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Unlocking circular business: A framework of barriers and drivers

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ABSTRACT

Circular economy increasingly attracts the interest of business, policy makers and academia in the search for answers to sustainability challenges. While earlier studies have presented drivers that support the introduction of new business concepts for circular economy, as well as barriers that hinder the rate of innovation in the field, no systematic categorizations of such factors have been brought forward. Drawing on current literature, a framework of drivers and barriers is introduced, including seven distinct areas: *environmental, economic, social, political and institutional, technological and informational, supply chain,* and *organizational* factors. The appearance and content of these areas in practice have been examined in four case organizations by conducting thirty-six qualitative, semi-structured interviews. Empirical illustrations of the potential barriers and drivers provide managerial implications for better execution of circular business.

1. Introduction

The transition towards a more sustainable future has a clear driver: the current linear economic system is reaching its physical limits. The concept of *circular economy* (CE) has attracted the attention of policy makers, academy and business increasingly as one of the latest approaches to respond to calls for sustainability (Murray et al., 2015), slowing down climate change, and addressing resource scarcity challenges (Ghisellini et al., 2016). In this study, CE is understood as a system in which value is created by minimizing waste and the use of energy and natural resources (e.g. Geissdoerfer et al., 2017; Bocken et al., 2016). This is achieved by utilizing models for slowing, closing and narrowing loops of material and energy flows regeneratively (Sauvé et al., 2016; Rizos et al., 2017) and following the principles of *reduce, reuse* and *recycle* (Jawahir and Bradley, 2016; Wu and Deng, 2013).

Circular business refers to solutions (including both products and services) and business models that aim at enhancing CE and responding to resource scarcity, minimizing environmental impacts, and producing short and long-term economic benefits (Lieder and Rashid, 2016; Loiseau et al., 2016). Although CE has received increasing attention among academics, the practical implementation of CE principles has been somewhat modest, as business processes are typically linear by nature (Schulte, 2013; Ellen MacArthur Foundation, 2013; Lacy and Rutqvist, 2015). The current literature discusses various concepts around CE (e.g. Loiseau et al., 2016), as well as some of the reasons explaining the gradual implementation of circular economy. However, the research focusing on factors that may either drive or inhibit circular business progress is nascent and has predominantly focused on a single category, such as financial and economic indicators (Di Maio et al., 2017; Tornese et al., 2017) or barriers hindering e.g. material efficiency in manufacturing (Shahbazi et al., 2016). Also the perspectives vary. For example, Lozano (2015) has concentrated on drivers for corporate social responsibility, Tukker (2015) and Tukker and Tischner (2006) on product-service systems, Pietzsch et al. (2017) on waste management, and Geng and Doberstein (2008) on societal factors. As research crossing several categories of drivers and barriers is virtually nonexistent, a holistic view of what different types of factors may either support or inhibit an individual firm's implementation of CE principles is lacking. Furthermore, as most contributions in this area are conceptual by nature, additional empirical research illustrating how industry actors are affected by different drivers and barriers of CE would be warranted.

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The study draws from the literature on different drivers enhancing and barriers inhibiting the design and development of business around CE. The research question addressed in this study is: *What are the drivers and barriers for developing new business in circular economy?* To study this issue in a real-life context, the multiple-case study approach, interviewing fourty-five managers in four firms is employed.

First, based on an analysis of existing literature, an integrative framework of circular economy drivers and barriers is introduced, including seven distinct categories: *environmental, economic, social, institutional, technological and informational, supply chain, and organizational* factors. After introducing the research methodology, additional depth into these literature-based categories is provided by discussing how they have influenced the development of CE business in the case firms. The study concludes with a discussion of potential implications, limitations and suggestions for future research.

2. Literature-based framework of circular economy drivers and barriers

Based on the review of existing literature, seven main categories of barriers and drivers the development and implementation of business aiming at CE (Table 1) were identified, including *environmental, economic, social, institutional, technological and informational, supply chain,* and *organizational* factors. These factors are discussed in detail in the following chapters.

