Breaking Circular Economy Barriers

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Abstract

Despite high estimated economic gains the implementation of a circular economy (CE) in most areas is generally slow. The purpose of this paper is therefore to examine the potential causes to this sluggish implementation and to discuss and illustrate how different types of barriers (technological, market, institutional and cultural) can prevent the further implementation of a CE. We conduct a systematic literature review where academic articles and “grey literature” on the barriers to a CE transition are analysed and classified into technological, market/economic, institutional/regulatory, and cultural/social barriers. We approach the research problem in a twofold way. Firstly, we recognize the barriers that currently seem to hinder a CE from developing. Secondly, we map these barriers to better understand how they are interdependent and entangled. Our main conclusion is that even small barriers can stop the emergence of a CE.

Keywords: Circular economy, barriers, sustainability, markets, recycling.

JEL classification: K23, L11, Q2, P18.
1. Introduction

Despite potential gains of a circular economy (henceforth CE) the implementation is slow in practice (Ellen MacArthur Foundation, 2013 and 2019; Enkvist and Klevnas, 2018). Actions get stifled by various barriers (Ghisellini, Cialani, and Ulgiati 2016; Govindan and Hasanagic, 2018; Kirchherr et al., 2018). Examples of barrier categories are technological (Milios et al., 2018; Kinnunen and Kaksonen, 2019), market (Tukker, 2015; Mangla et al., 2018; Rizos et al., 2015), institutional (de Jesus and Mendonça, 2018; Milios et al., 2019; Tura et al., 2019) and cultural (Agyemang et al., 2018; Singh and Giacosa, 2019). Any of these barriers can lead to what we argue is a “negative circle”, or a negative feedback loop. Hence, the CE breaks down and reverts to a linear economy.

Estimates of gains from a CE are substantial, the European Commission estimates that the manufacturing sector would gain 600 billion euros per year if it transformed to a CE (European Commission, 2014). On a national level Finland is estimated to gain 2.5 billion euros per year if it transitioned to a CE, and the global economy would benefit by 1000 billion US dollars annually (Arponen et al., 2015). To illustrate the problem let us contemplate an old economist joke told to first year students (who often are a bit confused) that involves two economists – one young and one old – walking down the street together. The young economist looks down and sees a $20 bill on the street and says “Hey, look, a twenty-dollar bill!” Without even looking, his older colleague replies “Nonsense. If there had been a twenty-dollar lying on the street, someone would have already picked it up by now”. The point is that in an efficient market, a large opportunity for profit will be absent, since someone would have already taken advantage of the opportunity.

However, the puzzle in the case of a CE is why are there billion-dollar bills on the street but nobody picks them up? Through policy decisions see e.g., the EU Circular Economy Package in 2015 (European Commission 2015) we should be on a path away from a linear traditional economic model, characterised to some extent by take-make-use-destroy (Korhonen, Honkasalo and Seppälä, 2018).

The purpose of this paper is to examine why the implementation of a CE is slow in some areas and illustrate how barriers (technological, market, institutional and cultural) can prevent the implementation of a CE. This paper tries to show how a “positive CE” might be implemented instead. Our contribution is therefore: (a) a theoretical reasoning of what needs to be done to
prevent CE barriers, (b) identification of key barriers and to show how even very small barriers can prevent the creation of a CE.

To empirically assess the literature, a framework adopted from de Jesus and Mendonça (2018) was used to classify findings from a range of studies, from manufacturing to plastics recycling, into four categories of hard – technological and market barriers - as well as soft - institutional and cultural barriers. Thenceforward, we will illustrate a model including these barriers and their possible inter-dependencies. The focus in the illustrative model will be on the market for recycled material arguing that a well-functioning market is an essential factor in a well-functioning CE system. The model provides an overview over how barriers create a negative loop hindering a CE from developing and the model illustrates how each of these barriers, on its own, could be enough to stop the creation of a CE system.

The remainder of the paper is organized as follows. Section 2 introduces previous literature and the broad concepts that we will consider. Section 3 presents our methodology and approach; section 4 provides our results. Section 5 synthesizes the findings and discusses the results. Section 6 contains concluding remarks and implications.

