extent applicable to all PSS BM in the CE.

4. Empirical findings

4.1. Interview design

As described in the methodology chapter, the researcher follows a triangulation approach that includes the sourcing of information based on qualitative interviews. Within the delimitations, the interview partners are chosen by answering the following four questions [6](Gläser & Laudel, 2010):

1. Who disposes over knowledge and required information?
2. Who is capable of giving precise answers?
3. Who is willing and allowed to share the required information?
4. Who of the possible informants is available?

These four questions are answered as following:

1. Practitioners and thought leaders, consultancies and researchers
2. Hence, the research field is a very young one, all in a senior level of experience can add value to the qualitative data sourcing
3. In concern of companies, most should be open to sharing their experience hence it is beneficial for their image showing their sustainable engagement. In addition to that, researchers should be open to that hence any new generation of knowledge in that field is beneficial.
4. To make the interview as available and easy as possible, the interview questions can either be answered during a call or meeting or offline on the experts' free time.

Out of the 20 inquired experts, the 9 following interviews introduced in table 13 agreed on participate in the interview.

Table 13. Interview partners

Name	Location	
Arnold Tukker	Netherlands, Leiden	Chair/professor of Industrial Ecology, CML, Leiden University, Professor of Sustainable Innovation
Peter Wells	United Kingdom, Cardiff	Professor, Cardiff University Cardiff Business School · Centre for Automotive Industry Research
Nancy Bocken	Netherlands, Delft	Associate Professor at TU Delft; Senior Research Associate at University of Cambridge
Florian Lüdeke-Freund	Germany, Hamburg	Postdoctoral Research Associate at the University of Hamburg, Chair of Capital Markets & Management,

[6] Translated from German into English by the researcher

Table 13. (continued)

Irina Tiemann	Germany, Oldenburg	Senior researcher at Carl von Ossietzky University Oldenburg and a member of the Oldenburg Center for Sustainability Economics and Management (CENTOS)
Michael Lieder	Sweden, Stockholm	Co-Founder CirBES, a 'change agent' supporting manufacturing industry to facilitate transitions from linear to circular systems
Arthur ten Wolde	Netherlands, Haarlem	Manager Public Affairs Circular Economy at De Groene Zaak, the leading Sustainable Business Association in The Netherlands
Jan Leyssens	Belgium, Gent	Program Manager at PLAN C, a Circular Economy think tank in Belgium
Sjoerd van der Zee	Netherlands, Eindhoven	Senior Project Coordinator at DLL, a global financial solution partner that supports the complete asset life cycle of products

The questions addressed to the interviewees are based and validated on the literature and therefore provide content validity. The questions asked were varying on the expert's field of expertise but generic about characteristics and obstacles of CE and PSS, value delivery, supply chains and activities and stakeholders of PSS business models. The majority of the questions asked were the same for all the partners which adds additional reliability. By answering the questions, the interviewees increase the reliability of the sourced data.

4.2. Findings

4.2.1. Findings on the Circular Economy concept

As a most important activity to enable a CE, the mindset of both suppliers and customers has to change – that's what all experts agree on. As the whole concept of the circular economy is a holistic view of systems thinking, it not only possible to change one company's business, the entire system around has to be changed as well. Not only the industrial ecosystem has to change, but the legal boundaries also have to be changed to support and enable different approaches to sustainability like Cradle2Cradle (Lüdeke). Not only the CE as a whole, as well the BM for a CE require a holistic view. A wider perspective is required and in contrast to traditional BM, the value creation has to be on an economic, environmental and social level and addressed not only to the customer but to stakeholders of the entire value chain (Tiemann).

Ten Wolde states that issue more concrete by addressing price incentives for CBM, circular public procurement and eco-design directives. Legislation has to be changed to both design and organisations. On one hand it has to benefit companies doing sustainable innovation, on the other new forms legal business structures are required to enable proper sustainable business models (Wells).

According to Lieder, the change towards a CE has to be industry driven as a top-down/bottom-up approach. The governments have to set the enabling boundaries, but the industry has to execute the change.

Wells assesses the concept of the CE more critical than other researchers and addresses the problem of overproduction and overconsumption. He argues that only by overthinking the way on how we think about value we can achieve a truly sustainable society. That problem is as well addressed by Bocken who argues that although society as a result of economic and environmental sustainability is better off has to think forward on the growth problematic which is strongly connected to a change of mindset. To address the issue of growth, Leyssans states that the economy must decouple the economic growth from the material use; this can be partly achieved by servicing product. In this context, Tukker argues, that because the product itself becomes a cost factor for the manufacturer, he has an incentive to execute the job in a most efficient way and use as few materials as possible which as a result reduces the consumption.

Tukker states what the majority of experts agree on, that it is required for our economy to grow in order to be stable. As Leyssans points it out, the economy doesn't have to change, the key is "keep the game, changing the rules". The benefit of a growth driven economy is the capability to force other market participants to change once the majority uses PSS.

Using new enabling technologies of the Industry 4.0 like IoT, Big-Data and digitalisation, it is possible to realize the transformation towards a CE, but it has to start with the change of the societies mindset (Lüdeke + Lieder). New production methods like additive manufacturing in combination with new business models (e.g. on-demand production) can help reducing the overproduction due to reducing the net production as Wells points out. Unfortunately, many mature companies don't know the technological possibilites and many industries are outdated because they concentrate on their old BM without looking into the future (Leyssans).

4.2.2. Findings on the values

The major change for a company in switching to PSS is the value delivered which is no longer in the form of a product but as a service (Lieder). One big challenge to be sustainable is to capture value for multiple stakeholders including society and environment as the main stakeholders and not only for the customer (Bocken). In addition to that, addressing and motivating the customer to be part of a PSS has to be made by making the value proposition better than existing ones, only make it sustainable most often won't be enough (Bocken). Leyssens states that delivering a successful PSS is a lot about design and states that the major problem is that often the service provider is a different than the manufacturer, so the product is not designed for a service.

The portion of sustainable interested customers is growing continuously, especially well-educated individuals care for sustainable values. Important to succeed as a company delivering sustainable values is to show up clear benefits, therefore the transparency of the entire value chain has to be ensured do gain credibility for the product (Tiemann).

Leyssans points out that a PSS BM works when it is more convenient than the existing solution and factors like experience, accessibility, convenience and reliability are very important for its success. He further states, that if the business doesn't work, it's not because the customer doesn't want to support sustainability, it's because the BM is bad designed.

Finally, it is about the willingness to pay, if the experience is better, then the customer is most likely willing to pay more. In contrary, if the experience a little less good but the price is significantly less, then the PSS can be successful as well (Tukker). Lüdeke states, that in many cases the traditional Porter strategies like differentiation (e.g. car2go) and cost leadership (cheap bus rides) still apply in PSS.

To be able to deliver value, it is more crucial to have a great customer experience than with product sales. Hence, PSS are new ways of doing business, the human interface towards a service (e.g. a mobile application) has to be faultless and the value proposition design has to be unique (Lüdeke).

According to Wells, a good PSS needs a very clear set of values, not only for the customer but as well for the internal stakeholders. This addresses the question of what the company wants to represent and how it wants to be noticed by external stakeholders. In this context, Leyssans argues that customers are not buying a product for the product, but for the story it tells and that is something any company has to realize and start with the "why" they do it. From a marketing perspective, a company shouldn't argue on why a product is more expensive, it should focus on how the competition realizes lower prices.