2.1. Drivers for circular economy

The root causes for accelerating the willingness to adopt CE rise from the pressure to reduce negative environmental impacts. These include resource scarcity (Lacy& Rutqvist, 2015; Moreno et al., 2014; Murray et al., 2015) and possibilities to prevent negative environmental impacts caused by current operations (Linder and Williander, 2015; Andrews, 2015; Ghisellini et al., 2016). From the economic perspective, CE is seen to provide opportunities for cost savings, e.g. by reducing waste and energy costs (Andersen, 2007; Esposito et al., 2015; Ghisellini et al., 2016; Liu and Bai, 2014; Murray et al., 2015; Pitt and Heinemeyer, 2015; Rizos et al., 2015). CE provides possibilities for new value creation, business growth and increase in margin and profits (World Economic Forum, 2014; Linder and Williander, 2015), and is seen to have potential for innovation and business development (Andersen, 2007; Schulte, 2013; Kok et al., 2013) and finding synergy benefits (Dong et al., 2016).

Market internationalization and stricter environmental regulations (Zhu et al., 2011) are examples of social drivers increasing the pressure for companies to find alternatives for traditional business. CE is seen to include the potential to increase workplaces and vitality (European Commission, 2014a). Institutional factors, such as governmental support through directional laws (e.g. processing toxic wastes) and regulations have a clear enhancing role towards CE (Dong et al., 2016; Velis and Vrancken, 2015). Subsidies and supportive taxation, such as recycling policies also lower companies' risks in establishing new business around CE (Desrochers, 2002; Witjes and Lozano, 2016). Furthermore, global standards (e.g. ISO 14001) and goals (e.g. energy intensity and emissions) encourage the development of CE (Bai et al., 2015; Dong et al., 2016; Velis and Vrancken, 2015).

Technological development encourages companies towards CE (Lacy and Rutqvist, 2015; Mathews and Tan, 2011). New technologies not only provide cleaner solutions for the future, but also help in avoiding and overcoming problems caused by the current technologies (Ghisellini et al., 2016). Information sharing platforms support cooperation with many stakeholders and enable better information transparency, thus helping in the adoption of CE business models (Ellen MacArthur Foundation, 2013).

Supply chain -related drivers include the potential to reduce supply dependence (Ghisellini et al., 2016; Andrews, 2015; Esposito et al., 2015; Pitt and Heinemeyer, 2015) and avoid high and volatile resource prices in the future (Moreno et al., 2014; Schulte, 2013). From the organizational perspective, by following CE principles companies may be able to achieve brand benefits, protect and strengthen their image (Geng et al., 2012), and enable differentiation (Linder and Williander, 2015).

2.2. Barriers for circular economy

Although the targets of CE are highlighted constantly and adopted e.g. as a part of the future strategies of the EU and China (Su et al., 2013; European Commission, 2014b), several environmental and economic barriers to CE still exist, including lack of financial capability (Ilić and Nicolic, 2016; Rizos et al., 2016) and support (Xue et al., 2010), as well as high costs of new technologies (such as re-processing of metals) (Gumley, 2014). One of the biggest reasons for the ineffective development of CE is high economic uncertainty, as defining and measuring the long-term benefits of CE is extremely challenging (Bechtel et al., 2013; Rizos et al., 2015).

The institutional and structural barriers are deep-rooted: industry policies still favor linear models (Gumley, 2014) and CE implementation relies on e.g. municipal government officials' awareness of the issue (Ilić and Nicolic, 2016; Xue et al., 2010). The complexity of laws and regulations harm CE business (Gumley, 2014; Radamaekers et al., 2011). For example, transporting waste across national boundaries is often difficult (Bechtel et al., 2013). Lack of governmental support appears as ineffective taxation policies, funding and royalty regimes (Gumley, 2014; Studer et al., 2006).

The lack of technologies, knowledge and information also hinder the adoption of CE business models. Knowledge of how to transform the firm's current operations into circular business may be lacking - e.g. how to replace existing materials with recyclables (Bechtel et al., 2013). Lacking technical skills create challenges for identifying, assessing and implementing more advanced technical options (Rizos et al., 2016; Radamaekers et al., 2011; Trianni and Cango, 2012). Due to the lack of databases for sharing waste information (Radamaekers et al., 2011) and technologies to establish CE business models (Suocheng et al., 2007), the identification of business opportunities is difficult.

From the supply chain perspective, barriers rise from the strong industrial focus on linear models (Gumley, 2014; Suocheng et al., 2007). CE business often involves multiple stakeholders. The lack of network support and suitable partners (possibly due to weak environmental awareness of the stakeholders) is a barrier for CE adoption (Wooi and Zailani, 2010). Lack of collaboration reduces the amount of available resources and hampers the establishment of supply chains meeting CE requirements (Rizos et al., 2016).

