HOW DOES MOVING FROM PRODUCT TO SERVICE SYSTEMS AFFECT BUSINESS MODELS?

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Abstract

Circular economy is seen more and more as a solution to natural resource exhaustion and as a potential economic superior system. A way of achieving a circular economy is through business model innovation. However, how exactly circularity affects models is still a fragmented subject in research. This bachelor thesis focuses on service systems as a way to achieve circular economy. Specifically, the Fairphone as a service model is used to assess how moving from a product to a service system affects business models. The literature is compared to the empirical material acquired from Fairphone through business model innovation. Evaluation of this process showed that innovation to service systems requires deeply involved stakeholders and continuous reassessment to counter barriers that occur. The outcome of the innovation is evaluated using a business model canvas, which offers an exhaustive view and provides insights into how business models are affected when moving to a service system. This in short showed that most notably the value proposition, channels, customer relations and the cost structure are affected. Additionally, it is suggested that government intervention may be required to advance the development of circular economy.

1. Introduction

Our economy has been predominantly linear for years. What characterizes linear economy is its flow of resources, which can be summarized as a take-make-dispose system. This entails taking the resources that are needed for production, making the products that are to be sold, and disposing of everything that is unnecessary, including any product at the end of its lifecycle (Sariatli, 2017). This yields an enormous amount of waste in both resources and production energy. The Ellen MacArthur Foundation (2013) state that at this rate, the economy is inevitably going to be constrained in its supplies. The **circular economy** (CE) has the aim to redesign this linear economy to one that can preserve environmental and economic value over time, based on flows of resources that are circular, or closed-loop, rather than the current linear flow (Stahel, 1994). This closed-loop flow can strongly improve resource efficiency and has the potential to reduce material inputs needs by 17-24% by 2030, potentially preventing a situation where supplies are limited (Meyer, 2011).

A way of realizing circular economy for companies is to implement circular **business models**. They are considered important to further enhance circular economy in politics, economics and in academic literature (Hofmann, 2019). For these circular business models to be created and ultimately implemented successfully, companies have to adapt the way they understand and do business (Bocken et al., 2013). When altering the core business of a company it helps to keep a clear overview with a business model (Osterwalder & Pigneur, 2010). This involves not only changing what companies do, they require changing how it is done (Amit & Zott, 2012). So, in order to help companies successfully map out such a novel business model, the process of **business model innovation** is required.

Research into business model innovation, however, is still fragmented. This and a lack of holistic approaches covering multiple stages of innovation makes it more difficult for companies to conceptualize, design and implement circular business models (Pieroni et al., 2019). Tools have been developed to aid the improved eco-design of products and there are numerous universal business modelling tools. However, there are still only a few tools that help firms in the creation of value through business models while also maintaining the CE principles (Bocken et al., 2013).

Not having a sole primary focus on making a monetary profit, business models that promote circularity are at risk of not being worthwhile at first, economically speaking (Bocken et al., 2014). However, they can potentially capture more value for the whole value chain when performed well, ultimately increasing economic welfare (Pieroni et al., 2019). One promising business model that is often proposed in circular economy is that of the **product service systems**. In such systems, companies focus more on providing the service of a product to customers instead of simply selling an end product. Transforming to service systems can be regarded as a key solution to quickening a circular economy, as companies are likely pushed to create products which have a more durable lifecycle, are more fully utilized, and are more cost- and material- effective (Tukker & Tischner, 2006).

As service systems are useful for advancing circular economy and the way changing to a service system is best done through an explicit business model, it is easy to see the connection between the two. To help companies create a service model and to help close the research gap in circular business model innovation, this research seeks to answer the question **how moving from a product system to a service system affects business models**. To do so, first the principle of circular economy will be introduced and used to explain the idea behind moving from a product to a service system in §2.1. This provides a context for the research question and explains why a company would go through the effort of changing to a service system. §2.2 discusses business models as a means for companies to outline what the essence of their business is. This can help them improve business continuously. Subsequently, business models can be used to implement new ideas such as circular economy while keeping a clear overview on how changing affects them. Although there are multiple ways of mapping a business model, this research will do so along the elements of the business model canvas. The canvas offers an

exhaustive overview which can be used to systematically show the essence of business and how exactly it might change when altering the business model. The process of such change begins with the innovation of a business model, which will be the subject of section §2.3. In this paragraph, the process of innovation and requirements for successful innovation will be discussed. One proposed sort of model that enables circular economy that companies can embrace is the service system, which will be introduced in §2.4. What a service system entails and how it differs from product systems will be presented here as well. The literature as a whole will serve as an introduction for the empirical material. Both will be compared and assessed, providing an answer to the question '*how does moving from product to service systems affect business models.'*

The **empirical material** contains a whitepaper and twelve in-depth interviews about the process and results of a single case study that was examined for this research. In this single case study, a community of practice was set up by the company Circular Economy, with the company Fairphone as its main subject. The idea behind Fairphone is that it sells modular phones, which in itself is a more sustainable and circular product than phones sold by other companies. The modularity offers the possibility of enhancing overall performance, since modules that become outdated due to technological innovations or that simply break down can be replaced. Because of this flexibility, the phone also has a prolonged life cycle. The main purpose of the community of practice was to develop a new, circular business model, in which the product is supplied to business-to-business (b2b) customers as a service. The customer pays an agreed upon monthly fee and in exchange, Fairphone supplies the service of its phones in Fairphone-as-a-Service. This entails that the customer's employees receive a modular Fairphone for the duration of the contract. During this contract, Fairphone is responsible for the proper functioning of those phones. Fairphone retains a better view of its products and receives the outdated or broken-down modules, which it can then use to recycle or refurbish for further use. This model is based on a specific type of service system called to the Product-as-a-Service (PaaS) business model. In this PaaS business model, the producer of a product retains ownership of that product, and instead sells the service of it to fulfil client needs (Manzini & Vezzoli, 2002). It is the framework for the Fairphone-as-a-Service (FaaS) that the community of practice introduced that was just described. The idea behind the community of practice was to develop a product-service business model for Fairphone that would help them further become even more circular: not only through their products, but also through their business model.

An underlying purpose of the single-case study was to use the development of this business model and the business model itself to help create a framework that is suitable for the further development of circular business models. The community of practice used a cross-disciplinary approach that inquired the insights of twelve specialists with backgrounds in several relevant areas. These specialists offered a combined knowledge of legal, financial, and accounting issues in business. This knowledge was used to attempt to create a business model that is not only circular, but also economically and legally achievable. As a result, the community of practice ended up with the FaaS business model. A detailed report was written in the form of a whitepaper, which was used to create the business model canvas for this research.

2. Literature review

2.1 Circular Economy

The necessity of a circular economy is apparent, now that the supply of available non-renewable resources is shrinking and the prices of natural resources are becoming more and more volatile (EMF, 2013). Circular economy is defined as a "system that is restorative by design and intention with a core strategic focus on reframing and reorganizing material, information and energy flows to achieve

greater resource efficiency by the reuse, remanufacture and recycling of materials" (Perey et al., 2018). Through this strategy it can help bring balance to economy and environment (Drakulevski & Boshkov, 2019). Essentially, products are meant to be kept in the economy as a resource after their life cycle so they can be reused efficiently in order to create extra value (Deselnicu et al., 2018). To illustrate, below is the idea of the circular economy with the accompanying explanation as offered by the Ellen MacArthur Foundation (2013) in figure 1. In this idea, four powers are shown that are used to describe the workings of circular economy. **The power of the inner circle** is about reducing the time and energy spent on returning products or resources that need refurbishing or remanufacturing back into use. The tighter the circle, the less energy, capital and labor intensive the process. **The power of prolonging the circle** involves optimizing how many cycles products or resources can be (re)used for. The power of cascaded use means to spread reuse of products and resources outside of the initially intended industries where possible. An example of this would be of Grodan, who use stone-wool for creating highly fertile blocks that crops can be grown on, that get remanufactured into bricks used for buildings after having served their initial purpose (Grodan, 2018). The power of pure inputs has the intention to use unadulterated resources as much as possible, which in turn increases the possibility of having a tight and longer circle. This research focuses on the first two goals of circular economy as illustrated above: the power of the inner circle and prolonging said circle.