Ten Wolde specifies that and argues that the biggest value to be delivered to the customer is by offering a lower price, what automatically will lead to a change of the earlier mentioned mindset. As further points to convince customers of the benefit of a PSS ten Wolde lists ease of use, superior quality and demonstrating a long-term financial advantage for a total cost of use. These hard factors are according to him more reliable than appealing to the sustainable motivation of a customer hence that is not necessary existing.

To be successful in doing so, Tukker states that it is crucial to look carefully at the use cycle from a user perspective and find steps in the use of an artefact in which a customer is not fully satisfied. If nothing can be found and everything is optimal, then it might be better not change anything because of the risk of turning it negative.

Lieder states that to be able to deliver that value to the customer and generate the most profit for the company, the design has to change. In order to realize the

highest possible cash-in and an efficient service, the goods have to be designed accordingly to be durable for more loops (Lieder). On the other hand, by designing a product that just has to execute a job like bringing goods from A to B, the customer doesn't look into service irrelevant features like e.g. the colour of the car (Lieder).

The more manufacturers move from a product to a result oriented product-service combination, the more the risks are moving from the customer to the manufacturer. These can again be outsourced to third parties such as DLL as a financing institution (van der Zee). Lüdeke relativizes the problem of having a higher risk in a PSS and argues, that by owning the risk and being aware of it the company has the possibility to steer it and design the products accordingly to prevent it so the net risk for a company can be equal. Comparing to product sales, Leyssans points out that the risk is very dependent on the quality of the good, the higher the quality, the lower the risk. This fact fosters an incentive to produce higher quality products for servitization.

In general, the risk increases by offering a service instead of a product by taking risks they didn't have before, states Tukker. By keeping ownership of the product, the service provider can monitor and plan services ahead and offer better maintenance than a customer could do on his own. He points out, that the risk increases in particular when the customer doesn't take as much care as he would do when he would own the product, that is a well-documented phenomenon in car leasing. From a strategic point of view, he argues that companies can be put into danger if they agree and offer new kind of contracts with new uncertainties and are set into situations where they have the responsibility but can't control the risk.

4.2.3. Findings on the activities

While transforming a company from selling products to selling services, the whole organisation of a company has to shift towards a more service-oriented structure. Hence, the most crucial part in a PSS is ensuring the flawless delivery of the service, stronger capabilities have to be built in fields like e.g. customer service (Lieder). Tukker states that this success has a lot to do with organizational learning and using competencies to find partners for the new value chain. It, for example, takes completely different capabilities for a producer to billing a customer on a real-time basis than in batches[7] (van der Zee).

Van der Zee describes the process of a company introducing a PSS as a transformation, rather than a revolution. Companies have to start small and via incremental changes move increasingly from a product oriented to a result oriented solution thereby co-developing the right back office capabilities to manage the service offering after point-of-sale. He adds that manufacturers first have to make

[7] Real time billing for example is you tracking usage and invoice per month or per scan. Billing in batches on the other hand can be leasing cars and paying for 20.000 kilometers and once per year over- and underutilization is being re-charged.

sure that they get back their product before changing the design to modular products suitable for upgrades and refurbishment. This can be accomplished by service-based business models.

As van der Zee points it out, a company changing towards a PSS is advised to conduct a slight transformation from product-oriented services to use-oriented services and finally to result-oriented services and not switch directly from product sales to a result-oriented PSS. A key success factor here are the internal capabilities of a manufacturer a PSS after point of sale. Selling a service contract is not too difficult, but making sure you will not be managing it after point of sale manually in excel is frequently considering to be a challenge. Leyssans relativizes that and states, that If a company aims to land on a use- or result-oriented PSS, they shouldn't bother to waste time in first implementing a product-oriented PSS. He argues that It depends on what the initial reason for changing towards a PSS is, whether it is design or disaster. If the current situation is not hurting the company enough, it might be easier to change their business incremental and organic. The problem then is that the customer has to participate that journey as well and the risk exists that the company gets locked in and doesn't want to lose customers. More often a change in business design is made necessarily out of a disaster, e.g. the target audience isn't you target audience anymore. In this situation more radical changes are required and beneficial. Tukker reasons the same and states that it is possible to switch from product sales to a result oriented PSS, but that depends from case to case. Proven concepts have been that either a company sets up a subsidiary which operates as service provider or the company teams up with another company to build an entire new BM.

Companies have to internally change their policies and apply other, new management tools like Key Performance Indicators, forecasting tools and Customer Relation Management tools. According to Lieder these tools are not sufficient developed yet, because it is a young, unestablished way of doing business. To take the example of a sales person which in a product sales business is evaluated in number of sales, in a PSS he, for example, has to be measured in the dimension of customer satisfaction which requires new steering methods and different skills.

That as well applies to designers and engineers who in the past might have been great product developers but might lack in capabilities to build great services and products that are instead of made for a planned obsolesce are made for longevity (Lüdeke).

It is important for designers is that they realize that in a PSS it is no longer about shaping and colour of a product, a process or a BM; it is an entire strategy on how to deliver value states Leyssan. The change towards a CE is more a design challenge than anything else and the biggest problem is that many "unknown unknowns" have to be solved. For him, two crucial things have to be kept in mind. First, when designing a PSS, the "one size fits all doesn't exist. Second, a product can't be

designed in mutual agreement, if nobody is offended, nobody is interested anymore.

In regards to design and development, Lüdeke points on the double externality problem that every sustainable entrepreneur or company faces. They are facing two problems; first, because they want to deliver a sustainable product or service what might is related to higher cost. In addition to that spill-over effects occur, that means that the innovator takes risk and cost to develop a product and competitors can learn or copy it for free.

Addressing the issue of overproduction and as a result overconsumption, the companies "financial voice" shouldn't be the strongest one. To be really sustainable, the company's philosophy shouldn't simply be basing on growing but rather be a localized "machine" that doesn't require a minimum volume of production to be profitable (Wells).

Although the risk of return on investment is not that high and the long-term income of a PSS is steady, an important obstacle to overcome is the required pre-investment to set up a PSS (Leyssans). In operation, the financial habits and characteristics change as a whole which threatens the transformation towards a PSS. In a traditional B2B product sales the investment good often is at least partly pre-financed, whereas in a PSS the manufacturer might be required to finance the goods upfront (Bocken). Companies can outsource part of the operational elements and risks associated with servitization to a third party, therefore one increasingly sees that partnerships become more important the more you move towards result-oriented product service combinations (van der Zee)

To be more competitive, mature companies have to take a more agile approach originated in the start-up context. Hence, they (mature companies) have the financial possibilities to bear the risk and finance PPS projects within existing boundaries, they are likely to succeed in implementing a PSS as a pilot (Lüdeke+Bocken).

4.2.4. Findings on the stakeholders

Along with the change of the value proposition of the company and its activities, the interaction with its stakeholder's changes. Generalized, a PSS has more stakeholders than traditional sales business (Lieder).

Crucial for a company to be successful with a PSS is its acceptance that they are moving in the value chain. Traditionally, manufacturing companies are in the middle of the value chain, whereas they move down- or up-stream by transforming to a PSS (Lüdeke).

Wells points out that the relation between the customer changes completely, hence they switch from being just customers they become resources as well. Depending on the kind of service provided, a company can gain power against

suppliers hence they can realize economies of scale when offering a service to customers (Tukker).

The competition in PSS are more between “networks”, rather than between single companies. Ten Wolde reasons that with the fact that in a CE contracts are of longer duration. Based on that, he as well argues that the bargaining power of suppliers and customers get in line hence all participants work together instead of against each other. Having long term contracts and the possibility to analyse the customer’s behaviour data allows the company to make better strategic decisions (Tukker).