Examples of organizational challenges related to CE business implementation include e.g. hierarchical systems inhibiting flexibility and innovation, silos between departments, and risk aversion of managers (Liu and Bai, 2014). Problems are also faced due to weak management support and failures in creating common understanding (Bechtel et al., 2013). Further barriers are lacking skills and capabilities and incompatibility with existing operations (Rizos et al., 2016). Missing abilities to change the mindset to long-term thinking, solve problems with the existing business culture, communication throughout the value chain and lack of systems thinking also present barriers for the promotion of CE business (Bechtel et al., 2013).

Table 1
Framework of circular economy drivers and barriers.

Category	Drivers - Emphasis areas	Barriers - Emphasis areas
Environmental	• Resource constraints and potential for preventing negative environmental impacts Andrews (2015); Ellen MacArthur Foundation, 2013; European Commission, 2014a; Ghisellini et al. (2016); Kok et al. (2013); Lacy and Rutqvist (2015); Linder and Williander (2015); Moreno et al. (2014); Murray et al. (2015)	N/A
Economic	• Potential for improving cost efficiency, finding new revenue streams and gaining profit • Potential for new business development, innovation and synergy opportunities Andersen (2007); Dong et al. (2016); Esposito et al. (2015); Ghisellini et al. (2016); Kok et al. (2013); Linder and Williander (2015); Liu and Bai (2014); Murray et al. (2015); Pitt and Heinemeyer (2015); Rizos et al. (2015); Schulte (2013); World Economic Forum, 2014	• High costs and lack of financial capability and support • Lack of tools and methods to measure (long-term) benefits of CE projects Bechtel et al. (2013); Gumley (2014); Ilić and Nicolic (2016); Rizos et al. (2016); Xue et al. (2010)
Social	• Increased internationalization and worldwide awareness of sustainability needs • Potential to increase workplaces and vitality European Commission, 2014a; Mathews and Tan (2011); Zhu et al. (2011)	• Lack of social awareness and uncertainty of consumer responsiveness and demand • Lack of market mechanisms for recovery • Lack of clear incentives Adams et al. (2017); Bechtel et al. (2013); Liu and Bai (2014); Planing (2015); Radamaekers et al., 2011; Xue et al. (2010)
Institutional	• Directing regulations and standard requirements • Supportive funds, taxation and subsidy policies Bai et al. (2015); Desrochers (2002); Dong et al. (2016); Ilić and Nicolic, 2016; Stahel (2013); Velis and Vrancken (2015); Witjes and Lozano (2016); Yu et al. (2014)	• Complex and overlapping regulation • Lack of governmental support • Lack of CE know-how of political decision-makers Bechtel et al. (2013); Gumley (2014); Ilić and Nicolic (2016); Radamaekers et al., 2011; Studer et al. (2006); Xue et al. (2010)
Technological and informational	• Potential for improving existing operations • New technologies • Increased information sharing through enhanced information management technologies, e.g. platforms Ellen MacArthur Foundation, 2013; Feng and Yan (2007) Ghisellini et al. (2016); Lacy and Rutqvist (2015); Mathews and Tan (2011)	• Lack of information and knowledge • Lack of technologies and technical skills Adams et al. (2017); Bechtel et al. (2013); Radamaekers et al. (2011); Rizos et al. (2016); Suocheng et al. (2007); Trianni and Cango (2012)
Supply chain	• Potential for reducing supply dependence and avoiding high and volatile prices • Open collaboration and communication practices • Multi-disciplinarity, increased availability of resources and capabilities • Management of (reverse) networks Adams et al. (2017); Andrews (2015); Ellen MacArthur Foundation, 2013; Esposito et al. (2015); European Commission, 2014b; Ghisellini et al. (2016); Kraaijenhagen et al., 2016; Kok et al. (2013); Lacy and Rutqvist (2015); Linder and Williander (2015); Moreno et al. (2014); Pitt and Heinemeyer (2015); Schulte (2013); World Economic Forum, 2014	• Lack of network support and partners • Strong industrial focus on linear models • Lack of collaboration and resources Bechtel et al. (2013); Gumley (2014); Kraaijenhagen et al., 2016; Rizos et al. (2016); Suocheng et al. (2007)
Organizational	• Potential for differentiation and strengthening the company brand • Increased understanding of sustainability demands • Circularity integrated in company strategy and goals • Development of skills and capabilities for CE Bocken et al. (2016); Ellen MacArthur Foundation, 2013; Geng et al., (2012); Kok et al. (2013); Lacy and Rutqvist (2015); Linder and Williander (2015);	• Incompatibility with existing (linear) operations and development targets • Silo thinking and fear of risks • Conflicts with existing business culture and lack of internal cooperation • Heavy organizational hierarchy and lack of management support • Lack of CE knowledge and skills Adams et al. (2017); Bechtel et al. (2013); Lacy and Rutqvist (2015); Liu and Bai (2014); Rizos et al. (2016)