2. Concepts and theory

2.1 Circular Economy – a broad concept

A CE has a diverse theoretical background. The key characteristic of a CE, that also distinguishes a CE from other attempts to reduce energy and material consumption, is a holistic approach with the creation of circular loops of material, energy and waste flows that include all activities carried out in a society (Masi et al., 2018; Bonciu, 2014).

The idea of a CE entered academic literature in 1966 when the ecological economist Kenneth E. Boulding criticised the linear “cowboy economy” of the past and described a future as a “spaceship economy” where all used resources were put back into another part of the system (Boulding, 1966; Ghisellini et al., 2016). A CE, built on the theory of Boulding, was later initiated by the environmental economists Pearce and Turner (1989). Pearce and Turner (1989) discuss the lack of price and markets for environmental goods (e.g. air and water quality, public goods), and stress the need of internalizing these externalities. By doing so, resources could be used more efficiently and a transition towards a CE would be more probable (Ghisellini et al., 2016).

To be able to analyze the barriers related to a CE, a discussion about the concept and its definition is essential. Among researchers, there is no consensus on neither the scope nor the
nature of a CE. In fact, earlier research has found up to 114 different definitions (Kirchherr, Reike and Hekkert, 2017; Masi et al., 2018). Prieto-Sandoval, Jaca and Ormazabal (2018) have tried to review the literature and construct a definition based on all previous definitions:

“The circular economy is an economic system that represents a change of paradigm in the way that human society is interrelated with nature and aims to prevent the depletion of resources, close energy and materials loops, and facilitate sustainable development through its implementation at the micro (enterprises and consumers), meso (economic agents integrated in symbiosis) and macro (city, regions and governments) levels. Attaining this circular model requires cyclical and regenerative environmental innovations in the way society legislates, produces and consumes.” (p. 610)

In that sense a CE is a vague concept, and this obstructs the development of a CE. The fact that the existing definitions of a CE are broad, and include all activities carried out in a society, may explain why there is no consensus among scholars about the interpretation of a CE. By summarizing definitions of a CE in existing literature, Masi et al., (2018) point out that the perception of a CE differs among scholars where some see it as a new label for old concepts, others as a combination of established concepts, and a third as a new set of guiding principles for economic activity. In Figure 1 we visualize a case of a CE with its diverged areas. By studying figure 1, and using the summarized definition above, one may comprehend that a successful implementation of a CE requires actions from all levels (micro, meso, macro) in the economy as well as from all actors along the value chain.
Figure 1 Illustration of the Circular Economy with its different components.

The practical implementations of a CE can be divided into initiatives on three levels: the micro-level, the meso-level, and the macro-level (Masi et al., 2018): The micro-level refers to the firm-specific initiatives that usually emerge in the literature as the 3R’s Principles: Reduction, Reuse and Recycle. Reduction implies minimizing the inputs of energy, raw materials, and waste. Initiatives related to this principle might be product design favoring zero waste (Ranta et al., 2017). The reuse principle indicates that resources should be used more than once to manufacture goods with less resources, less energy, and less labor. Moreover, the recycle principle refers to the reprocessing of waste materials, in other words the materials that cannot be reused as is, into products for either original or other purposes (Directive 2008/98/EC, 2008).

On the meso-level, or the inter-firm level, initiatives related to cross-chain and cross-sector collaboration can be found. Initiatives like eco-industrial parks, a common property where businesses cooperate to use resources more efficiently, are also CE activities linked to the meso-level (Masi et al., 2018). Macro-level initiatives can be described as the implementations made by governments and policymakers (Masi et al., 2018). EU Circular Economy Package, the action plan undertaken by the European Commission in 2014, is an example of these initiatives (European Commission, 2015).

Understanding the broad concept of a CE, including diverged areas on different levels in society related to production and consumption, one might see that the barriers of implementing CE strategies are varied and complex. Masi et al. (2018) explain how the different levels of
implementation are interdependent and connected, since initiatives on the macro-level can affect both micro and meso-levels, and initiatives on the micro-level might have importance for collaborations on a meso-level. Hence, the barriers are also expected to be interdependent and related, which e.g. Kirchherr et al. (2018) and de Jesus and Mendonça (2018) confirm.