Leyssans argues that it is much easier to take away the ownership of a business customer than of a private individual hence they want their free will do decide what happens with a good and not only reason out of an economic perspective. In that context, he as well states that a company can have diminishing bargaining power in a peer to peer service system p2p service system where consumers become the provider of a service.

5. Analysis

In the foregoing chapters, two different bodies of literature, as well as expert opinions, have been investigated. First, business model frameworks and their origin have been displayed, in a second part characteristics of PSS within the CE were presented. In this chapter, the BMF are assessed basing on the sourced characteristics of PSS. The reviewed characteristics according to the research sub-questions are value, activities and stakeholders.

5.1. Characteristics for PSS

Based on the sources from the literature and the interviews, a set of 26 questions to assess the BMF were developed. These questions primarily base on characteristics of sustainable PSS; generic aspects of BM were not taken into consideration for the assessment. The questions are the following:

Questions on value

- Why is the company doing its business? What are the beliefs and reasons?
- Is the design strategy consistent for the service position as well as for the product (risk, durability, re-manufacturability)?
- Are the long-term financial benefits for the customer explicit?
- Are tangible and intangible values showed, not only for the customer but as well economic, environmental and social?
- Is the economic growth strategy decoupled from the material consumption?
- Does the BM build up incentives to reduce materials and energy and use resources most efficient?
- Is the experience, accessibility, convenience and reliability of the service better than the competition or product buy?

Questions on activities

- Are the financial activities including the financial stakeholders depicted?
- Are the activities shown for a manufacturer who provides service as well as for 3rd party service provider?
- Is the core business enough depicted (manufacturing or service provision)?
- Are the risks and cost of risks shown? Are the products designed to prevent risk?
- How is the performance of the service measured and assured?
- How many and which life cycles are shown (reuse, repair, remanufacture and technology upgrading)?
- Is it possible to protect IP to prevent spillover effects?
- How does the company collect customer data for consumer behaviour analysis?
- Do the activities realize material reduction e.g. on-demand productions?

- Does the company extend the offering or change the BM? Is it cannibalizing the existing business?

Questions on stakeholders

- It the remanufacturing facility local and not reliable on a minimum volume?
- How is the customer loyalty ensured?
- Are the financial stakeholders depicted?
- Does the company know the competitors and competing networks?
- Are the internal stakeholders depicted?
- Are different customer segments shown e.g. new customer vs. existing?
- Are the customer's resources as well and if, how is that shown?
- Is the company competing with other services or product sales?
- Is the company threatened by a 3rd party like P2P?

5.2. Assessing the BMF

To assess the 26 defined characteristics, the researcher rates each characteristic within each BMF. The numeric rating counts from 1 (characteristic not sufficient displayed) to 5 (characteristic very well displayed). By summarizing the single scores, the researcher is able to establish a statement about the suitability of the different BMF as shown in table 14. The bold numbers on the bottom of the table represent the BMF's ability to represent the assessed characteristics, whereas the numbers in italics on the right side of the table show the general representation of the characteristic within the different BMF. A bigger version of the table can be found in appendix 2.

Table 14. Assessment of the BMF

	Business Model Canvas	Flourishing Business Canvas	Component Business Model	Foudered BM Innovation	VARIM Model	Business Model Navigator	Mozaffar's Circular BM	Causal Loop	Board of Innovation	sum of scores	percentage of possible score
Value (max 35)	18	24	17	22	18	14	24	20	20	*177*	*56%*
Why is the company doing its business? What are the beliefs and reasons?	2	4	2	5	1	1	3	2	3	*23*	*66%*
Is the design strategy consistent for the service position as well as for the product (risk, durability, re-	3	4	4	4	3	3	4	4	2	*31*	*89%*
Are the long term financial benefits for the customer explicit?	4	4	2	4	4	3	3	3	3	*30*	*86%*
Are tangible and intangible values showed, not only for the customer but as well economic, environmental and social?	3	3	1	3	2	2	4	4	4	*26*	*74%*
Is the economic growth strategy decoupled from the material consumption?	1	2	3	2	4	1	2	2	2	*19*	*54%*
Does the BM build up incentives to reduce materials and energy and use resources most efficient?	2	3	2	2	1	2	4	3	4	*23*	*66%*
Is the experience, accessibility, convenience and reliability of the service better than the competition or product buy?	3	4	3	2	3	2	4	2	2	*25*	*71%*
Activities (max 50)	27	34	34	31	28	23	32	35	35	*279*	*62%*
Are the financial activities depicted?	5	5	4	4	4	4	4	5	5	*40*	*80%*
Are the activities shown for manufacturer who provide service as well as for 3rd party service provider?	3	3	4	3	3	3	3	4	4	*30*	*60%*
Is the core business enough depicted (manufacturing or service provision)?	3	4	4	5	5	3	3	3	4	*34*	*68%*
Are the risks and cost of risks shown? Are the products designed to prevent risk?	2	3	3	3	2	1	3	4	2	*23*	*46%*
How is the performance of the service measured and assured?	2	4	5	3	2	2	2	3	3	*26*	*52%*
How many and which life cycles are shown (reuse, repair, remanufacture and technology upgrading)?	2	2	2	2	2	2	5	3	4	*24*	*48%*
Is it possible to protect IP to prevent spill over effects?	4	4	3	3	3	2	3	3	3	*28*	*56%*
How does the company collect customer data for consumer behavior analysis?	3	3	3	4	3	2	4	5	5	*32*	*64%*
Do the activities realize material reduction e.g. on-demand productions?	2	4	3	2	2	2	3	3	2	*23*	*46%*
Does the company extend the offering or change the BM? Is it cannibalizing the existing business?	1	2	3	2	2	2	2	2	3	*19*	*38%*
Stakeholders (max 45)	26	30	24	24	23	19	27	29	28	*230*	*57%*
It the remanufacturing facility local and not reliable on a minimum volume?	3	3	4	2	2	3	4	2	2	*25*	*56%*
How is the customer loyalty ensured?	4	4	3	4	3	3	4	4	4	*33*	*73%*
Are the financial stakeholders depicted?	4	4	3	4	3	3	3	5	5	*34*	*76%*
Does the company know the competitors and competing networks?	1	2	2	1	1	1	2	2	2	*14*	*31%*
Are the internal stakeholders depicted?	3	4	4	5	1	1	2	4	3	*27*	*60%*
Are different customer segments shown e.g. new customer vs. existing?	5	5	2	3	5	3	3	4	4	*34*	*76%*
Are the customers resources as well and if, how is that shown?	4	4	2	3	4	3	5	4	4	*33*	*73%*
Is the company competing with other services or product sales?	1	2	2	1	2	1	2	2	2	*15*	*33%*
Is the company threatened by 3rd party like P2P?	1	2	2	1	2	1	2	2	2	*15*	*33%*
sum of scores	**71**	**88**	**75**	**77**	**69**	**56**	**83**	**84**	**83**		
percentage of possible score	**55%**	**68%**	**58%**	**59%**	**53%**	**43%**	**64%**	**65%**	**64%**		

The different BMF all show unique characteristics and for each business case and situation every single one of them can be useful. Basing on the analysis made in table 14, table 15 summarizes the main strength and limitations of the assessed BMF.