3. Methodology

Research approach of the study is both qualitative and exploratory, focusing on examining how the barriers and drivers for circular business manifest for individual firms. The data comprises interviews in four case companies representing different industries. The case study was seen as the appropriate research method to create deep and detailed understanding of the phenomenon in real-life contexts (Corbin and Strauss, 2015). The embedded multiple case design allowed to provide rich empirically grounded descriptions and create more holistic understanding of the drivers and barriers for CE in a broad and more generalizable context (Yin, 2014).

3.1. Research data and analysis

The data was collected by conducting 36 semi-structured interviews in four case organizations (Table 2). Purposeful sampling (Palinkas et al., 2013) was used to identify and select information-rich cases. The research team had ample opportunities to interact with the four case organizations and became familiar with the salient characteristics and cultures of the participating organizations, providing access to rich data (Erlandson et al., 1993).

Data collection involved 45 informants with different managerial positions in sales, strategic management, R&D, service implementation, communication, and asset and technology

Table 2
Overview of the interview data.

Company	Industry	Employees approx.	Data collection	No. of informants
Fortum	Energy	8000	7 individual and 2 group interviews	12
BMH Technology	Waste management and recycling	100	14 individual interviews	14
Solita	Information and communications technology	600	4 individual interviews, 2 group interviews	5
UPM	Bio and forest	20 000	2 individual and 5 group interviews	14

management. These individuals were seen to be especially knowledgeable about the topic of interest (Cresswell and Plano, 2011). The duration of the interviews varied between 39 and 104 min, and they were conducted in Autumn 2016 - Spring 2017. All interviews were recorded and transcribed.

The interviews started with the introduction of the CE concept and asking the informants to describe how they see CE as a part of their business. The informants were then asked to identify specific CE projects in their organizations and describe the development, sales, selection, and execution processes of these projects. The focus was especially on identifying and describing the specific drivers and barriers that had impacted the CE projects. The interviews then continued with a discussion on how the case firms developed new CE business practices. In this final section, the aim was to increase the richness of our data by ensuring that the informants could raise additional viewpoints they considered relevant for developing new business in CE.

The data analysis was conducted by textual coding and looking for emerging categories in the data. These were then analyzed in the context of the theoretical framework and discussed with representatives of the four studied organizations in two facilitated workshops. The purpose of the workshops was to verify that the interviewed individuals considered our results to present a summary of the research findings and that the results represented the reality in their organizations accurately, and to provide a further opportunity to add details to individual findings.

3.2. Case firms

The empirical data was based on insights of four case companies headquartered in Finland and operating internationally. In the following the case companies and their premises for conducting business for CE are introduced, providing information about the selected focus areas of the research.

3.2.1. Fortum city solutions

Fortum is a large energy company offering its customers clean-energy solutions including electricity, heating, cooling, and smart solutions to improve resource efficiency. Here the focus is on Fortum City Solutions Division, which develops and delivers sustainable business solutions. City Solutions offers expert services, district heating and cooling, energy recovery of waste, biofuels, and other recycling solutions. The solutions are provided in a sustainable manner e.g. by utilizing industrial surplus heat.

3.2.2. BMH technology

BMH Technology is a medium-sized firm operating globally and offering its customers fuel production plants and waste management systems. In addition, different services, such as spare parts, life cycle maintenance and modernization are offered. This study focuses on the company's waste management solutions unit which offers its customers solutions for refining community and industrial waste into Solid Recovered Fuel (SRF) that can be combusted in power plants. When delivering and designing the solutions to global customers BMH relies on its network, and several subcontractors and local workshops are used.

3.2.3. UPM renewable diesel

UPM is a large global company operating in bio and forest industry. Its main products are biofuels, biocomposites and biochemicals, paper, pulp, plywood, and energy. This study concentrates on the UPM renewable diesel unit which produces fuel from the side streams of pulp production processes. Compared to fossil fuels, renewable diesel reduces greenhouse gas emissions and cuts down the use of limited non-renewable resources. In comparison with traditional biofuels, UPM renewable diesel utilizes non-edible materials as raw materials, increasing the sustainability of operations.