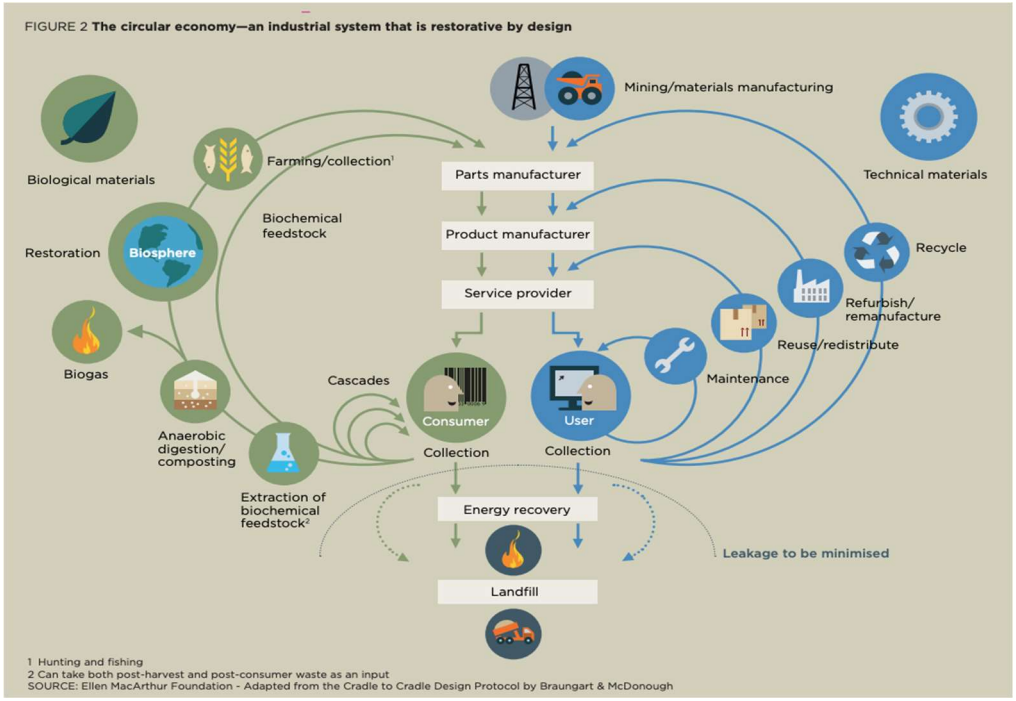

Fig. 1. The circular economy (EMF, 2013)

The means of enhancing these powers is with a focus on the **3R's principles: reduce, reuse, recycle** (Ghisellini et al., 2016). These three principles were hierarchically listed from most to least efficient with regard to reducing waste pollution in the Waste Hierarchy introduced by Dutch scientist and former politician Ad Lansink in 1989 (Parto et al., 2007). It has been seen as a guideline for proper waste management ever since (Van Ewijk & Stegemann, 2016). It also formed the basis for EU legislation in 2008, formally stating it as the preferred order of managing waste (EC, 2008).

Reducing seeks to reduce the input of primary energy, raw materials and waste by improving production efficiency and consumption processes (Ghisellini et al., 2016). Reducing is the first and most efficient of the three R's, with fewer initial resources being needed for production to begin with, effectively preventing waste in the first place rather than offering a solution to dispose of it properly. Improvements of production and consumption processes can involve introducing enhanced

technologies, lighter products and minimized packaging (Zhijun & Nailing, 2007). The Dutch supermarket Albert Heijn, for instance, has stopped using the outward pointing, convex shaped lids to cover soft fruits such as strawberries and grapes and introduced a thin top seal instead. With an innovation so seemingly simple, Albert Heijn has reduced its plastic usage by 300.000kg, and has simultaneously reduced the space needed for transporting the boxes of fruit as well (Albert Heijn, 2019). The second principle, **reusing**, which also involves remanufacturing and repairs, is defined as "any operation by which products or components that are not waste are used again for the same purpose for which they were conceived"(EU, 2008). An example of an industry that is built around this principle would be any second-hand market. This is a very accessible way of using less recourses, as customers themselves can easily enter the second-hand market by offering their own old products for sale using Marktplaats or eBay for example. Companies are drawn to the market as well, such as Leapp. Leapp is a Dutch company that takes used Apple products off customers' hands, refurbishes them, and sells them for second-hand usage at a discounted price. Reusing has a large impact on the environment as it alleviates the exhaustion of natural resources, requires less energy and less labor when compared to manufacturing brand new products (Castellani et al., 2015). The third and last principle, **recycling**, refers to "any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations" (EU, 2008). When recycling waste, resources that are still usable can provide extra value, and the amount of waste that needs to be destroyed is reduced, both decreasing the impact that waste would have had on the environment (Ghisellini et al., 2016). Recycling, even though it is often what circular economy is associated most with, might actually have the smallest sustainable impact with regard to resource efficiency and potential profit (Stahel, 2014). This is mainly due to the energy that is lost when repurposing resources for the use of manufacturing a new product.

It is evident from the examples that, especially when reducing and reusing products and resources, there is not only great potential environmental advantage, but also possible **substantial economic gain**. For this reason, circular economy has come to be seen more and more as an enabler that helps create a competitive advantage rather than being just an environmentally focused approach to doing business, spiking companies' interest in circular economy (Wijkman & Skånberg, 2015). This trend is consistent with the report by Kirchherr et al. (2017) on the concept of circular economy, which shows that economic prosperity is the most prominently mentioned aim in literature, with environmental quality coming in second. The competitive advantage that circular economy offers originates from more value being generated from every unit of a given resource than would be generated in the linear take–make-dispose business models (EMF, 2014). To illustrate, the European Commission (2014) estimated that over 600 billion euros can be gained every year in the manufacturing sector in the European Union alone. Research done by the Ellen MacArthur Foundation (EMF, 2013) shows that the more efficient ways of using resources with circular economy could for example already potentially increase EU GDP by up to 3.9% due to its potential to generate new markets and to help create extra value for businesses. Furthermore, EMF et al. (2015) show that when the CE principles are implemented, the European market could yield a potential net benefit of €1.8 trillion by 2030, which is €0.9 trillion more than reports show for the current expected development with a linear economy. It stands to reason, then, that industries are becoming more interested in the advancement of circular economy as well. Although circular economy is being talked about and being recognized more and more in the academic world, the private sector has to incorporate it as well in order to unlock its full economic and environmental potential. The importance of business models and their innovation in this process must be stressed if the circular economy is to become mainstream (Kirchherr et al., 2017); both are essential in enabling companies to create value using the circular economy principles (EMF et al., 2015). In order to help the private sector unlock the full potential circular economy offers, the way businesses are run has to be reinvented.

2.2 Business models

A **business model** is the core logic of what value a company offers and how it creates, delivers, and captures value (Osterwalder & Pigneur, 2010). They are a way of mapping the business processes and they help understand changes that happen in a company's environment or in a company itself (Osterwalder & Pigneur, 2010). This could for example also help companies better understand how they are affected when they move from a product system to a service system and what is needed to implement an effective innovation that will last. Four generic foundations of how this is done are offered by Boons and Lüdeke-Freund (2013):

1. Value proposition: what value is embedded in the product/service offered by the firm;
2. Supply (or value) chain: how upstream relationships with suppliers are structured and managed;
3. Customer interface: how downstream relationships with customers are structured and managed;
4. Financial model: costs and benefits from value proposition, supply or value chain, customer interface and their distribution across business model stakeholders.

Circular business models in addition to this are "designed to improve resource efficiency through contributing to extending useful life of products and parts and closing material loops" (Nußholz, 2017). In other words, they adhere to the 3R's principle where possible. They also emphasize creating value for a larger scope of stakeholders, and it takes into account the societal and environmental views (Antikainen & Valkokari, 2016). Other researchers conclude that a circular flow should also embrace the wastes caused by production and the by-products (Loomba & Nakashima, 2012).

Next to being helpful in mapping the way companies handle value as mentioned above, business models can have **additional purposes** for a company. They can also help a company achieve organizational alignment and are complementary to strategy implementations. This is due to the standardization, which leads to easily transferable and communicable business models (Amit & Zott, 2012; Magretta, 2002). Companies can create a business model beforehand, or if they have not done so, it could quite easily be inferred from the way value is already being created, proposed, delivered and captured. So although not every company follows an explicit business model, every single business at least implicitly has one, whether they knowingly mapped it out or not (Micieta et al., 2020). As Demil & Lecocq (2010) state, the way the elements interact can strongly influence business performance for the better or for worse, so companies are at an advantage when they properly map their way of doing business in order to fully understand how to manage it.