Table 15. Strengths and limitations of the assessed BMF

+ Strength	**- Limitations**
Business Model Canvas	
+ The financial aspects of the BM can be well depicted hence cost, revenue stream, and key partners are part of the BMF + The customer segments and the customer binding can be depicted by using the customer relationship and the customer segment components of the BMF	– Aspects of the growth strategy, as well as the sustainability strategy, can hardly be imaged – The BMF only concentrates on the company and the customer, not on other stakeholders and not even competition – Operational and financial risks are hardly depicted in the BMF
Flourishing Business Canvas	
+ The motivation and the reason why the company does business, and especially sustainable business is shown in that BMF + The BMF takes resources and the design into consideration and depicts material use + Many different stakeholders, as well the internal ones, are imaged in this BMF	– The competition is merely depicted in this BMF – The decoupling of growth-strategy or the growth strategy as a whole is missing
Component Business Model	
+ The activities on each level can be depicted very well, not only internal but as well to the customer + It is possible to show the strategy on different levels + Financial stakeholders and activities can be depicted well	– The BMF hardly shows any relation to value creation, only on activities and stakeholders – Competition and market aspects are very insufficient represented – The framework only concentrates on the customer, in no dimension on other stakeholders
Fluidmind BM Innovation	
+ This BMF concentrates very much on value and depicts not only the customers value but as well the internal values and reasons for making business + It concentrates very much on the core business and activities but still leaves the possibility to show other stakeholders and activities + The customer value propositions, as well as the customer binding possibilities, can be well shown	– The BMF only concentrates on internal activities and not at all about competition – Activities to reduce resource consumption can be depicted but are fairly sufficient – Only to a certain extent suitable do show up different lifecycles of a product

Table 15. (continued)

VARIM Model	
+ The BM growth strategy, although not necessarily sustainable, is depicted in this BMF + The BMF sets the core capabilities of the company in the centre of all other actions + Different customer segments can be well imaged	– The value dimension of the BMF only concentrates on the customer, not on other stakeholders – It shows no incentives to be sustainable or reduce resources in any way – The risks and completion of the BM are not shown at all in this BMF
Business Model Navigator	
+ The revenue and value components are depicted in this BMF + The value chain can be described well in the BMF	– Operational activities are missing to a big extend – The competition and market-strategy are not depicted well – The values are only concentrating on the customer and not on other stakeholders
Moonfish Circular BM	
+ The different lifecycles of a CE-Product are very well depicted + The whole value strategy including design can be shown using this BMF + It shows the value for different stakeholders, not only for the customer	– The growth strategy as wells as the decoupling of resources is not mentioned in the BMF – The competition with new or existing markets is not shown in this BMF
Casual Loop	
+ The BMF allows depicting the financial activities and its stakeholders very well + Internal and external stakeholders and the activities integrating them in the BM can be imaged in a high level of detail + The different lifecycles of a product and the activities to handle them can be depicted very well	– The BMF depicts on a very operational level, the strategic aspect, and the mission are not depicted – The BMF concentrates on value adding stakeholders and not on competitors and markets
Board of Innovation	
+ The different values for the stakeholders can be imaged well in this BMF + All the stakeholders as well the interlinking activities are easy and well interpretable shown + Different customer segments and the products therefor can be easy shown + It is possible to show the different lifecycles of the product as well as manufacturing and service proposition	– The strategy component can hardly be imaged easily hence the BMF concentrates on the activities – The BMF doesn't take competition into consideration – Risks can't easy be shown because they are no activities, only maybe risk reducing activities can be depicted

6. Conclusion and implication

6.1. Answering the research question

Within the given limitations and the delimitations chosen by the researcher, the two-step research approach presented in the methodology chapter was conducted and allows to draw conclusions to answer the sub-research questions.

Among other reasons, the limited viability of the analysis and so on the answered research question are because of:

- Only a limited amount of BMF were assessed
- Only the researcher assessed the BMF
- The questions for the assessment were only developed by the researcher
- The questions were all weighted the same despite some of them are more important

As already mentioned in the methodology chapter, the described limitations and delimitations lead conclusions, that the findings are highly generic and only to a certain extend applicable to all PSS BM in the CE.

***Sub question 1**: Do existing BMF display the value delivered by a PSS?*

The aim of this question was to find out if the assessed BMF display sufficient levels of value, especially taking the aspects of environmental, social and economic sustainability into consideration.

As the evaluation showed, the value proposition is central in all assessed BMF. Unfortunately, in most of the BMF, only the value for the customer is displayed, and other stakeholders are missed out. Most of the BMF rarely show a strategic component of the BM, only an operational. That includes the fact that within the assessed BMF it is hard to represent incentives on resource conservative growth strategies, and the related sustainability aspects are hard to visualize. Within a PSS, the design strategy and the characteristic of the product that is offered as a service is a vital ingredient for the success of the BM. In all of the BMF, these 'hard' characteristics for a product are left out.

Basing on these arguments, the question if the assessed BMF display the value delivered by a PSS has to answer with no.

***Sub question 2:** Are existing BMF suitable to depict activities of a PSS?*

The aim of this question was to find out if the assessed BMF depict the main challenges on activities for companies having PSS.

The assessment of the BMF demonstrated that the financial activities in terms of revenue streams and costs are depicted well, to find faulty is the visualizing of risks both financial and operational. The Even if the BMF show is suitable for imaging product sales, they are hardly useful to depict multiple lifecycles of a product integrating reuse, repair, remanufacture and technology upgrading. In addition to that, depending on the company a PSS consists of two independent activities, the product manufacturing, and the service offering. The assessed BMF are only to a certain extend suitable to depict these different and complicated activities. Hence, one of the main advantages of a PSS is an enhanced customer loyalty, this aspect should be covered more (e.g. gathering customer data).

Basing on these arguments, the question if the assessed BMF depict the activities of a PSS has to be answered with no.

Sub question 3: *Do existing BMF cover the critical stakeholders for a PSS?*

The aim of this question was to find out if the assessed BMF show the required stakeholders for companies with PSS.

By assessing the 9 BMF, it turned out that the majority of them are well suiting to depict the stakeholders for PSS. To a certain extend they as well show up the possibility to show not only the external but as well the internal stakeholders, the manufacturing facilities can be visualized although it is hard to show their capability to be dependent on economies of scale. In a PSS, the customers become suppliers and resources as well what is possible show in most of the BMF. They all give the possibility to depict different customer groups and market segments but in all of them an option for the completion is missing. Hence, the competition as a component for a BMF is missing in all of the frameworks, the assumption is close that the experience so far showed that it is not required.

Basing on these arguments, the question if the assessed BMF cover the critical stakeholders of a PSS has to be answered with yes.

Do existing BMF cover the information requirements for PSS BM within the CE?

The answering of the main research question of this thesis is basing on the results of the three sub-questions. Hence, two of these three sub-questions are answered with no, the tendency leads to the conclusion that the main research question has to be answered with no as well. As a result, the presented hypothesis statement, that current BMF are the result of e-business and direct selling business and there for not suitable for CE can be verified.

6.2. Further research

As stated in answering the research question, the existing BMF are not suitable for PSS within the CE. The findings of the interviews and the result of the analysis showed that key features of such BM are missing at all, and therefor the need for new management tools in that field is proven.

Hence, the transformation from a linear to a circular BM is a challenging process, it would be beneficial to not only show up the 'new' BM but as well the transformation steps towards that BM, that aspect has not been considered in this research.