3.2.4. Solita

Solita is a medium-sized digital business consultancy serving customers in both public and private sectors. Solita supports their customers through service design, enterprise architecture, custom software, eCommerce, analytics, data science, business intelligence, IoT, integrations, and cloud services. Solita's digital business solutions are customer-driven, tailored and include typically multiple stakeholders. From the CE point of view, Solita develops and delivers sharing economy -based solutions which increase the resource effectiveness of the customers' business processes.

4. Results

In the following, the observations regarding each of the seven identified categories are discussed, highlighting particularly areas where there was either strong homogeneity or strong heterogeneity in the findings across the four cases. A summary of the results, together with empirical illustrations is shown in Tables 3–9.

4.1. Environmental factors

Resource scarcity is a major driver in all firms to develop CE solutions. For example, by separating valuable materials, such as metals from waste (BMH) and the utilization of production by-products such as ashes (Fortum), improved material usage and cycles of valuable resources can be achieved. Furthermore, minimizing negative environmental impacts (such as CO2 emissions) is considered of paramount importance in production processes (UPM, Fortum). From the environmental perspective, no clear barriers were recognized.

4.2. Economic factors

The case firms generate value from production side streams and waste. For example, the ongoing banning and decommissioning of landfills increases the demand for solutions for utilizing waste, thus creating new business opportunities. Economic potential is also seen in business renewal and new service business enabled by for instance increased availability and reliability of CE-related data and new information management solutions. These include platform-based solutions which provide better visibility to the supply chain of retail business (Solita). The potential for cost savings due to reducing waste and energy usage was emphasized in two firms (Fortum, UPM).

Table 3
Observed environmental drivers and barriers.

	Observed drivers	Observed barriers
Environmental	**Global trend to minimize negative environmental impacts** (Fortum, UPM) *"The importance of CE solutions will increase in the future. The business logic will change. We cannot trust on electricity price, and need to consider sustainability values - operations need to be efficient and environmentally friendly, and in every way profitable to the society and a bit also to the shareholders." (Fortum)* **Resource scarcity (fossil fuels, waste material)** (Fortum, BMH, Solita, UPM) *"The common desire (and political decisions) to reduce greenhouse gases affected the decision to start the project... We wanted to create a product for the future that has lower CO2 emissions. We looked at our production side streams to see what can be processed further. Tall oil was identified as one." (UPM)*	*N/A*

Table 4
Observed economic drivers and barriers.

	Observed drivers	Observed barriers
Economic	**Cost savings** (Fortum, UPM) *"Material and energy efficiency, sustainability and environmental values are included (in the renewable diesel production)… all the material should be utilized as effectively as possible" (UPM)*	**High initial investment costs** (Fortum, UPM, BMH) *"Small operators (in waste management industry) take huge economic risk: making an expensive investment, buying the plant, and starting the fuel production." (BMH)*
	Potential to create value from waste and production side streams (Fortum, BMH, UPM) *"Our focus is on producing fuel [from waste]... and separate the fractions that make sense from economical perspective."" (BMH)*	**Scarcity of raw material, assets or infrastructure** (Fortum, BMH, UPM) *" The customer base and scalability (of CE projects) in Finland is so small that investments in technologies may be unprofitable" (Fortum)*
	Potential for new service business development (Fortum, BMH, Solita) *"Emphasized customer need for CE is an opportunity for us to develop information system solutions i.e. products and services that pay attention to CE information needs" (Solita)*	**Dominance of economic indicators in decision making** (Fortum, BMH, Solita, UPM) *"Assessing potential financial returns and the need for resources that allow the estimated return, is a very difficult task." (Fortum)*

The dominance of economic indicators in decision-making was identified as a barrier to CE solutions. The firms emphasized the difficulty of convincing potential customers of CE benefits. For example, BMH has faced difficulties in convincing customers of the monitoring benefits for optimizing the usage and extending the lifetime of their equipment. Firms with a large installed base of equipment considered high initial investment costs as a major barrier for CE. Other highlighted barriers were lacking regional infrastructure, as well as inadequate availability of assets and scarcity of raw material.

4.3. Social factors

All four companies emphasized the increasing awareness of sustainability as a key social driver for CE. For example, BMH has faced demands towards more efficient and accurate waste separation technologies, whereas the customers of Fortum demand solutions for the utilization of residual heat e.g. from sewage. CE has been visible in public debate, which has increased the demand for new solutions, such as recycled plastics.