There are several ways in which a company can map its business model. This research uses the **business model canvas**. The canvas is a standard form by which the four foundations mentioned above can be identified. Communicating the business model through a standardized format makes it easier to analyze and communicate the model. The canvas was created by Alexander Osterwalder et al. (2010) and it uses the following nine elements:

1.	Customer segments	Defines the market that a company chooses to create value for. This can be either a niche market or a mass market.
2.	Value proposition	Explains what value is offered to the market to fulfill the needs of the customer segments. This can range from for example beautiful design or functionality, to great service, or to anything the customer segment could value.
3.	Channels	Defines the channels a company will use to reach the market, such as websites with delivery service or stores.
4.	Customer relationships	Helps control how customers perceive the value that is offered.
5.	Revenue streams	Creates insights to how revenue will flow into the company. Three

types of revenues exist: transaction revenues, recurring revenues and usage fees. Transaction revenues are one-time incomes. Recurring revenues are incomes from subscriptions. Usage fees vary depending on how much of a service or product a customer uses.

6. Key resources — Controls how a company gets access to the resources needed to successfully run its business. There are three types of resources: physical resources, human resources and intellectual resources.
7. Key activities — These are activities that are critical to the survival of the company, such as production and problem solving.
8. Key partners — Partners that the company can't do business without, not including suppliers.
9. Cost structures — Defines what costs there are in the business and where they occur.

The canvas can be filled in by answering questions regarding each element, using the processes specific of the focal company that the canvas is being created for. It can then be used as a tool to better understand a company and its environment. The structure of the canvas is as shown in figure 2.

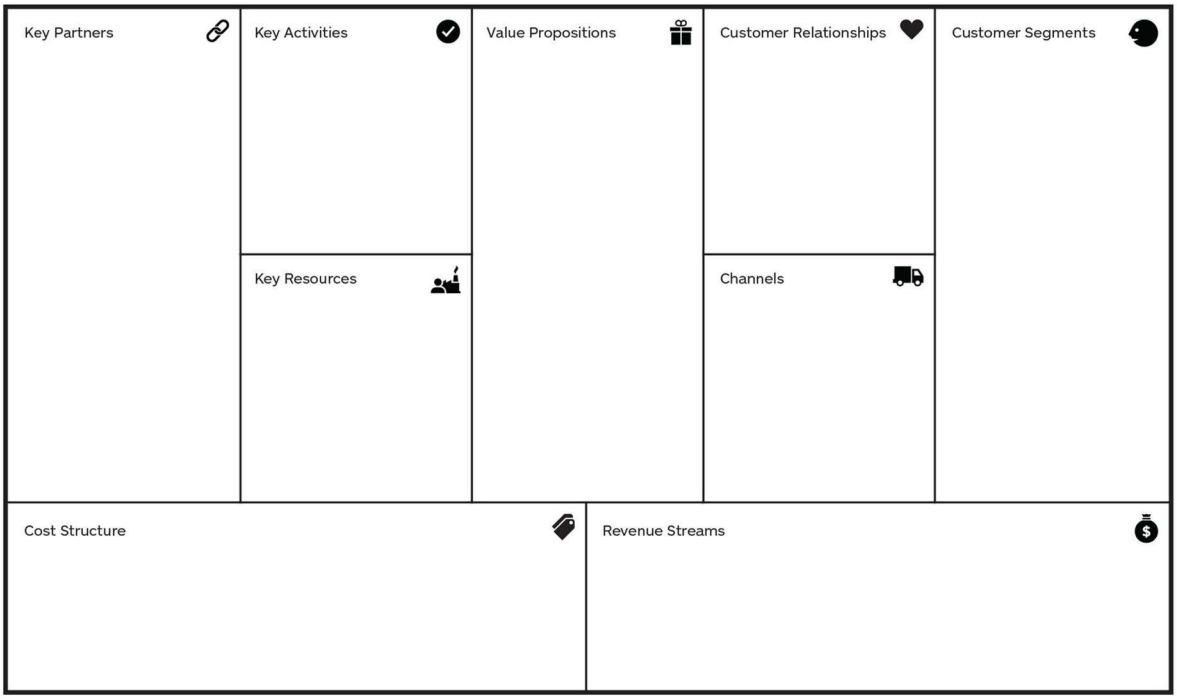

Fig. 2. The Business Model Canvas (Osterwalder & Pigneur, 2010)

The business model canvas can be used for comparisons quite easily. As it uses a standardized format for business models, differences are quickly spotted and can then be assessed further. This is valid for models of different businesses, but just as much so for an existing and new model within the same company, which is how it will be used in this research. Creating a more circular business model, which is what was done in the community of practice about Fairphone, required substantial changes to the existing model of selling ownership of phones to end-customers. Using the business model canvas, the changes that are caused by moving from a product to a service system can be mapped. As the elements are interconnected, changing a single element can disrupt interactions between other elements as well (Amit & Zott, 2012). So, for any business model to be properly understood and mapped, business model innovation is essential.

2.3 Business model innovation

Business model innovation is twofold: it can act as an enabler for the innovation of products and technologies, bringing new inventions to the market (Nußholz, 2017). It can also **alter the established way of handling a business** (Dodgson et al., 2013). This research focuses on the latter. To realize innovative business ideas, a new business model is often needed This is challenging, because unforeseen difficulties come to light in a company when bringing new models into practice. For context, these challenges make it more difficult for a company to innovate business than it is to innovate models products and technologies (Chesbrough, 2010). These difficulties consist of uncertainties and complexity, which can be caused by the **collaborative and networked nature** of these innovations (Antikainen & Valkokari, 2016). Furthermore, innovative business models are potentially threatening to the current business model of a company, which can lead to an internal unwillingness to innovate (Chesbrough, 2010). In order to prevent such potential threats and decrease the number and the severity of unforeseen problems, the business model has to be developed as wholesomely as possible. As the elements are interconnected, changing a single element can disrupt interactions between other elements as well, which further complicates innovation (Amit & Zott, 2012). Therefore, companies may need to reassess their business model innovation from a focal point of view to a more holistic and system-oriented view, creating a circular network that is willing to innovate (Amit & Zott, 2012).

Circular business processes have to involve proper cooperation between the organizations across a supply chain and other stakeholders from related expertise areas, or even different areas (Yang et al., 2018). Stakeholders from the entire value chain or even outside of it are actively involved in the process to help create a business models that works for and across the chain. This is called **stakeholder co-creation**, which has been defined as "the collaborative activities during which interdependent external stakeholders contribute to a firm's innovation process" (Kazadi et al., 2016). A reason for involving stakeholders more is that they can help create unique knowledge, as these stakeholders may have access to information and resources that are not easy to come by for a company by itself solely through market transactions (Harrison et al., 2010; Gulati, 1999). The creation of value for a network of stakeholders including society and environment is central in cooperation (Leising et al., 2018).

Recently, stakeholders are becoming more and more willing to share their knowledge and business ideas, posing better opportunities for collaboration (Kazadi et al., 2016). However, working together with a varied set of stakeholders can also lead to conflicting goals and interests, problems with communication, distrust between stakeholders, or disagreement on the way the value is divided among stakeholders (Waligo et al., 2014). A big challenge in remodeling linear business systems with **stakeholder participation**, then, is to find the "win-win-win" setting, which balances the self-interests of participating actors so that they can co-create a circular business model. This smooths cooperation and helps to collectively create a business model that follows the circular economy principles (Antikainen & Valkokari, 2016). In order to successfully transform from linear business models to circular business models, a redesign and reorganization of the way value is created, delivered, and captured is required (Hofmann, 2019).

One type of model that offers a novel value approach while also adhering to the circular economy's 3R's principle is that of the **product-service system**, which integrates end products with services (Tukker, 2004). What these services can include will be discussed in the next paragraph. The FaaS business model that this research focuses on is based on a specific type of product-service system: the Product as a Service model, which allows companies to provide services that satisfy users without them necessarily having to actually own the products (Bocken et al., 2019). For this specific case, the Fairphone is offered as a service instead of it being sold to the end customer as a product. This way, Fairphone can continue to become more circular, which was ultimately the goal of the business model innovation.

2.4 Product vs. service systems

In a **product-based system** the focus is on selling products to end consumers with no particular intention to reduce, reuse or recycle, adding to the exhaustion of our natural resources (WEF, 2014). After the sale of a product, the end of life treatment rests upon the buyer, which means it will likely end up in a landfill. Product-service systems, however, can be a way of achieving greater circularity (Mentink, 2017). As mentioned before, **product-service systems** integrate services with products. A service is "an activity or series of activities of more or less intangible nature that normally, but not necessarily, take place in interactions between the customer and service employees, and/or physical resources or goods and/or systems of the service provider, which are provided as solutions to customer problems" (Grönroos, 1990). Because of this intangible nature, the way service is perceived by customers can vary per individual case, making the customer essential to ultimately realizing the service (Dolfsma, 2011). Compared to just selling products, product service systems are widely viewed as a superior and more preferable business models in many ways and as such they have seen a peak of interest from actors in society, business and governments (Tukker, 2015). Innovations within such service business models involve moving from selling a product to the consumer to providing the service of that product and having the consumer pay for the service, a process called servitization (Vandermerwe & Rada, 1988). Servitization includes using systems such as rental and lease, pay per use, and other product-service combinations (Bocken et al., 2019). Well-known examples of servitization are *Swapfiets* and *Greenwheels*, where customers pay for the availability and reliability of a bike or car, and not for the objects themselves. Depending on the structure of the PSS, in other words the ratio between products and services, product-service systems are categorized into three different classes that each vary in their characteristics and that can have different environmental and economic effects (Tukker, 2004). A representation of the cycle of product resources to illustrate the difference between product models and service models with regard to **resource efficiency** is given in figure 3, with definitions supplied by Yang et al. (2018).