Future research basing on this thesis can include following aspects:

- Assessing more BMF and assessing them with other criteria's
- Assessing other BM of the CE and not only PSS
- Validate the results of the analysis with experts to have a triangulation of investigators
- Modelling a new framework and test this with cases

The implication of the results delivered by this research can be broken down into four dimensions:

- From a theoretical perspective, the outcomes showed up that the managerial toolkits for the CE are not yet sufficient. It takes effort from both academia and practitioner to enable companies to develop new tools to enable a CE. The findings give a starting point for further research in this area and show up a research gap in this field.
- As a practical implication, the findings show that some BMF is more suitable than other for BM in the CE. It has to be highlighted, that the Business Model Canvas is not suitable for all types of BM and just because it is the most known, it is worth to look around for more suitable tools.
- Although there are no direct implications for policy, the findings of the interviews showed that legislators have to do their homework and look for incentives to change towards a CE. This, for example, includes new legal bodies and incentives for a more sustainable production.
- The methodological approach basing on a two-step procedure can be adapted for any further research on frameworks, not only BMF but all kind of managerial tools.

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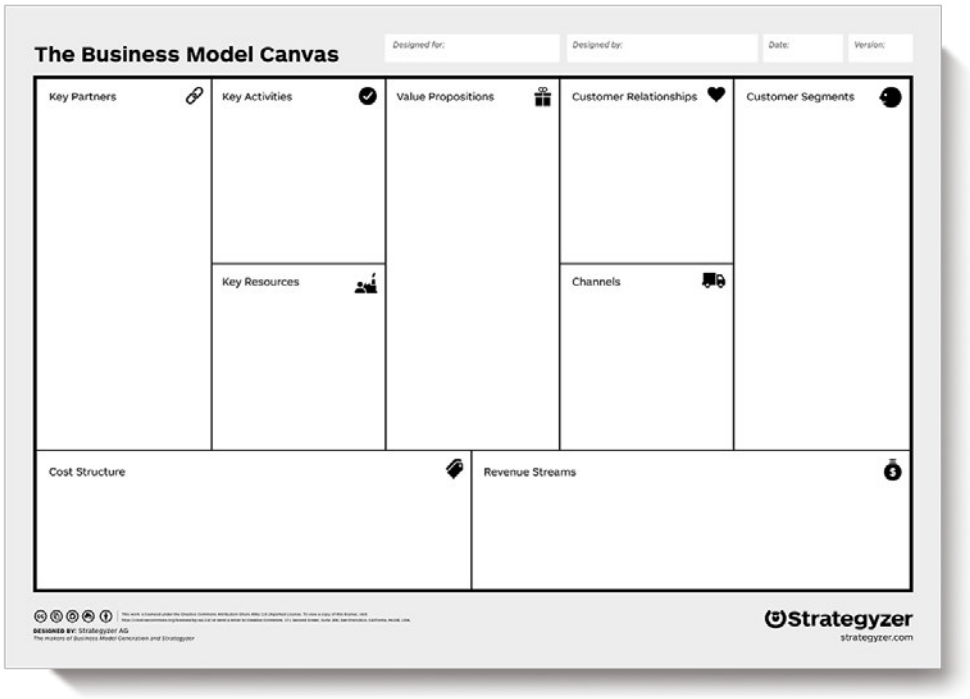
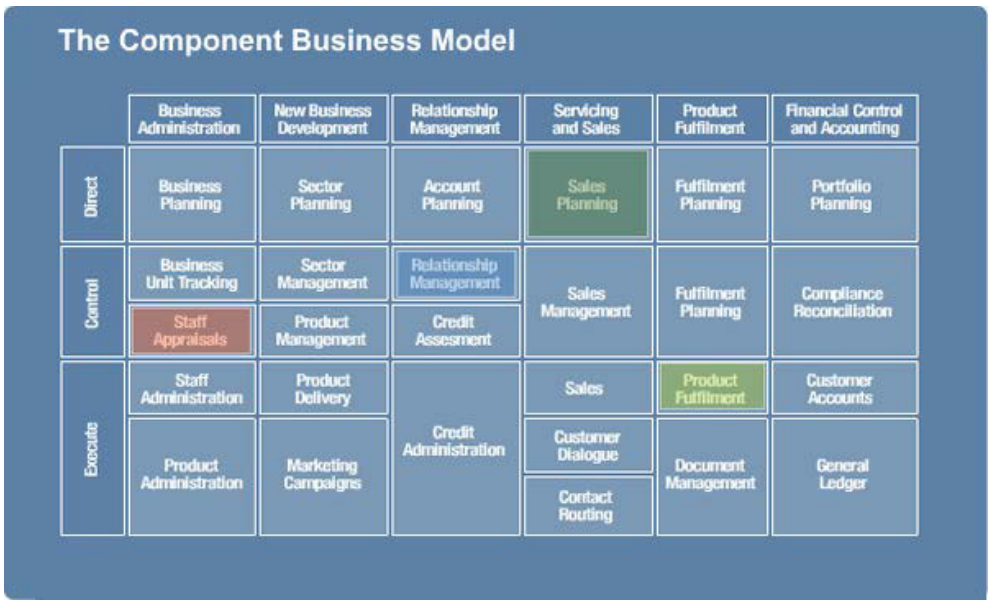
Appendix 1: Business Model Frameworks