2.2 Economic theory for explaining barriers that prevent a CE
To understand why in some areas a CE is not established we must understand the market process. In the introduction we noticed that there might be a billion-dollar bill on the sidewalk that no one is picking it up. Why don't entrepreneurs rush to the occasion and make a profit? To analyse this, we need to understand the functioning of an entrepreneur and what is needed for a market to work, hence we will look at the institutions that could matter.

Institutions create rules which incentivize certain behaviors by changing the payoffs associated with different behaviors. Institutions consequently form the entrepreneur’s actions and are instrumental in economic activity (e.g., Boettke and Coyne 2003, 2009; Grafström 2017, 2019). Institutions that are emphasized as important in economic literature to create market conditions are: 1) well-defined and enforceable private property rights, 2) the rule of law, and 3) a moral code of behavior that legitimizes and recognizes these traditions. For example, Hayek’s (1937, 1945, 1948) property rights argument revolved around the information problem. Without private property, exchange is distorted. Without market competition the discovery process will be hampered (Hayek, 1968/2002).

A prerequisite for successful entrepreneurial action is guidance by relative price signals and the attraction of pure profit (which requires the calculation of profit and loss accounting). The price system economizes information which economic decision-makers must process. Without these important indicators the economic actor is lost (Mises, 1949). These indicators are a product of specific institutional configurations. Absent the institutional context of a private property market society, economic actors will still strive to achieve their goals, as best they can (North, 1990).

The Schumpeterian view of the entrepreneur emphasizes the entrepreneur as a creator of new combinations of knowledge (Klein, 2008). In Schumpeter’s work ideas about an economy’s creative response to changes in external conditions are highlighted (Schumpeter, 1934, 1942, 1947). Under the existing institutions of any society, the entrepreneurs will act to better their position e.g., money, position, promotions, or future advancement (Boettke and Coyne, 2009; Redford, 2020). Schumpeter’s entrepreneur is essentially disruptive, destroying the pre-existing state of equilibrium, while Kirzner’s entrepreneur spots opportunities in a dis-equilibrium and
moves the economy towards an equilibrium. In Kirzner (1999) it is argued that the two types of entrepreneurs are not that different, rather they are different in a glass half full - half empty way.

Relying on economic theory presented above we can construct a crude checklist that will help us to see if we can expect a CE to grow. If one of the boxes cannot be checked then we should expect that the opportunity for a change from a linear economy to a circular economy is smaller. An example we will elaborate on later in the paper is the case of household waste, that in Sweden is by law owned by the municipalities. The municipalities do not have to economize the resource and burn it as free fuel for heating. We do not say that the household waste could have a better use, but we do know that no entrepreneurs can get into the nonexistent market and prove otherwise.

Table 1 Necessary conditions for the establishment of a market

<table>
<thead>
<tr>
<th>Is there private ownership?</th>
<th>Is there a functioning rule of law?</th>
<th>Is there freedom of enterprise, freedom of establishment and freedom of contract?</th>
<th>Is the price set in a market today?</th>
<th>Is there a functioning competition? (either between actors or between products from different sources)?</th>
<th>Does profit work as a signal system?</th>
</tr>
</thead>
</table>

3. Methodology and approach

Following the communication of the EU Circular Economy Package in 2015 (European Commission, 2015), the academic and grey literature on a CE has increased rapidly (Wautelet, 2018). In our study, a desktop research was performed to identify academic articles and grey literature on the barriers to a CE transition. These studies were then read, and the barriers were extracted and classified into the frameworks constructed by de Jesus and Mendonça (2018). Systematic literature reviews should be replicable, scientific and have transparent methods, and they allow readers to follow the path researchers took to arrive at their findings (Tranfield et al., 2003). We followed the process found in Tranfield et al. (2003), which comprises three steps: planning, execution, and reporting. In the planning step, the keywords of interest and a protocol for realizing the chosen approach is defined.

Search terms containing “circular”, “economy” and “barriers” as well as synonyms of these were used in different orders to avoid missing out on relevant articles. A search on circular economy barriers on Scopus, for example, generated 241 results and 24 results on Science Direct. In a
first step the abstracts to these studies were then read to eliminate all irrelevant articles that did not contain any empirical investigation of barriers of any kind.