The main barriers identified included especially region-specific standards and local culture, and conservativeness in business practices. For example, the waste management industry is developing at different paces in different countries, which is reflected in the demand for waste management solutions (BMH). Fortum and BMH have experienced low customer interest in investing into new technologies supporting CE. Furthermore, many CE solutions are relatively new and lack references (success cases) which are demanded by customers.

Table 5
Observed social drivers and barriers.

	Observed drivers	Observed barriers
Social	**Increasing awareness of sustainability needs** *(Fortum, Solita)* *"There is external pressure to get rid of coal… Our consumers are becoming more informed, they actually follow what is going on, what is burned, what are the emissions… and what is happening to their garbage." (Fortum)*	**Region-specific and (local) cultures hamper the implementation of new solutions** *(Fortum, BMH)* *"In East-Europe, heating has been a social service which people are not used or willing to pay for." (Fortum)*
	Increased external demand for sustainability *(Fortum, BMH, UPM)* *"The combustion of waste will increase [in China] in the future since the landfills in the cities are becoming full and no new ones can be built due to the high cost of land and environmental problems" (BMH)*	**Conservativeness in business practices (e.g. waste management industry)** *(BMH, Solita)* *"Still today our customers are just digitizing their traditional ways of doing business, while they should be questioning their entire value chains and what is actually sold" (Solita)*
	Societal development projects e.g. industry roadmaps supporting sustainable development *(Fortum)* *"Promoting factors include increased awareness and external pressure… Overall, industry roadmaps make these ideas more concrete… many actors could benefit from CE ideas, but they have not yet acknowledged it." (Fortum)*	**Lacking or uncertain customer needs** (Solita, Fortum, BMH) *"A big problem for business is that environmental issues are not valued... customers are not willing to pay more for pyrolysis oil than for traditional oil." (Fortum)*

4.4. Institutional factors

EU and national laws, regulations and standards, such as bans for landfilling, and global standardization of SRF, as well as demands for increased business transparency, create opportunities and demand for CE solutions. However, region-specific laws and regulations form barriers for CE. For example, combusting waste is illegal in many countries and regions, nullifying investments in waste management systems effectively (BMH). Furthermore, the lack of consistent subsidy and taxation policies (e.g. related to renewable fuels or definitions of waste) hamper business development (Fortum, BMH, UPM).

4.5. Technological and informational factors

Several unlocking technologies have reached a high maturity level, lending support to CE initiatives. For example, UPM produces renewable diesel at an industrial scale. Another important driver is the rapid development of technologies such as IoT, platforms and analytics enabling the collection, analysis and utilization of knowledge from a wide variety of sources. For example, Solita delivers solutions supporting the development and optimization of supply chains, and continuation of equipment lifetime, and BMH considers IT crucial in collecting data from customers' waste management processes.

Many identified CE barriers were related to material characteristics and logistics. For power plants, the handling of material flows may be difficult due to a lower homogeneity level of raw material. For example, Fortum's HorsePower solution requires technologies for burning horse manure (defined as hazardous waste) safely and effectively in existing power plants. Technology for the new types of fuels has to be developed, which is an expensive initial investment. Furthermore, barriers were identified in the context of information collection, storing and sharing, and specification and characteristics of the information management system.

4.6. Supply chain factors

The development of long-term relationships with supply chain partners was considered to promote information sharing and transparency. In addition, standardization and harmonization of information was seen to increase transparency in supply chains, creating opportunities for CE innovations. Many CE solutions have been created in collaboration with supply chain partners, e.g. Fortum has developed HorsePower in collaboration with UPM and BMH.

Differing and even conflicting interests in the supply chain reduce opportunities for CE solutions. For example, BMH mentioned attitude, operational and behavioral differences towards preventive maintenance between countries. Fortum emphasized the lack of transparency and unwillingness to share money-related information as factors hindering cooperation. Potential CE projects were also hindered by a lack of ownership and unclear partner responsibilities.

4.7. Organizational factors

Organizational factors supporting CE included acquisitions, availability of raw material from own production sites as a side

Table 6
Observed institutional drivers and barriers.