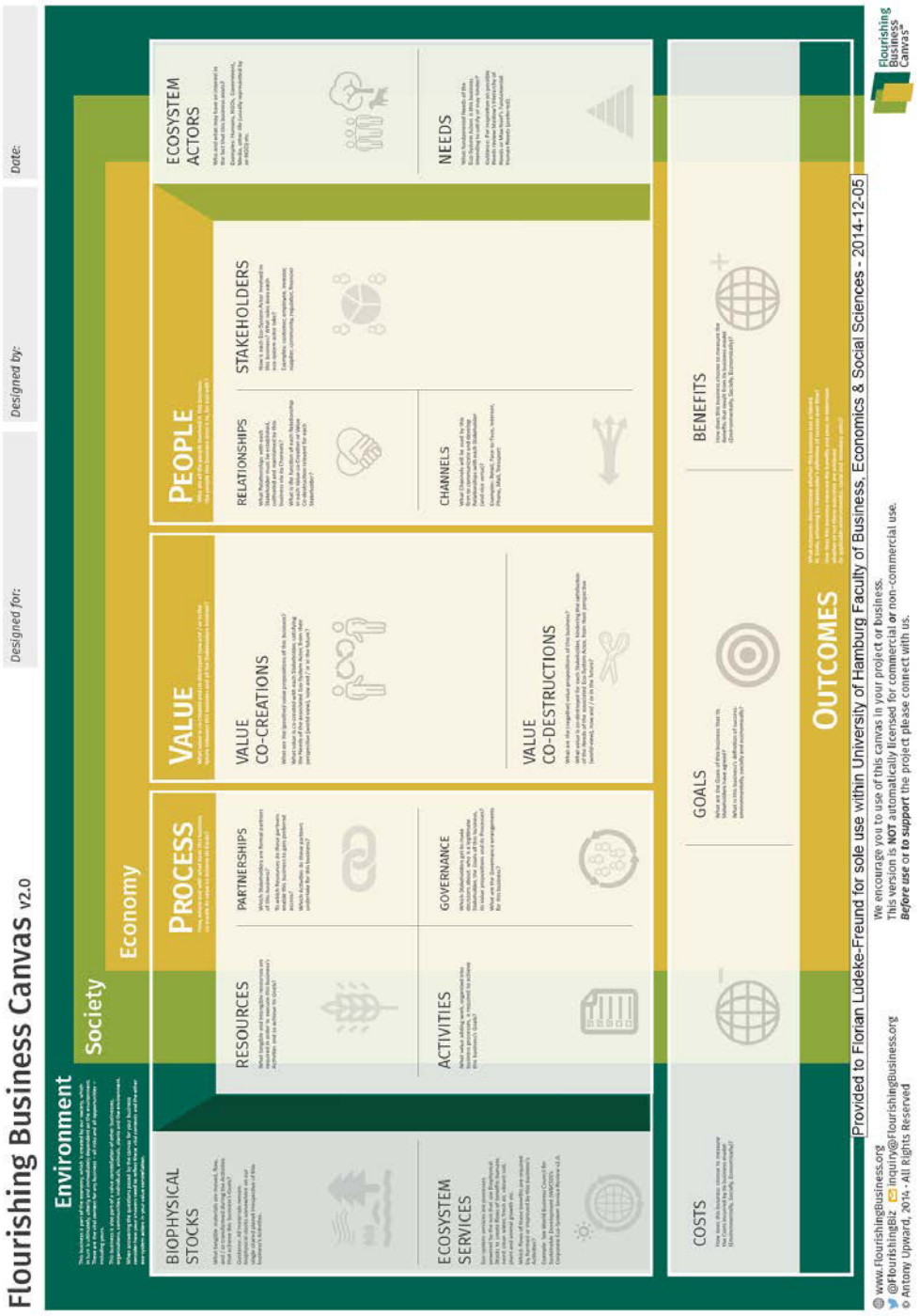
Business Model Canvas



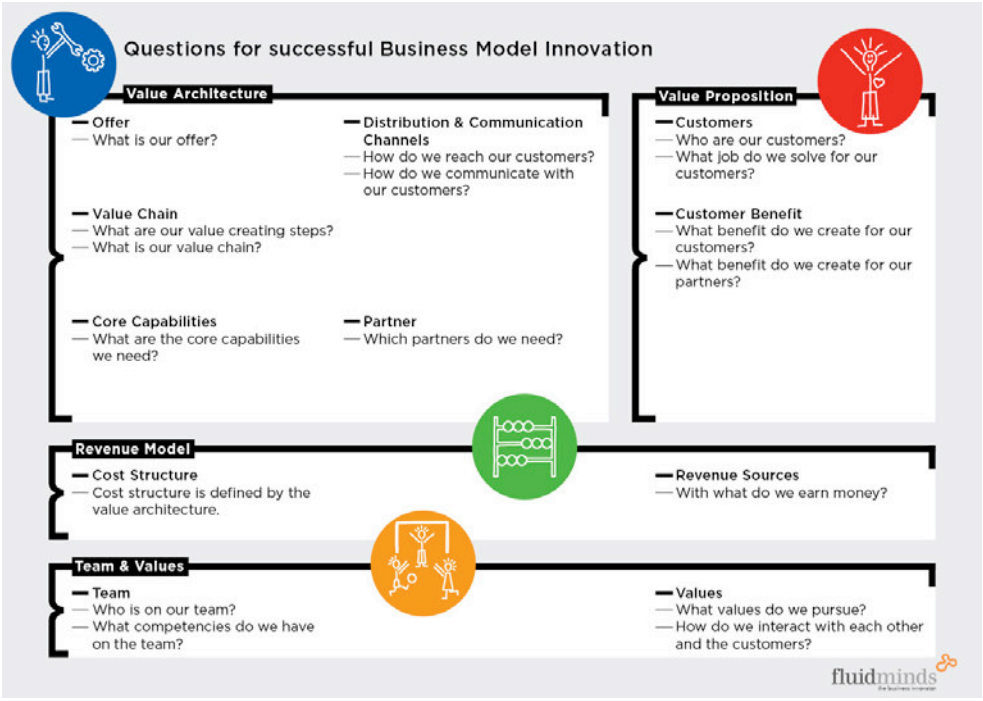
IBM's Component Business Model (CBM)



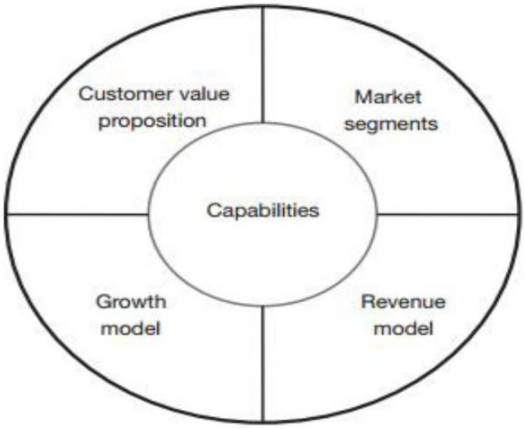
Flourishing Business Model



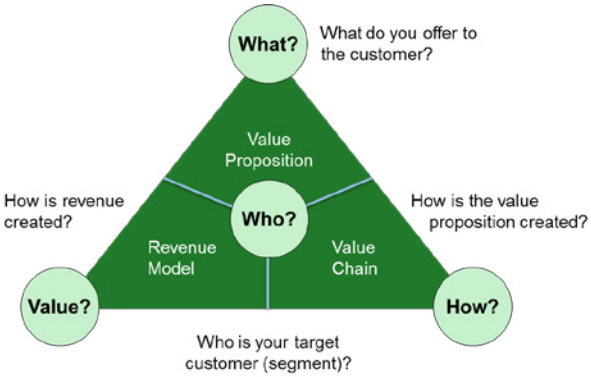
Fluidminds framework for a successful business