Three search engines were used to identify relevant studies: Elsevier’s Scopus, Google Scholar and Elsevier’s Science Direct. We focused on the last decade i.e. 2010 to 2019 with an emphasis on recent papers, since reviews about different aspects of the CE have been done in the past (see e.g., Govindan and Hasanagic, 2018).

Next a selection of academic articles commenced. Academic articles are expected to embody a serious research work aiming at expanding knowledge and the articles have been validated by the scientific community through the peer-review processes (Murray, 2013). All articles were evaluated to confirm that the paper considered fitted the scope of our topic. Any article that did not deal with the topic area or that played a minor role was not considered. However, articles in which the topic appeared as a significant sub-theme were included.

In the second step, articles with applications in strict niche markets, such as Brazilian Polystyrene, were removed while studies investigating a broader sector, such as plastics, manufacturing, or different supply-chains, were chosen for in-depth analysis. Those studies whose barriers were only mentioned because they had been identified in previous studies were not considered, only their original source, to avoid one barrier being counted twice although only empirically valid once.

A “snowball” technique was also used to identify other studies not found in the initial desktop research. We then proceeded with a content analysis which can be defined as: “A research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use” (Krippendorff, 2004, p.18). When the studies were gathered, we proceeded with a content analysis that comprised of procedures which are expected to be reliable, replicable, and valid (Seuring and Gold, 2012). In the analysis multiple research assistants and then a researcher read the content to ensure the validity and reliability of the results rather than trusting the judgements from a single person.

4. Results

The barriers are divided into four categories: technological, economic, institutional, and cultural barriers. Since the reviewed literature, mirroring the nature of the CE and thereby varying in scope, the identified factors apply to different stages in the supply chain and to a wide variety of sectors in the economy.
4.1 Technological barriers

Four major technological barriers categories have been identified: product-design, quality of recycled goods, know-how of technical solutions and IT systems for monitoring progress.

The concept of life-cycle costing analysis suggests that a large share of cost reduction opportunities for a project or product pertains to the early stages in its development (Water Environment Research Foundation, 2011). The same is true for environmental impacts. Design for product-life extension, as opposed to e.g. fast fashion, or design for opportunities for repair is therefore crucial (Ellen MacArthur Foundation, 2017). Current product design is a major obstacle for remanufacturing, re-use and recycling and is mentioned in academic articles by Masi et al., (2018) who surveyed business leaders worldwide and Vanner et al. (2014) who reviewed the literature on barriers to CE in the EU.

In many countries, separation of waste is limited, which causes real or perceived problems with the quality of recycled goods and materials. One issue, described by Milios et al. (2018) who investigated plastics in three Scandinavian countries, is how recycled goods can be of lower quality or less flexible than virgin material. Another issue is the reliability of supply of recycled goods making virgin material preferred by many producers (Kinnunen and Kaksonen, 2019).

Historically, the CE literature has been more focused on availability of technical enablers (de Jesus and Mendonça, 2018). Although various necessary technologies have been developed, many studies cite the lack of know-how among the practitioners of these solutions (Agyemang et al., 2018; or Tura et al., 2019). Many of the CE technologies may involve niche technologies that differ from the expertise within the firm, especially evident in SMEs (Rizos et al., 2015).

The infrastructure for effective waste management seems to be lacking in many places. Many collected recyclables are not separately collected. Food waste appears especially difficult to separate (Ranta, 2018). There is not always capacity to handle all the collected recycled goods which are instead placed in landfill (Milios et al., 2018). The goods that are recycled, however, may lack proper standards and therefore customers willing to purchase what is recycled, only partly due to the insufficient separation.

The last category of inhibiting technological factors for a CE adoption is the lack of IT systems for measuring and monitoring progress. Although specific software for detecting waste may exist, it appears not to have spread to all businesses or not been used due to the lack of waste stream data (Kirchherr et al., 2018). IT systems are also necessary for the shift from a physical-
goods dependent economy to a service economy and less resource-intensive immaterial satisfiers of human needs (de Jesus and Mendonça, 2018).

4.2 Market/Economic barriers

Market barriers are classified as obstacles to a CE adoption due to non-existent or ill-functioning of markets and economic barriers as financial arguments for why a CE is not adopted. The most frequently mentioned economic arguments include difficulties for funding CE business models, high up-front investment costs and low virgin material prices.