(1) Product-oriented PSS, in which companies offer services related to the products they sell, for example maintenance and advice. This can involve services such as free installment Coolblue offers with each laundry machine they sell, or free yearly check-ups and light maintenance a garage offers with each car purchase;
(2) Use-oriented PSS, in which "the ownership of products remains with the manufacturing firms and the customers pay a rental fee over an agreed number of years" (Yang & Evans, 2019). This can involve a lease car for which a prespecified amount is paid monthly by the user, while the garage remains the owner of the car. The producer holds the ownership, the consumer is the user of the product;
(3) Result-oriented PSS, in which manufactures keep ownership of the products and the consumers only buy the result of that product. An example of this would be a lighting service that Signify (formerly Philips Lighting) offers, in which consumer pays for the number of hours lightbulbs are used rather than paying for the lightbulbs themselves. Signify is the owner and actual user of the lightbulbs and is fully responsible for their functionality as such.

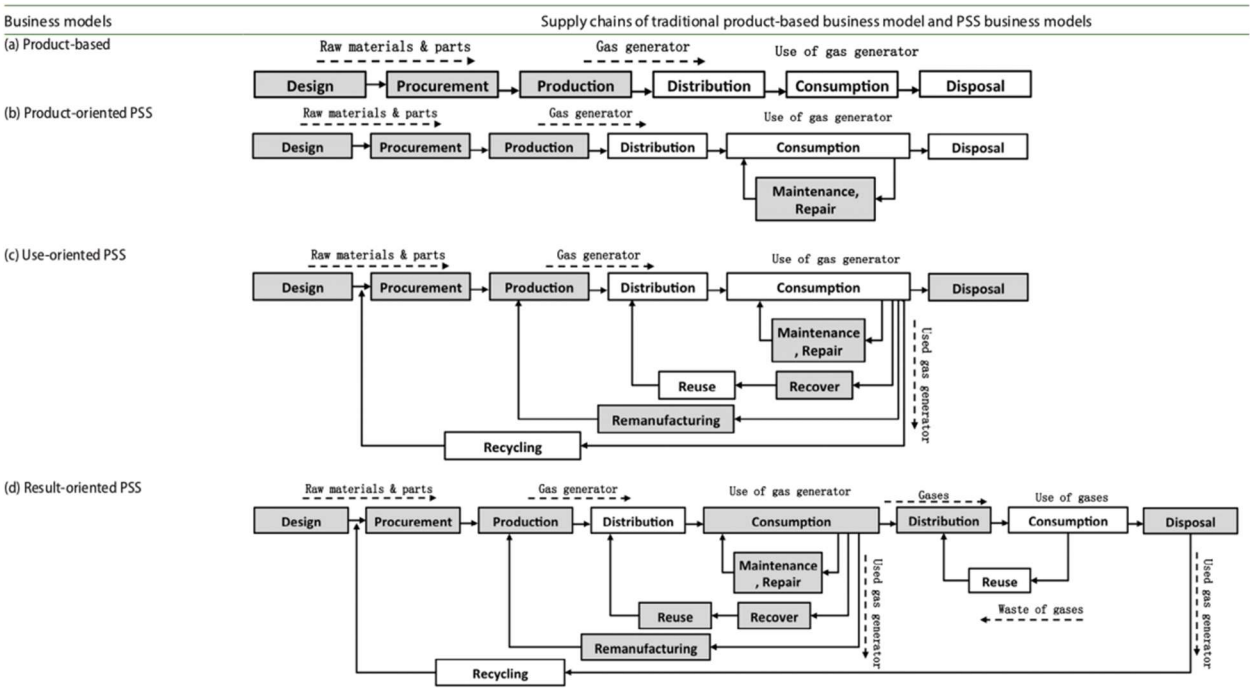

Fig. 3. Supply chain architecture of the different PSS business models for the gas generator industry (Yang et al., 2018).

It is clear from the illustration that pure product-based business models make it difficult for companies to prolong the powers of the inner circle and of circling longer when compared to any product-service system. Additionally, the more service is integrated into the model, the stronger the powers of the inner circle and of circling longer become. This is because the total resource usage is reduced and the product and its resources are used more throughout the entire life cycle instead of having no end of life care (Maxwell & van der Vorst, 2003). This makes the reuse, reduce and recycle rates higher for PSS models than for the linear take-make-dispose models (Yang & Evans, 2019). As a result, material flows can be minimized while user satisfaction and service output can be capitalized (Tukker, 2015). Because of this reduction of resources and the way the resources that are used can be reused and recycled in PSS, authors and policy makers coin PSS business models among the most important ways of moving towards a circular economy (Tukker, 2015).

Next to environmental and economic effects, **interaction between a company, its stakeholders and its customers** is inherently affected as well. For end customers, product-service systems bring about a shift from buying and consuming a product to renting, consuming and returning it; for manufacturers, PSS can be used to gather more information on customers and how their products are used, to generate continuous income and to get more out of their resources (Yang et al., 2018). This together can result in a synergy between company profits and environmental benefits (Yang & Evans, 2019). For providers, this shift means a major change in the financing of their models is necessary (Achterberg et al., 2016). Moving from a linear to a circular flow of resources like in this PSS model involves moving from the established way of generating value instantly by selling products and receiving income directly, to sustainable business models that generate value from the flow of materials and products spread out over time (Bocken et al., 2016). Initial investments are mostly recovered over a longer period of time than when selling directly, as receiving payment per use for example spreads out the gains (Tukker, 2004). These changing interactions together can result in a synergy between company profits, customer experience and environmental benefits, while also better aligning stakeholder interests (Ritala et al., 2018; Yang & Evans, 2019). This in turn creates a smoother operating value cycle, which enhances businesses too.

2.5 Propositions

As mentioned, service and the perception of it is relative to customers. Due to its relative nature, service contracts could vary per customer. Customers have to have trust that their needs are met in a service system just as well as or even more than they were in a product system. Customers and how they perceive service are essential to realizing the service. Therefore, clear mutual expectations have to be communicated between a company and its customers to ensure quality service. This leads to the first proposition.

Proposition 1
Creating clear mutual expectations and commitments between companies and their customers is crucial for service systems.

The literature suggests that in order to successfully move to a service system, companies have to re-evaluate their way of doing business and they have to do so in close cooperation with their stakeholders. That is why constant feedback is crucial when establishing a service model, which leads to the second proposition.

Proposition 2
Once a new service system is created, it will only be successful and continue to be successful if the company gathers a constant stream of feedback from its stakeholders and integrates that feedback into the service.

Furthermore, the theory shows that research into business model innovation that supports circular economy is fragmented and there are few service system development tools. Since service is a continuous and interactive process, as the previous propositions suggest, theoretical models and tools will not be enough to advance circular economy. Therefore, the third proposition is as follows.

Proposition 3
Service systems need to be put into practice to advance development tools.

The theory and empirical material will be compared in section 5, the discussion. Using both, the three propositions and the research question '*how does moving from product to service systems affect business models'* will be discussed and answered.

Lastly, proposition 4 was added after revising the results because it combines several elements in the theory and is in line with the expectations of the first three propositions. Circular economy is not yet mainstream for multiple reasons, and progress is sluggish. From this, a fourth proposition is formulated.

Proposition 4
Government intervention is necessary to encourage companies to innovate to service systems.