VARIM model



Business Model Navigator



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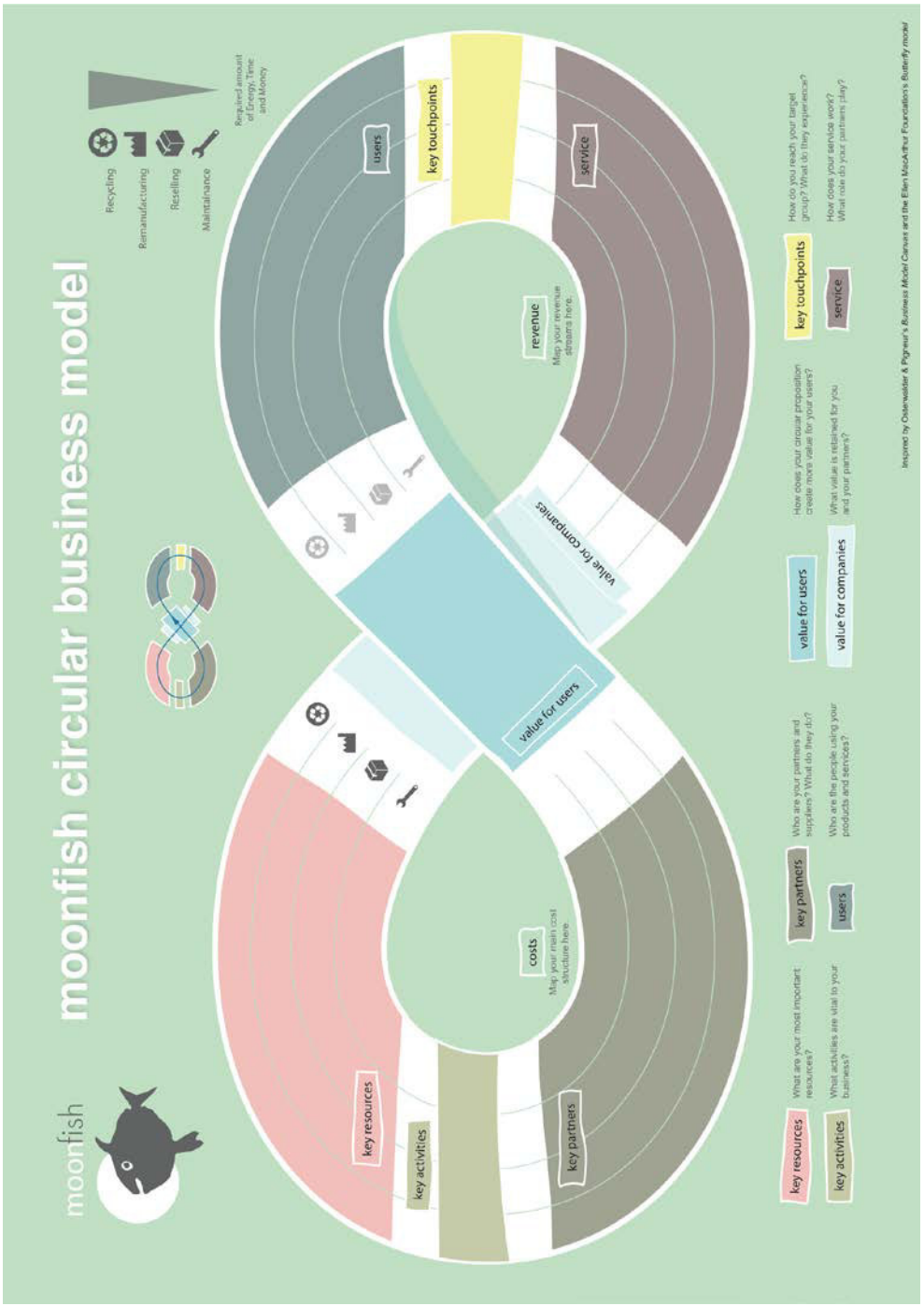
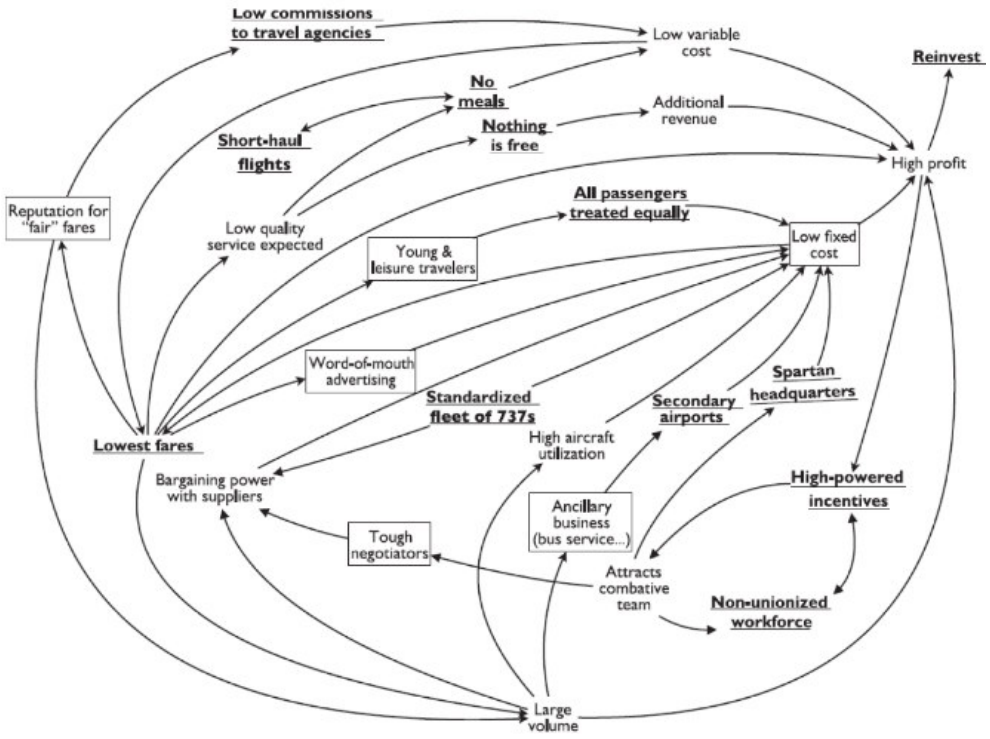
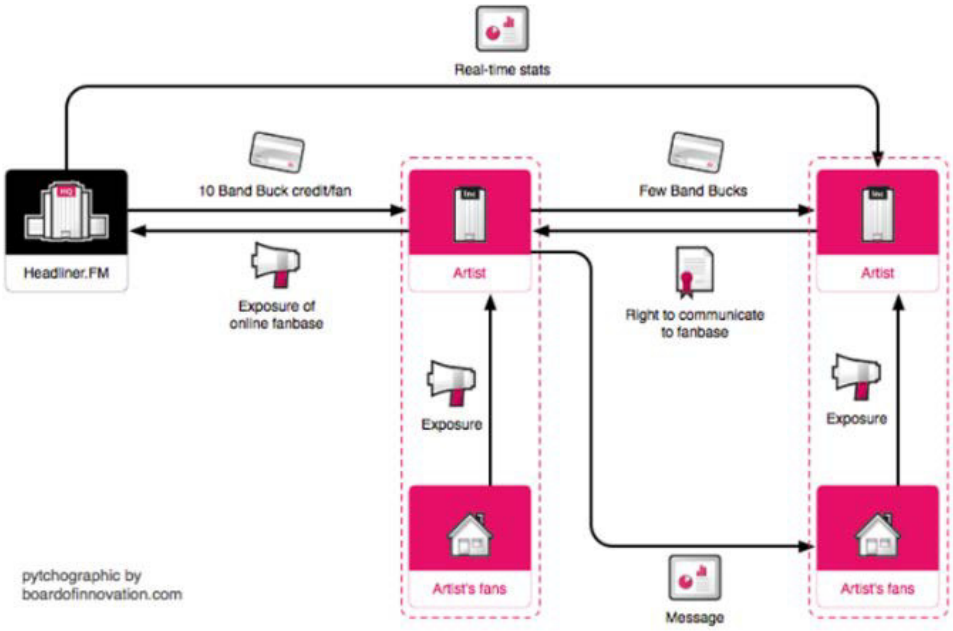
Moonfish Circular Business Model



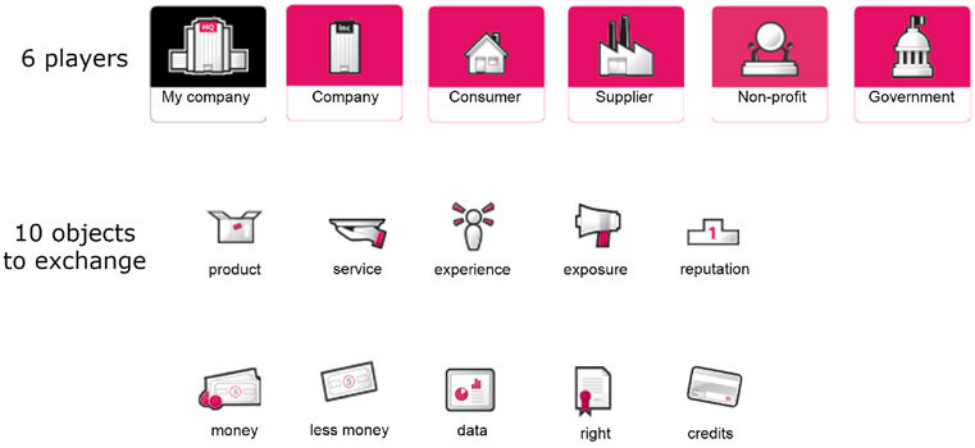
Causal Loop Diagram (Example of Ryanair's Business Model)