The argument concerning a lack of market is twofold. First, as mentioned by Tura et al. (2019), the market mechanism for recovery is not in place which is particularly evident in the market for recycled goods, which fails due to a combination of factors including quality standards (leading to the classic lemons problem in resale markets, see Akerlof, 1970), perceptions of quality, supply uncertainties and lack of economic incentives. Furthermore, externalities are not internalised through taxes or economic incentives (Masi et al., 2018).

One reason often cited in the literature for low perceived benefits (and another example of poorly internalised externalities) is that low virgin material prices (Kirchherr et al., 2018). The lower perceived prices of raw materials are due to lock-in-effects into current linear infrastructure (Preston, 2012). Another explanation is the perceived quality of recycled materials making the price-performance ratio insufficiently beneficial to switch to CE operations (Kinnunen and Kaksonen, 2019). Furthermore, the supply of virgin materials adapts more easily to price changes than the supply of recycled material since new mines can start material price rises. Recycled materials are dependent on previous consumption patterns and have therefore an inelastic supply. Thus, the price volatility of recycled materials is larger which creates uncertainty (Åkesson, 2014; Blomberg and Söderholm, 2009). The uncertainty might lead to a decreasing willingness to invest in recycled material markets, and the substitution to recycled material markets stays low.

Lastly, the high up-front investment costs are often mentioned in and were, in a survey study with business leaders by Masi et al., (2018), cited as the second most important barrier (after lack of awareness and sense of urgency). Any major shift in a society requires switching costs and these costs can take many different forms. Reversing the supply-chain, renegotiating contracts, adapting technology to suit new inputs or high development costs for new product design are just some examples. Another example is given by Milios et al. (2018) who mentions high research and development costs for making better use of recycled plastics.
4.3 Institutional/Regulatory barriers

The institutional and regulatory barriers include inconsistent policy-messages and poor institutional infrastructure. Since many supply-chains are highly internationally integrated, the consistency of policies between countries is crucial for CE adoption in large firms, heterogeneity in policies between countries is a main hindrance. Stimulating use of energy-efficient appliances may also be inconsistent with a CE, since existing products are replaced earlier, sometimes not compensating for the saved energy (de Jesus and Mendonça, 2018).

Another issue is that by-products are often legally classified as waste before the end of its life cycle which switches ownership from private to public (de Jesus and Mendonça, 2018). Another issue is the agreements around North-South trade of goods for reuse, recovery, and recycling from the Basel Convention of hazardous waste from 1992 which some argue fails to recognize the value of waste (Krueger, 1999). Other researchers mention high administrative costs of reporting waste streams, complex waste legislations and poor implementation of existing CE policies (de Jesus and Mendonça, 2018; Milios et al., 2019; Tura et al., 2019).

An often-cited barrier is that the institutional infrastructure is path dependent and favours a linear economy. Too little R&D, lack of support with training, poor physical infrastructure for reversed logistics and lack of CE management tools for SMEs are problematic (de Jesus and Mendonça, 2018; Masi et al., 2018).

4.4 Social/Cultural barriers

Three main categories of cultural barriers to CE adoption are resistant company culture, lack of consumer awareness and weak cooperation throughout the supply-chain. The CE-resistant company culture plays out on three levels: resistance from managers, CE initiatives in isolation from main operations and low engagement in management strategies. Both Mangla et al. (2018) and Agyemang et al. (2018) identified how top and mid-management resisted initiatives in a CE direction as change may not be in line with their incentive schemes. Mangla et al. (2018) also found that whilst CE initiatives may be happening within a larger firm, all divisions are not aware of the changes being made. Some firms report that a CE is not a part of their current innovation strategy and they do not have any measurable goals related to a CE, indicating low strategic engagement in many firms.

A framework to explain the low consumer awareness and interest in a CE was provided by Singh and Giacosa (2019) who concluded that psychological ownership of products, strong status-quo bias, consumerist culture to satisfy needs and status were key factors behind negative attitudes
toward CE goods. As was found by Rizos et al. (2015), a CE was a low priority in consumers’ decision process and many reported lacking awareness both about the meaning of the concept and about the circularity of their purchased goods.