3. Methodology

3.1 Literature study

For the literary review, a literature search for English articles and reviews was conducted on the online databases of WUR Library and Google Scholar. Several search terms were used, such as *Circular Economy/Circular business models/Innovation for Circular Economy/Business model canvas/Business*

model innovation/Product-service business model. These searches resulted in 10 main initial articles that were used. These articles were:

A Framework for Sustainable Circular Business Model Innovation	Antikainen, M., & Valkokari, K., 2016
A value mapping tool for sustainable business modelling	Bocken, N., Evans, S., Short, S., & Rana, P., 2013
Product design and business model strategies for a circular economy	Bocken, et al., 2016
The Circular Economy – A new sustainability paradigm?	Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J., 2017
Stakeholder co-creation during the innovation process: Identifying capabilities for knowledge creation among multiple stakeholders	Kazadi, K., Mahr, D., & Lievens, A. 2016
Designing the Business Models for Circular Economy—Towards the Conceptual Framework	Lewandowski, M., 2016
A Review and Typology of Circular Economy Business Model Patterns	Lüdeke-Freund, F., Gold, S., & Bocken, N. M. P., 2018
Business model canvas in global enterprises	Micieta, B., Fusko, M., Binasova, V., & Furmannova, B., 2020
Product-service systems business models for circular supply chains	Yang, M., Smart, P., Kumar, M., Jolly, M., & Evans, S., 2018
Circular Business Models: Defining a Concept and Framing an Emerging Research Field	Nußholz, J. L. K., 2017

The references from these articles, that were found with the search terms mentioned above, led to additional relevant literature in a snowballing effect.

3.2 Data collection

The empirical data was collected from the single case study that studied a community of practice about Fairphone. The community of practice covered a timespan of 10 months: from May 2017 to February 2018. In total, 21 meetings were held to discuss the development of a new and circular business model.

The community of practice resulted in a whitepaper, a report by Circle Economy and Sustainable Finance lab. In this whitepaper the resulted FaaS business model and its implications for Fairphone are presented, together with a conceptual contract that was created to act as an enabler of the business model between Fairphone and its customer. The contract was used in a pilot afterwards, of which the results can later be used to assess the success of the community of practice and its outcome.

At the end of the community of practice, twelve in-depth interviews were conducted about the process of working together and about the outcome of the community of practice. This research uses only those interviews and the whitepaper. The interviews have been coded by hand in two rounds. In the first round, sensitizing concepts were highlighted with an attempt to find patterns. In the second round these sensitizing concepts were connected to themes. These themes firstly include the main changes in a service system model compared to product system models: legal contracts, accounting and financing. Secondly, they include advantages of having a cross-disciplinary approach and the commitment it requires. The themes that were found in the interviews were compared to the relevant literature that was used in this research to open up a discussion.

3.3 Reliability

There are obvious trade-offs between research methods that have a broader scope of research subjects and single-case studies. This study has a limited scope because it focuses on one community of practice that was set up for one single case. Being a single case, it makes it difficult to repeat the research under the exact same conditions. This could hurt the reliability of the research. However, in comparison to a research using a broader scope, this single-case study has a deeper focus on the research subjects. This presents very detailed and in-depth information on the community of practice and its results in the form of twelve elaborate interviews with experts.

The literature research can be reproduced by using the beforementioned search terms. The empiric evidence, in turn, is supported by that literature. In other words, the results of a single case study that uses expert insights are in line with an elaborate literature review. Therefore, it can be concluded that when another research is conducted under similar circumstances, similar results can be expected.

3.4 Validity

The aim of this research is to analyze how moving from product to service systems affects business model innovation. The case that was used studied just that. There was an open-minded approach during the deep dives of the community of practice. This is because the question asked was how do we make a more circular business model, there was not an already preferred outcome that was desperately tried to reach. Instead, using the knowledge of financial, legal and accounting experts, solutions to problems that arose were found that were within the scope of what was possible in each of those areas. As such, the community of practice offered an environment where there was ample time to discuss possible outcomes. During this process, it became clear what would work and what would not, and what had to change about the current way of building a business model in order for it to become circular instead of linear.

The outcomes of this research are widely generalizable. An underlying purpose of this study was to help create knowledge about building a feasible circular business model. Generalizability was therefore not a coincidental outcome but it was consciously focused extra on. The outcomes of the Fairphone pilot have resulted in a concept business model that will be used in the near future in the form of a pilot, with a single customer. Although this may seem fairly specific to this case, the way the community of practice was set up makes that the way business model innovation is affected by service systems can be seen as a more general outcome.

4. Results

As the case that is discussed in the empirical material starts with business model innovation and results in a business model, that is the order in which the results will be discussed as well. In the first two parts of the results, the interviews will be used to first reflect on the **process of business model innovation** for the FaaS business model. Then a **business model canvas** will be provided to map the changes from sales to FaaS. The canvas was created using information from the whitepaper ‘Fairphone-as-a-Service’. The elements of the canvas and how those elements have changed compared to the initial product-selling business model will each be discussed separately. Thirdly and lastly, the differences between product systems and Fairphone as a service will be shown using information from the whitepaper.

4.1 Business model innovation

During the in-depth interviews, the twelve respondents were first asked about their opinion of the **innovation process** and whether it had been successful in their eyes. Since the project still had to be aired at the time of the interviews, the success remained a subject of discussion. Whether the achievements would be enough and whether the project would be a success will become clear over time. It was clear to some that potential success depended on whether the project would be put into practice.

> *"I have to say to them once, hit them on the head and say "we're just going to do it" …. Then you can hit me on the head if it doesn't work out or it doesn't work. That is also a form of practice."*
> – Respondent 12

The themes that were mostly associated with the workings of the community of practice were the importance of having a **cross-disciplinary team** that was committed to the cause. Having experts from different industries and departments helped everybody to better understand the full scope of the business model Fairphone was trying to create.

> "*As far as the circular economy is concerned, you can see that business models are still struggling to actually shape their new revenue model, and that is partly due to the existing conventions on accountancy and reporting … whether those existing conventions might have to change. But we don't know how to do it ourselves, and we can only do it by working together in a coalition…."*
> – Respondent 3

One of the main reasons the respondents thought the process had worked was the commitment that all different agents had to the community of practice. This led to a work environment in which input was welcomed and stimulated.

> "*…There is a huge commitment, we are not always complete, but I feel a good commitment, people give real input, nobody is sitting back like 'can I go home already', not at all, people really want to participate*"
> – Respondent 2

Although the average overall sense was that respondents were happy with the community of practice, there were still some areas that they felt could have been done better as well. This was themed **old-fashioned thinking**. Respondents noted that a lot of the times, although the community was co-creating with a cross-disciplinary team, some participants had trouble stepping out of their own perspective. This is not to say that they did not try, but that some respondents felt that more rethinking would be needed for such an innovative process. The same was said for customers, who are still very much used to product-based businesses.

> *"Funnily enough everyone is very fond of the old-fashioned idea, thinking from their perspective… the kind that still very much goes back to the 'okay I buy a product' model."*
> – Respondent 4

Following that, respondents felt that in order to have a really successful innovation, the scope of possible solutions should extend past conventional ideas. This could also be linked to clinging to the old-fashioned thinking. To enhance possibilities, the framework has to be pushed, as one respondent put it.

"I think it makes sense that there should be a push not only from "this is within the framework of what we can do", but "how can we push the framework further"
– Respondent 11

Summarizing, the results showed that in the innovation process, having a cross-disciplinary team and having deep commitment is crucial to success. One of the biggest issues in the innovation process according to the results was the old-fashioned product-based thinking of both companies and customers.

4.2 Business model canvas

Using the whitepaper and information from the interviews, a business model canvas was constructed to show how the move from a product-based system to Fairphone as a service has affected Fairphone's business model. The canvas shows the elements and how they are filled in with the FaaS model. Following that, how each element has changed compared to the sales model will be discussed.

<table>
<tr>
<td rowspan="2">Key partners
- Cooperation between stakeholders of the CoP
- Government</td>
<td>Key activities
- Production of a modular phone
- Providing of continuous services
- Marketing
- Contributing to development of circular economy through product
- Contributing to development of circular economy through business model</td>
<td rowspan="2">Value proposition
- Access to functioning Fairphone devices for all employees of the business client
- Services around the maintenance and updates of devices
- Guaranteed end of use take-back of devices
- Fixed monthly fee
- Reduction of environmental impact
- Incentive to use product less through reduced fee when under a certain amount of energy is used</td>
<td>Customer relations
- Personal help: forms of maintenance are offered per phone when needed
- Automatic services: planned maintenance is offered to any customer
- Communication: Availability of a representative of the service provider at all reasonable hours
- Self-service: self-repair options
- More intense communication through continuous updates of devices</td>
<td rowspan="2">Customer segments
- Businesses that offer their employees a business phone
- Businesses that value being environmentally responsible</td>
</tr>
<tr>
<td>Key resources
- Product development
- Cash, debt and credit for financing
- Product database on energy consumption and technical failures
- Customer database used to create understanding between usage and device performance</td>
<td>Channels
- Ongoing service offered, which leads to continuous back and forth customer communication throughout the duration of the contract</td>
</tr>
<tr>
<td colspan="3">Cost structure
Asset purchases
Quarterly VAT payments</td>
<td colspan="2">Revenue streams
Periodic fee
Instalment fee</td>
</tr>
</table>