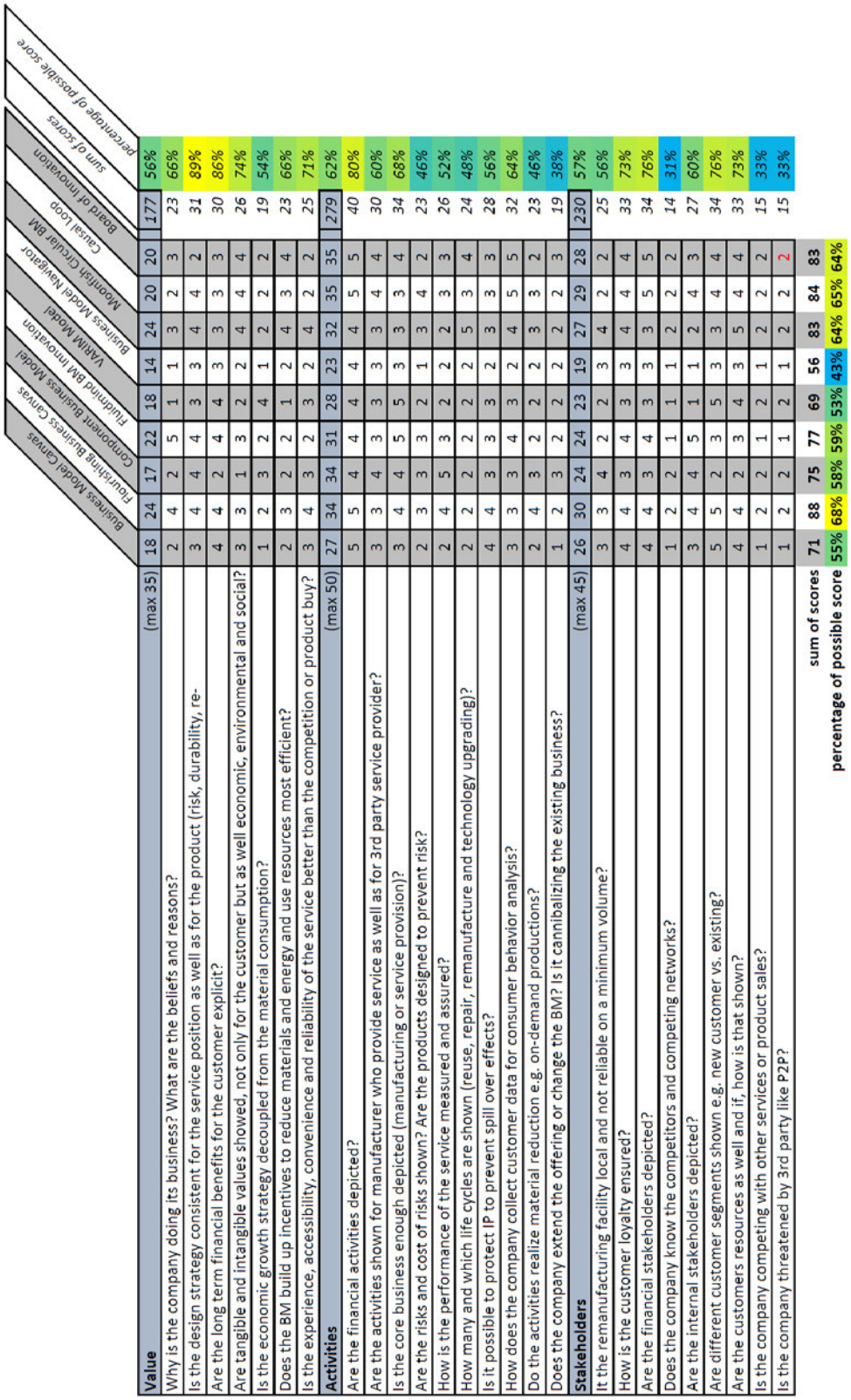
Board of Innovation business model mapping tool (Example)



Board of Innovation business model mapping tool (Players and Objects)



Appendix 2: Assessment of the BMF



Value	(max 35)	18	24	17	22	18	14	24	20	20	177	56%
Why is the company doing its business? What are the beliefs and reasons?		2	4	2	5	1	1	3	2	3	23	66%
Is the design strategy consistent for the service position as well as for the product (risk, durability, re-		3	4	4	4	3	3	4	4	2	31	89%
Are the long term financial benefits for the customer explicit?		4	4	2	4	4	3	3	3	3	30	86%
Are tangible and intangible values showed, not only for the customer but as well economic, environmental and social?		3	3	1	3	2	2	4	4	4	26	74%
Is the economic growth strategy decoupled from the material consumption?		1	2	3	2	4	1	2	2	2	19	54%
Does the BM build up incentives to reduce materials and energy and use resources most efficient?		2	3	2	2	1	2	4	3	4	23	66%
Is the experience, accessibility, convenience and reliability of the service better than the competition or product buy?		3	4	3	2	3	2	4	2	2	25	71%
Activities	(max 50)	27	34	34	31	28	23	32	35	35	279	62%
Are the financial activities depicted?		5	5	4	4	4	4	4	5	5	40	80%
Are the activities shown for manufacturer who provide service as well as for 3rd party service provider?		3	3	4	3	3	3	3	4	4	30	60%
Is the core business enough depicted (manufacturing or service provision)?		3	4	4	5	5	3	3	3	4	34	68%
Are the risks and cost of risks shown? Are the products designed to prevent risk?		2	3	3	3	2	1	3	4	2	23	46%
How is the performance of the service measured and assured?		2	4	5	3	2	2	2	3	3	26	52%
How many and which life cycles are shown (reuse, repair, remanufacture and technology upgrading)?		2	2	2	2	2	2	5	3	4	24	48%
Is it possible to protect IP to prevent spill over effects?		4	4	3	3	3	2	3	3	3	28	56%
How does the company collect customer data for consumer behavior analysis?		3	3	3	4	3	2	4	5	5	32	64%
Do the activities realize material reduction e.g. on-demand productions?		2	4	3	2	2	2	3	3	2	23	46%
Does the company extend the offering or change the BM? Is it cannibalizing the existing business?		1	2	3	2	2	2	2	2	3	19	38%
Stakeholders	(max 45)	26	30	24	24	23	19	27	29	28	230	57%
It the remanufacturing facility local and not reliable on a minimum volume?		3	3	4	2	2	3	4	2	2	25	56%
How is the customer loyalty ensured?		4	4	3	4	3	3	4	4	4	33	73%
Are the financial stakeholders depicted?		4	4	3	4	3	3	3	5	5	34	76%
Does the company know the competitors and competing networks?		1	2	2	1	1	1	2	2	2	14	31%
Are the internal stakeholders depicted?		3	4	4	5	1	1	2	4	3	27	60%
Are different customer segments shown e.g. new customer vs. existing?		5	5	2	3	5	3	3	4	4	34	76%
Are the customers resources as well and if, how is that shown?		4	4	2	3	4	3	5	4	4	33	73%
Is the company competing with other services or product sales?		1	2	2	1	2	1	2	2	2	15	33%
Is the company threatened by 3rd party like P2P?		1	2	2	1	2	1	2	2	2	15	33%
	sum of scores	**71**	**88**	**75**	**77**	**69**	**56**	**83**	**84**	**83**		
	percentage of possible score	**55%**	**68%**	**58%**	**59%**	**53%**	**43%**	**64%**	**65%**	**64%**		