Lastly, cooperation across the supply-chain is poor as CE measures are viewed as intrusive on business models, not economically beneficial and hampering the competitive nature throughout the supply-chain (Agyemang et al., 2018). Confidentiality about processes and volumes in production hampers industrial symbiosis and exchange of by-products (Masi et al., 2018).
<table>
<thead>
<tr>
<th>Study background</th>
<th>Technological barriers</th>
<th>Market/Economic barriers</th>
<th>Institutional/Regulatory barriers</th>
<th>Social/cultural barriers</th>
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<tr>
<td>(Preston, 2012) analysed grey literature – exploratory work on barriers and opportunities.</td>
<td>Intellectual property and information sharing of resource use</td>
<td>High up-front costs</td>
<td>Lock-in to linear infrastructure</td>
<td>Lack of consumer enthusiasm</td>
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<td>Political obstacles to putting an optimal price on resource use</td>
<td>Low willingness for cooperation throughout the supply chain</td>
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<td>Poor institutional cooperation across international supply-chains</td>
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<td>(Vanner et al., 2014) performed a literature review on barriers to CE implementation in the EU.</td>
<td>Lack of skills and investment in CE product design</td>
<td>Low raw material prices Challenges in obtaining finance for CE investment</td>
<td>Lacking policies to internalise externalities</td>
<td>Limited cooperation throughout supply chain</td>
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<td>Lack of know-how in product design</td>
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<td>Insufficient waste separation at source</td>
<td>Limited community and business acceptance for sharing models</td>
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<td>Limited public procurement incentives</td>
<td>Lacking consumer awareness and interest</td>
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<td>Insufficient in infrastructure for recovery and innovation</td>
<td>Lacking knowledge for implementation of CE policies</td>
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<td>(Kirchherr et al., 2018) performed a desktop research, 47 semi-structured interviews and a survey with 208 respondents in EU-countries.</td>
<td>Poor quality of recycled goods Products not designed for CE Too few large-scale demonstrations projects Lack of data on impacts</td>
<td>Low raw material prices High up-front investment costs Limited funding for CE business models</td>
<td>Obstructing laws and regulations</td>
<td>Hesitant company culture</td>
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<td>Lacking global consensus</td>
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<td>Lacking standardization of recycled goods</td>
<td>Lacking consumer awareness and interest</td>
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<td>Lock-in in current linear system</td>
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<td>Limited circular procurement</td>
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<td>(Rizos et al., 2015) Literature review on barriers to CE implementation in SMEs.</td>
<td>Lack of know-how and technical skills to implement CE practices</td>
<td>High up-front costs No excess human resources for CE focus Lack of access for funding</td>
<td>Lack of support for funding, training and taxation policy</td>
<td>Some SMEs have neutral/negative attitudes to “green business”</td>
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<td>Lack of eco-management tools for SMEs</td>
<td>Lack of knowledge about CE benefits</td>
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<td>Lack of understanding of CE concept</td>
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<td>Low priority in consumers’ decision process</td>
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<td>(Kinnunen and Kaksonen, 2019) Workshop and theme interviews with representatives in the mining industry.</td>
<td>Difficult to scale up use of recycled materials Some materials difficult to separate</td>
<td>High investment costs and long payback-periods Cheapest virgin material High logistics costs Low concentrations of valuable material in recyclables</td>
<td>Too strict regulation on dangerous waste that could be reused</td>
<td>Prices of recyclables sometimes unknown</td>
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<td>Heterogenous regulations across countries</td>
<td>Uncertainty about quality of recycled goods</td>
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<td>Poor cooperation between companies</td>
<td>Mindset to focus on maximising extraction</td>
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<td>(Mangla et al., 2018) Modelled interrelation between supply chain barriers to CE in India, based on literature review and expert interviews.</td>
<td>Lack of information system for follow-up process Lack of short-run rewards Lack of technology diffusion No incentives for CE adoption</td>
<td>Lack of regulatory pressures and taxation for CE promotion</td>
<td>Lack of training for HR and supply-chain managers</td>
<td>No demand for environmentally superior technologies</td>
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<td>Lack of awareness within firms about CE initiatives</td>