Repair and handling costs Financing costs	Termination fee Recycling benefits

Fig. 4 Business model canvas based on Fairphone-as-a-Service

The business model canvas has changed from a product system to a service system in the following ways:

1. **Customer segments** have changed from end-customers to business to business (b2b) customers. The segment of environmentally aware customers remains the same.
2. The **value proposition** changes from offering products for sale as one-at-a-time transactions to offering the service of the products instead. This comes with elaborate pre-determined and contractual services offered by Fairphone. These services include:
   - Use of products
   - Scheduled maintenance
   - Preventive maintenance
   - Corrective maintenance caused by machine breakdown
   - Corrective maintenance caused by physical damage
   - Insurance
   - Replacement of products when needed
   - Reclaim of the products after suspension of the services or termination of the contract
   - Self-repair service in the form of extra spare parts supplied with the phones

   Fairphone still offers the reduction of environmental impact through the use of a more sustainable, circular phone. It now also offers potential extra reduction through a financial incentive to reduce phone usage. This further enhances the life-cycle and reduces energy waste, which both help reduce environmental impact.
3. **Channels** have moved from sales to ongoing service. They are now focused on the continuous feedback that is received and the communication that is sent out with each update or repair. This leads to continuous back and forth customer communication throughout the duration of the contract, resulting in a wider interface to help determine and improve customer satisfaction. Purchase and after sales have seized to exist, and evaluation has become the key activity in this element.
4. **Customer relationships** become more intensive, with a constant elaborate service being offered and extra service being available when needed. The customer is no longer in contact with Fairphone at the moment of purchase, but rather an active communication between the customer and Fairphone must be maintained throughout the duration of the services contract.
5. **Revenue streams** will be more constant. Rather than only receiving transaction revenues through instant payment for a product, recurring revenues and usage fees will be collected in the form of periodic fees, instalment fees and end of life benefits. This will ensure a more constant and durable stream of revenue.
6. **Key resources** still revolve mostly around product development to help improve the product. This will now be helped, though, with a more extensive and constant data stream on energy consumption and device performance.
7. **Key activities** now also involve contributing to circular economy through the use of a circular business model. The goals of the key activities, stimulating circular economy have not changed, but more so the extent to which circular economy is being stimulated. Fairphone now focuses not only on the production of phones, but takes on lifespan management of the phones and its modules.
8. **Key partners** are the non-customer relations that are crucial in the business operations, such as government and suppliers. These key partners now also include the participants of the community of practice that helped develop the FaaS model.
9. **Cost structures** now, next to the already existing costs of asset purchases and quarterly VAT payments, also involves the extra costs incurred by repairs, handling and financing costs.

Moving from a product to a service has changed the value proposition, which trickled down to changes in all elements of the business model canvas, showing how all of the elements are connected. This is in line with what was mentioned in the interviews, where respondent 8 commented on why creating an innovative business model in the form of Fairphone-as-a-Service was so challenging.

> *"…It was difficult to break through. Because where do you start? Do you start with the accountancy rules, or do you start with the wording in the contract, or do you let the wording depend on the accountancy rules? That was a circular reasoning all the time. On the other hand, it revealed nicely why it is so complicated, and why it is so difficult to take steps and roll it out like this."*
> – Respondent 8

4.3 Product vs. service systems

To understand how the FaaS model differs from product systems, it helps to obtain a better understanding of the basics of Fairphone-as-a-Service compared to sales. Figure 4 has been constructed based on a FaaS versus lease evaluation made for the whitepaper. The figure was originally constructed to show the differences between lease and FaaS based on four elements. To have an exhaustive and clear view of the differences between FaaS and sales, the same elements were used in this comparison. Each of the elements will be discussed separately below.

Fairphone-as-a-Service	**Sales**
Focus on the service and experience	Focus on the product
Possible for assets of medium to low value (e.g. like phones, consumer appliances, jeans)	Typically for assets of both low and high value, potentially with a payoff period for higher cost assets
Cash-flow based financing (i.e. portfolio of contracts is key)	Cash-flow based financing (i.e. direct income of sales is key)
Reuse opportunity (i.e. multiple uses and incentive to add value for successive use cycles)	Customer-initiated resale opportunity only

Fig. 5. Fairphone-as-a-Service vs. sales, based on Fischer et al. (2018)

For starters, the changed focus of Fairphone specifies that the business model innovation in this case is about innovation from a sales business model to a combination of a **use and result-oriented service system**. Fairphone-as-a-Service is use oriented in the sense that the ownership of the phone remains with Fairphone while the customer pays a fixed periodic fee to use the phone. This indicates payment for use and not for result, which would for example be the case if the customer only paid flexible fee that differs per phone usage. There are however also result-oriented elements, such as the monetary incentive for using the phone less. On top of that, depending on the specifications of the services agreed upon in contract, Fairphone is responsible for the functionality of the phones through offered preventive and corrective maintenance. These specifications are as shown in figure 5.

SCOPE OF SERVICES	SERVICE FEE
Use of Product(s)	Part of Base Service Fee
Scheduled Maintenance	[EUR [◊] per event][Part of Base Service Fee]
Preventive Maintenance	[EUR [◊] per event][Part of Base Service Fee]
Corrective Maintenance caused by "machine break-down" (*van binnen komende oorzaak*)	Part of Base Service Fee
Corrective Maintenance caused by "physical damage" (*van buiten komende oorzaak*)	[EUR [◊] [per event][, unless this is insured against in accordance with Clause 12(b)]
Insurance	EUR [◊] per [month][quarter][year]
[Replacement of the Product(s)]	[EUR [◊] per event][Part of Base Service Fee]
[Reclaim of the Product(s) after suspension of the Services or termination of the Contract]	[EUR [◊]][Part of Base Service Fee]

Fig. 6. Scope of the services and fees (Fischer et al., 2018)

Fairphone also commits to supplying a pool of spare parts that the customer can replace faulty modules with. Fairphone is responsible for the timely replenishment of the pool of spare parts in addition to this. Depending on the specifications in the contract, Fairphone offers this as a service that is to be paid per event, or it is included in the base service fee. The last case leans towards a result-oriented service system in which the company is responsible for the functionality of the product. This analysis was done using the PSS definitions by Yang & Evans (2019) that were discussed in the theory and the scope of services and fees in figure 5.

Then the **difference in applicability** was discussed. Whereas sales are possible for assets of basically all assets, it is reasoned that the FaaS model can only be used for assets of low to medium value. This is a limiting factor and it reduces the range of possible assets. Figure 4 further shows a change in the basis of the **financial model**, from direct incomes of sales to a model financed by a portfolio of contracts and the fees that are earned with them. The interviews revealed this as being one of the difficult challenges in the innovation process. The Fairphone whitepaper suggests that financiers are reluctant to invest in circular business models as there is a lack of quantitative data. On top of that, the cumulative cash flow is initially negative, as revenues are spread out over the duration of the contract. Financiers are progressively important to this type of model, as the model is initially financed with debt to cover the acquisition of phones. As such, more assets would require more financing. The added risk that is introduced with this model was countered in the community of practice by offering securities to help attract financiers. In short, a portfolio of quality clients with low credit and debtor risk, asset quality that ensures sale in case of bankruptcy and contract robustness were seen as key securities to reduce risk. This places an extra emphasis on cost structure, customer relations, key activities and key resources, as was also confirmed in the business model canvas.

The obvious advantage with regard to **resource efficiency** is that FaaS offers the opportunity to better manage its resources with reuse opportunities. Reusing initiated by Fairphone itself improves the efficiency greatly when compared to sales models, where reusing is only happens if and when owners of a product decide to sell it for secondhand use. To ensure maximum reusing, Fairphone committed to using refurbished parts first until they are out of stock and to only purchasing and offering new modules after that happens.

5. Discussion

In the results, several themes in the innovation process and the resulting business model were identified. These will now be compared to the literature review to uncover potential notable

similarities or differences with which the research question '*how does moving from product to service systems affect business models'* and the accompanying propositions will be discussed.

5.1 Business model innovation

Antikainen & Valkokari (2016) suggest that the innovation of business models is challenging due to uncertainties and complexity caused by the collaborative and networked nature of the innovations. On top of that, the theory shows that few business model development tools exist because research into circular business model innovation is fragmented. This is confirmed by Guldmann & Huulgaard (2020), who found in a cross-case analysis of different circular business model innovations that companies similar in size, industry and customer segment all experienced different obstacles in their own innovation process. This further shows the difficulty of innovation and explains why there is still a lack of holistic approaches in the field of circular business model innovation. The only obstacle that all companies shared was a lack of resources, knowledge or competencies in the company itself (Guldmann & Huulgaard, 2020). A way to counter the lack of in-house knowledge and other unforeseen obstacles is to create innovation using **stakeholder co-creation**. This is in line with the results, where respondents noted that indeed having a cross-disciplinary team involving several stakeholders was important to the success of the innovation. In the case of Fairphone, external opinions in the fields of accounting, contractual agreements and finance were consulted.