	Observed drivers	Observed barriers
Institutional	**Directing laws and EU regulations create a demand for new solutions** (Fortum, BMH, UPM, Solita) *"The driver for renewable fuels is the common desire to reduce CO_2 emissions (global and EU legislation to cut CO_2 emissions)" (UPM)*	**Region-specific laws and regulations against CE solutions** (Fortum, BMH, UPM, Solita) *" Some plants have permissions to combust SRF but not waste…. SRF is not waste, it is fuel…. In many countries this is not understood." (BMH)*
	ISO -standard development for solid recovered fuels (BMH) *"The increase in real CE models is clearly seen, e.g. different communities actuating these issues are interested in the standardization of recovered fuel… We are involved in global recovered fuel ISO-standard development" (BMH)*	**Conflicts of interest and fluctuations in taxes and governmental subsidies - high future uncertainty** (Fortum, BMH, UPM) *"Companies need to trust that political decisions will not go back and forth and will extend over multiple parliamentary terms and over the life-cycle of the plant" (UPM)*

Table 7
Observed technological and informational drivers and barriers.

	Observed drivers	Observed barriers
Technological and informational	**Emerging process technologies support CE business** (Fortum) *"For example heat pump technologies have improved, thus plants can be built more cost-effectively, in a larger scale." (Fortum)*	**Increased technical difficulty in handling CE material flows (lower homogeneity of raw material)** (Fortum, BMH) *"CE shortens the life-cycle of production equipment. From the power plant perspective, there is more variation in the fuel mix (cheaper fractions)" (Fortum)*
	Enhanced information sharing and management technologies support the creation of new services, increase transparency and enable more efficient processes (BMH, Fortum, Solita, UPM) *"Our investments in the industrial internet is part of aftermarket establishment, meaning that we are closer to the customers and could hopefully extend the lifetime of a product."(BMH)*	**Lack of compatible technologies and high technological uncertainty** (Fortum, UPM) *"One challenge is the rapid development speed of technologies. For example the best solar panel in the market two years ago can now be out of date" (Fortum)*
		Lack of practices and systems for collecting, sharing and utilizing CE information (Fortum, BMH, Solita) *"Especially large organizations (and information in these organizations) are quite siloed... I wonder how well companies understand the critical factors of their processes to actually enhance CE and efficiency." (Solita)*

Table 8
Observed supply chain drivers and barriers.

	Observed drivers	Observed barriers
Supply chain	**Increasing the transparency of the supply chain (BMH, Fortum, Solita, UPM)** *"Data-based services are a rising trend aiming at increasing transparency and creating new value from supply chain data" (Solita)*	**Conflict of interest, values and modes of operation between different stakeholders** (BMH, Fortum, UPM, Solita) *"Money and lack of transparency are the biggest issues in the lack of collaboration... For example, a company is not willing to reveal information of the pricing principles of ash agreements, although the situation could be win-win."(Fortum)*
	Increased availability of knowledge and technological resources through collaboration (BMH, UPM, Fortum) *"(In developing renewable diesel) we have had smart partners, good ideas and have managed to combine technologies into new solutions" (UPM)*	**No clear responsibilities and ownerships in CE projects** (Fortum, Solita) *"Systematic development of CE solutions and supporting IT architecture require a holistic approach and clearly defined ownership. Many customers have recognized that the current IT architecture and lack of ownership are barriers for data-based CE solutions" (Solita)*
		Validating and verifying all environmental effects is a challenge for transparency and analytics (UPM) *"The calculations for verifying emissions are complex and demand a lot from production systems and raw material tracking… Auditing all the procurement transactions is very expensive" (UPM)*

stream, flexibility due to the small size of the firm, and an own proprietary service development model. In addition, corporate strategies highlighting the importance of sustainability encouraged experiments and multi-disciplinary actions.

The identified barriers to CE included a lack of connection between CE and strategy, risk-aversion, and strong dependency on traditional (linear) operations. Focusing R&D resources on innovations with clear economic benefits instead of CE solutions was expressed as a barrier by many informants.

5. Discussion

The results of the study present the framework, which combines the existing literature and the empirical evidence from four case companies to seven categories of the drivers and barriers for CE business. The implications for theory and practice, limitations and suggestion for future research are discussed next.

5.1. Implications for practice and research

The review of earlier literature resulted in the identification and categorization of factors which either facilitate or hinder the introduction of new CE business concepts. As earlier studies have typically focused on the role of a limited set of factors at a time (e.g. Jawahir and Bradley, 2016; Bai et al., 2015), the framework of this study is expected to provide managers and scholars with a somewhat richer and more exhaustive view of different antecedent factors affecting the introduction of new CE business concepts. As such, the categorization established here should also reduce the risk of decision-makers ignoring relevant antecedent factors when considering the introduction of new business concepts.