An obstacle that was suggested in the results for FaaS is **old-fashioned thinking** in business model innovation. Building on old-fashioned thinking limits the scope of a business model innovation to conventional ideas. That way, the innovation can only extend to the limits of a confined and established working area rather than lead to revolutionary changes in the industry. Large innovations that are required for moving towards a service system can only be realized when broadening the "framework", as it was called in the results. A reason for this old-fashioned thinking can be unwillingness to innovate, as was discussed by Chesbrough (2010). Another reason suggested in the theory is that there is disagreement on the division of value among stakeholders (Waligo et al., 2014). However, the interviews suggest that there could also be potential inability to innovate. This can be caused by agents having difficulty adjusting their own perspectives, which was suggested by respondent 3 in his opinion how "existing conventions" about the setup of a revenue model in service systems complicates the process. This old-fashioned thinking led by inability was seemingly successfully countered in the community of practice during multiple cross-disciplinary meetings, which confirms the theory that stakeholder participation can lead to a "win-win-win" situation that every party is satisfied with (Antikainen & Valkokari, 2016).

The problems mentioned above require careful consideration with a stakeholder network to resolve. This further indicates the complexity of business model innovation for service systems and it proves the importance of encouraging stakeholder participation. The community of practice has brought these issues forward and has produced a pilot business model for Fairphone. It remains to be seen whether they have tackled the problems but the results look promising, with positive feedback on the innovation process of those involved and positive views on their development tool. However, what remained undiscussed is that there is an apparent **lack of support from the government** for circular business model innovation (Kuo et al., 2010). For example, in many instances labor is taxed, but the use of raw materials is not. This puts labor intensive circular business models at a disproportionate disadvantage compared to raw material intensive linear business models models (Stahel, 2010). This is highly relevant for Fairphone-as-a-Service and similar models. The move towards circular economy through business model innovation is inherently difficult due to the problems that were discussed in the results and the theory, but on top of that there appears to be a constitutional disbalance that makes it even more difficult. It was already suggested that before circular economy can become

mainstream more development tools are required. Now it seems that a more institutional change is needed as well.

5.2 Business model canvas

The goal of the community of practice was to make a more circular business model, which resulted in a combination of a use and result-oriented service system. Figure 7 shows what the key elements of such a circular business model are. The main changes in the business model canvas in the results will be evaluated along these key elements to see whether they are in accordance with the theory and if they can be applied to the more general view of business models.

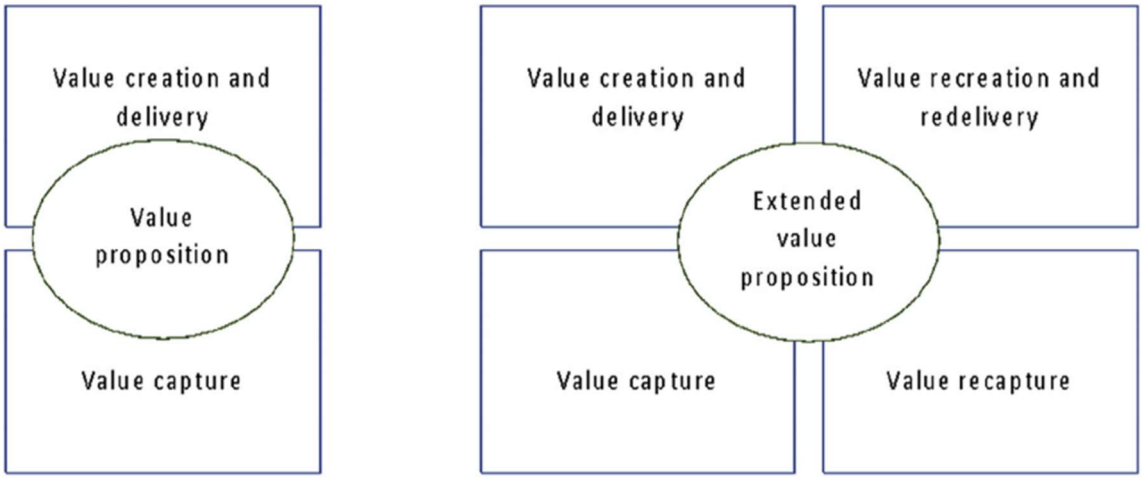

Fig. 7. Key elements of a linear business model (Richardson, 2008) vs. key elements of a circular business model (Bocken et al., 2016)

A circular business model is "a model that integrates environmental and economic value creation by shifting the business logic from generating profits from one-time sales of goods, to generating profits from a continual flow of reused materials and products over time by capitalizing on the value embedded in used products (Guldmann & Huulgaard, 2020). The first part of this definition is represented in the business model canvas by the shift from sales to Fairphone as a service. This is the extended **value proposition** that the theory suggests is added to a business model. This extended value proposition requires adding product lifespan management to **key activities**. This is how the 3R's principle of circular economy is adhered to. Improved product lifespan management leads to fundamentally decreased environmental impact, as expected in service systems (Tukker, 2015). Simultaneously, this also affects the finances as the total lifecycle is prolonged and the end of life care is controlled. A more economically and environmentally efficient way of handling resources is introduced in the model, as less raw materials are required for production and reproduction while reusing adds value in the model. FaaS was designed to improve resource efficiency by further closing material loops and prolonging the product cycles, which in accordance with the purpose of circular business models (Nußholz, 2017). This confirms the statements in the theory that business model innovation is an important facilitator to circular economy (Bocken et al., 2016). This activity ensures a value recreation and redelivery of used resources.

Furthermore, **channels** are in this model closely linked with **customer relations**, both of which are now a continuous stream of information back and forth between Fairphone and its customers involving extensive contracts. Customer relations move from once-off transactions to an extensive contractual agreement about services. These services introduce recurring revenues and usage fees and completely cancel transaction revenues. This type of business ensures the value recapture of the delivered value. Overall, the changes in the business model canvas are as could be expected from the theory. The

business model canvas showed an important change in the **cost structure** as well, which is less highlighted in the general review of the changes. This is where a more detailed evaluation of a business model shows its importance.

5.3 Product vs. service systems

The theory focuses essentially on the improved circularity that service systems facilitate compared to product systems or sales. While product systems have a primary focus on selling a product, ignoring or at least not explicitly supporting the 3R's principle, circular business models such as the FaaS model have the following characteristics (Tukker, 2015):

1. The inner cycles are prioritized over outer ones (e.g. reuse and recover comes before recycling)
2. Slowing the cycles (e.g. using resources for as long as possible)
3. Reducing waste at every stage of the product life cycle
4. Reduce, reuse, recycle and recover resources as much as possible

This suggests that moving to a use and result-oriented service system brings about a vital change in resource efficiency. This is coherent with what was found in the results, as the opportunity for adhering to the 3R's principle of is improved, especially for reusing. Reusing simultaneously reduces the total usage of resources through a more efficient handling. Retaining ownership of the phones gives Fairphone insight to what is happening to its products and their modules, how they are used and where they are. This gives more control over the lifecycle as well as the end of life treatment. In this improved resource management lies the essence of the characteristics as described above. The modularity of the phones offers the possibility of enhancing overall performance, since modules that become outdated due to technological innovations or that simply break down can be replaced. Because of this flexibility, the phone already has a prolonged life cycle. The FaaS model adds to this prolonged lifecycle the option of multiple cycles. Fairphone receives the outdated or broken-down modules which it can then use to reuse, refurbish for further use or recycle. This is in line with the theory, which show that service systems offer opportunities for circling natural resources in the model longer (Maxwell & Van der Vorst, 2003; Tukker 2015; Yang & Evans 2019). Retrieving modules and keeping track of them for updates and repairs does intensify customer relations.

While the theory offers several types of service systems, it provides no insights into what type of products these systems can be used for. The whitepaper adds a specification of the range of products that FaaS can be applied to. Product systems are possible with about anything with regard to **asset value**. FaaS or a similar model is possible for assets of medium to low value. Higher valued assets are not yet feasible, possibly due to the added risk and financiers' reluctance to invest which may make it difficult to acquire the proper financing. The securities introduced to reduce risk once more reflect on the complexity of innovation and the necessity of stakeholder co-creation. Companies have to ensure that their customers are trustworthy while also committing them to tedious, exhaustive contracts that are fair and attractive to customers at the same time. This trusted cooperation helps companies' financial credibility to their financers. Companies can also improve their credibility with collateral value of their assets to ensure payout in case of default.

The advantages to service systems like more constant revenues and synergy between company, customer and environment are advocated in the theory by Tukker (2004); Ritala et al. (2018); Yang & Evans (2019) and they are confirmed in the results. However, while the advantages are widely advocated in the theory, challenges in transitioning to circular business models is under-researched (Guldmann & Huulgaard, 2020). The results about the comparison between sales and services provide potential barriers that come with FaaS. They show that several potential barriers make it difficult to start innovating in the first place. In the case of the FaaS system, the buildup of the financial model

was a barrier. To reduce the risk and create financing opportunities, the contracts with customers had to be specified in great detail, which also presented its own barriers.

A problem with the potential barriers for Fairphone could be the same problem in the theory: the potential barriers that are researched are often specific to a case and are therefore less easily applicable to other industries or companies (Linder & Williander, 2017). However, although Fairphone-as-a-Service was a single case study, the initial approach of this community of practice was to create a service business model development tool. This tool offers a more general development strategy that can be used for any assets of similar value. This makes it more widely applicable tool and counters the argument that the barriers are too specific to apply to other companies and industries that are looking to adapt a similar use-oriented service system.

5.4 Propositions

Proposition 1
The results add to the theory that old-fashioned thinking is not only an issue that should be looked out for within a company itself, but also in its customers. They are essential to the success of a business model as the value proposition is directed at them. Customers need to be convinced that service systems are to their advantage too. Including the customers in the stakeholder co-creation process creates a better understanding of their expectations and how they can be met. This could help persuade customers to move away from the idea of buying and owning a product, and rather pay for a service instead. In the end, this will help ensure customer satisfaction which is essential for a sustainable growth of customer base. This suggests proposition 1 is correct, which stated that **clear mutual expectations between companies and their customers** is essential for service systems. The results show this is even more important than expected, as customer quality is an important factor to reducing risk for companies.

Proposition 2
While the first proposition is concerned with clear agreements between companies and customers from the start, it can be concluded from the stakeholder process that the only way to keep improving a novel business model and become more fool-proof is through continuous assessment and adjusting. Feedback from stakeholders, customers and from within the company about the practical workings of the business model are key in this. This confirms proposition 2, which stated that the success of a newly introduced business model is **dependent on how well continuous feedback is integrated** into the model. This way, the unforeseen problems can be recognized quickly and be dealt with accordingly, which will ultimately continuously improve a business model.

Proposition 3
It is extremely difficult, if not impossible, to create a business model that is “hassle-free”, in other words which includes all potential problems and has a solution for them. This is supported by the theory, which states that business model innovation involves many unforeseen problems that do not arise until after the model is already in use. This and the confirmation of propositions 1 and 2, which confirms the essence of feedback and customer relations to improving a model, supports the third proposition as well: **service systems need to be put into practice to advance development.** This holds even more true for service models, as they require more intensive assessment and are more complex than models purely based on sales.

Proposition 4
Proposition 3 suggests that for companies to be able to innovate their business models to be more circular, the models have to be put into practice first. The recurring mention of complex innovation, potential unwillingness and inability to innovate and hesitance to finance leads to the assumption that

the industry on its own is not yet able to initiate a change to service systems. This is where proposition 4 is relevant. This proposed that **government interference is required** for the advancement of innovation towards service models. As said, this proposition was added after revising the data and does not necessarily originate from clues in the theoretical framework. However, the data provide a possible answer to the claim in the theory about why there are still few tools for developing service systems. The problem with this type of circular business model innovation is a vicious cycle: there are few tools for creating business models that adhere to circular economy principles, which discourages companies from innovating. At the same time, putting innovative models into practice and improving them constantly is essential to advance development, assuming proposition 3 holds. Taking Fairphone's community of practice as an example: the process took place over the course of six months and included several external stakeholders and multiple meetings. It shows that the process of innovation is costly and time consuming with no guarantee of success, which further discourages companies to innovate. Therefore, financial or legislative government interference could be a way of encouraging companies to initiative action. This could be through either financial aid to help development, or through legislation to enforce it.

5.5 How does moving from product to service systems affect business models

The business model canvas that was used to map the changes in business models when moving from product to service systems offered a more exhaustive view of what exactly changes. These changes were reviewed in the discussion and can now be used to supply an answer to the research question on a wider scale, for business models in general. To make the outcomes more general, the changes are categorized in the initial purpose of business models, as mentioned in the theory (Boons & Lüdeke-Freund, 2013).

1. Value proposition: what value is embedded in the product/service offered by the firm;
2. Supply (or value) chain: how upstream relationships with suppliers are structured and managed;
3. Customer interface: how downstream relationships with customers are structured and managed;
4. Financial model: costs and benefits from value proposition, supply or value chain, customer interface and their distribution across business model stakeholders.

It is clear that there have been major changes in all of the elements. The value proposition moves from selling a product to offering a service related to the product. The upstream relationships in value chain are more intense and require involvement from the upstream stakeholders. The customer interface is now structured on continuous back and forth contact to ensure the proper service instead of a once-off transaction. The financial model has changed as the revenues are stretched out, initial risk is bigger and acquiring financing is more challenging as a result. As was predicted in the theory, changing one element of a business model subsequently affects all other elements, which causes the entire model to completely transform. The service system adheres to the 3R's principle and consequently advances circular economy through enhanced product lifecycle and multiple cycles but it also complicates the business model.

In addition to the changes in the elements of a business model, the innovation process itself is inherently affected as well. This was further supported by the outcomes of the propositions. Involving a wide set of stakeholders, including customers, in the innovation process has become more crucial. This co-creation is needed to gather the proper information about what all involved parties require, what they can offer and how all that information can be used to create and maintain a successful service system. The intense innovation process and complete shift of the business model are all elements to consider when moving from a product to a service system. At the same time, they are

elements that currently still prevent a lot of companies from innovating because they are unable or hesitant due to their business environment and their stakeholders.

6. Conclusion

In conclusion, the change from product to service systems requires an intensive assessment of business operations, leading to a reinvention of the entire business model. Further, it involves a more complex innovation process that requires a committed cross-disciplinary team. The value proposition, customer relations and financial model are most notably affected. Changing these elements involves an extensive continuous communication between companies, stakeholders and customers, leading to constant reassessment and improvement of the business model. This process is time consuming and expensive. However, the potential advantages are great, both economically and environmentally speaking.

It seems that companies are unable to develop a multi-deployable business model innovation tool without aid as of yet. This shows the importance of the FaaS development tool, as it can potentially be used in other industries for similar valued assets. When more successful tools have been developed, more companies should see the opportunity to innovate and the innovation process should able to advance more quickly.

Research strengths and limitations

The results of the business model canvas have been made more general by including the original purpose of business models. So, even though the FaaS business model was created specifically for Fairphone and one customer as a pilot, it can be used as a tool for similar models in other phone companies. Moreover, it could serve as an example for industries such as white and brown goods like TVs and laundry machines, as they are in the same medium to low asset value range as Fairphone. The concept FaaS contract and the rights and commitments that it produces can help companies assess the feasibility of offered services and how they are valued by customer. This research can help companies understand how their business is going to change when introducing a similar service system much in the same way.

Furthermore, most of the research found about business model innovation in the field of service systems was focused on the resulting improved resource management and circularity. This research provides more insight into how the innovation process itself was affected and offered a clear overview of the how the improved circularity affected the business model itself.

However, the business model canvas is as mentioned an exhaustive list, and as such it could exclude important factors. So, although changes can be reviewed extensively, there could be changes relevant to business models that are still unknown. Assessing the innovation from multiple points of view should help create a more complete understanding of what changes and how those changes can be managed and improved. The same can be said for the comparison between FaaS and sales. Although there are many differences between product and service system, for the sake of simplicity and clear overview, some main differences were discussed. This could result in missing other important elements.

Suggestions for further research

This research has led to ideas and assumptions that are interesting but cannot be answered because they fall outside the scope of this research. Further research would be required to study the accuracy and relevance of these ideas. First, as was mentioned in limitations of the research, the business model

canvas is exhaustive but not all-inclusive. What could help overcome this limitation is to use **other business model tools** than the canvas to further study the changes in future research to create a wider range of knowledge. This could enhance validity of the outcomes and help the development of a more definitive and broadly applicable tool for product-service model business innovation.

What could help advance circular economy as well is more research into the effect of government intervention. As said this could be through legislation or financial aid. Before any sensible actions can be suggested, the effect of either should be looked into.

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