The empirical observations revealed that the significance of the individual barriers and drivers is highly context-specific. As an example, the extent to which CE principles were integrated in the company-level strategies of the case firms varied remarkably. Two of the firms (Fortum, UPM) had clearly integrated CE principles to their strategy, whereas the role of CE was much weaker in the strategies of the two other firms (Solita and BMH). The role of company-level strategies in CE has also been acknowledged in previous literature (e.g. Ghisellini et al., 2016). The main implication resulting from this empirical case study is that, as both the drivers and barriers are context-specific, business concepts that are successful in a specific context may fail in another context. Thus, CE concepts should not be directly copied from a context to another,

Table 9
Observed organizational drivers and barriers.

	Observed drivers	Observed barriers
Organizational	**CE innovations foster a sustainable company brand** (Fortum, UPM) *"Customer references (such as Espoo hospital, in which waste heat is re-used) are examples of how we execute carbon neutrality."(Fortum)*	**Incompatibility with existing (linear) operations and development targets** (Fortum, BHM, UPM) *"This should be visible in our strategy so that we should have ideas, plans and visions about changing our solution models" (BMH)*
	Changed organizational structure, strategy and culture to support CE (Fortum, UPM) *"Due to organizational change, these issues are visible in our strategy… It is now acceptable to try, test and in a way also fail." (Fortum)*	**Conflicts with existing business culture** (Fortum, BMH) *"Thinking of my own history, it feels that I am again working in a totally new field, swimming so deep that the feet do not touch the bottom. I just need to flounder hard (to stay up)!" (Fortum)*
	Development of skills and capabilities for CE (Fortum) *"In our organization we have now more people who understand CE. ...Through implementing Ekokem and bio-oil, we have know-how capital inside the company by which we can do and process things forward." (Fortum)*	**Silo thinking and fear of risks** (Fortum, Solita, BMH) *"A project needs resources from various departments that have their own managers. Sometimes it is a challenge to get the resources due to conflicts in a single department" (BMH)*
	Flexible decision making and product/service development models (BMH, Solita) *"We question the customer's current practices and aim at identifying the real needs of their customers" (Solita)*	

but firms should instead analyze their own internal and external business environments to identify the most crucial drivers and barriers for CE and take these into consideration when designing the CE business concepts. Presented framework is likely to support firms in this process.

The role of information technologies in the introduction of new CE business concepts is also highlighted in the empirical results. This observation is aligned with earlier research by Winans et al., (2017), who argue that information exchange plays a crucial role as a constraint to the success of CE initiatives. Thus, unclear practices and lack of methods and platforms for information exchange can hinder the development of CE business. CE calls for shifting the attention on value creation, destruction and delivery activities from the perspectives of various network actors such as customers, supply chain partners and society (Bocken and Short, 2016; Tura et al., 2018a). Lowering the barriers for CE call for collaborative actions, sharing of resources and knowledge between the academia, business and government. For instance, the design of technological platforms enable actors to connect their resources across markets, creating value through complementarities and network effects as well as helping in avoiding conflicts of interest and increasing the sharing of knowledge (Tura et al., 2018b).

5.2. Limitations and suggestions for future research

While concentrating on identifying the drivers and barriers of circular economy and elaborating them empirically, this study did not specifically address the relative influence of individual factors on the development of new CE solutions. Furthermore, due to the qualitative nature of the research approach (e.g. respondent bias could not be completely eliminated), no claims regarding the generalizability of the identified of barriers and drivers to different contexts can be made. For example, the legislation regulating the use of waste is highly area-specific, very likely giving rise to area-specific CE solutions. For example in China the perspective on CE is wider in contrast to Europe's environmental focus on waste, resources and business opportunities. Thus, additional quantitative research in this field would be likely to result invaluable insights regarding the significance of the different framework categories in relatively different business environments. To provide additional understanding on this context-specificity of the drivers and barriers to CE and linking them to the performance outcomes of CE solutions, the adoption of a contingency approach (e.g. Lawrence and Lorsch, 1967) is suggested.

6. Conclusion

This study combined the insights from previous literature on CE with results from an empirical case study to develop an integrative framework of drivers and barriers for circular economy business. The proposed framework consists of seven distinct categories of *environmental, economic, social, institutional, technological and informational, supply chain,* and *organizational factors.* The main observation is that, the introduction of CE business concepts is strongly influenced by drivers that are highly context-specific, such as social pressure as well as regulation and legislation. In addition, it was found that information technology plays a central role in the transformation towards CE. The framework offered in this paper is likely to support firms developing CE initiatives in their efforts to analyze their internal and external business environments.

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