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<td>Lack of involvement from middle managers</td>
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<td>(Masi et al., 2018) Exploratory surveys with international government officials and firm representatives.</td>
<td>Limited attention to end-of-life design Limited availability and quality of recyclables</td>
<td>High up-front costs Cheapest virgin material Benefits external to the firm Diverts focus from management</td>
<td>Government incentivises linear economy Difficult to separate bio-waste Recycling policies insufficient for high-quality use of recyclables Weak capacity for reversed logistics Path dependency to linear system</td>
<td>Lack of long termism among stakeholders</td>
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<td>Lack of measurable goals</td>
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<td>Lack of stakeholder awareness</td>
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<td>Competition rather than cooperation within supply-chain – confidentiality</td>
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<td>(Milios et al., 2018) Literature review and semi-structured interviews with experts on the Nordic plastics markets.</td>
<td>Recycled plastic less adaptable Lacking technology to sort plastics Development cost of switching to recycled plastics</td>
<td>Expensive with separate collection of plastics Lacking capacity to handle all plastic waste Difficult to identify consumers of recycled plastics</td>
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<td>Effort needed from consumer to separate plastics</td>
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<td>Poor awareness about types of plastics</td>
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<td>Source/Study</td>
<td>Challenges</td>
<td>Barriers</td>
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<td>(Milios et al., 2019) Exploratory semi-structured interviews with experts in the Nordic maritime sector.</td>
<td>Uncertainty about supply reliability of recycled plastic</td>
<td>Waste rules and time-consuming administration</td>
<td>Customers prefer new materials</td>
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<td>(Agyemang et al., 2018) Survey and expert interviews in Pakistan’s automobile manufacturing industry.</td>
<td>Lack of technical capacities and technical skills</td>
<td>High costs and difficulties with financing</td>
<td>Lack of supply-chain integration</td>
<td>Resistance from top management</td>
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<tr>
<td>(Tura et al., 2019) Literature review and case studies based on interviews with firms across industries.</td>
<td>Lacking skills and technology for using of recyclables</td>
<td>High costs and lack of funding possibilities Unmeasurable benefits Lack of market mechanism for recovery Lack of incentives</td>
<td>Complex regulations Lack of government support Poor knowledge among decision makers No supply chain networks/collaboration</td>
<td>Lack of awareness Industrial focus still on linear models Risk aversion, low management support and business model acceptance</td>
</tr>
<tr>
<td>(de Jesus and Mendonça, 2018) Reviews academic and grey literature to analyse trends of CE in the wider literature.</td>
<td>Lag between design and diffusion Lack of training and support</td>
<td>Up-front costs Capital requirements Uncertainty about profitability</td>
<td>Materials classified as waste when they can still be reused Lacking knowledge for implementation of CE policies Not enough R&amp;D</td>
<td>Customers prefer new products Informal recycling makes formal system difficult to measure Sustainability-performance trade-off Separate from strategic objectives</td>
</tr>
<tr>
<td>(Ranta et al., 2018) Case studies and interviews across EU, US and China, primarily focused on institutional barriers.</td>
<td>Low perceived business impacts</td>
<td>Difficult to separate food waste Variation in regulation across countries No accreditation system Low enforcement of legislation Logistics of materials classified as waste</td>
<td>Customers prefer new products Informal recycling makes formal system difficult to measure Sustainability-performance trade-off Separate from strategic objectives</td>
<td></td>
</tr>
<tr>
<td>(Geng and Doberstein, 2008) Review of local literature on CE transition in China.</td>
<td>Lack of training No data on waste collected</td>
<td>Low prices on virgin material Difficulties in obtaining funding</td>
<td>Tax policies favour linearity Externalities not internalised Consumption tax exemptions on some linear goods</td>
<td>Low priority among public officials Low company enthusiasm Low awareness of concept</td>
</tr>
<tr>
<td>(Mahpour, 2018) Literature review focused on construction and demolition waste management.</td>
<td>Ineffective technologies for separation Very little accessible data</td>
<td>Lack of incentives for sorting Lack of funding for CE transition Competition for (human) resources</td>
<td>No monitoring of waste management Lack of producer-responsibility Ownership issues of waste</td>
<td>Projects not designed for CE Lock-in to non-recyclable goods No targets for reducing waste Low CE concept understanding Consumers prefer new materials Low management commitment</td>
</tr>
<tr>
<td>(Ritzén and Sandström, 2017) investigated the organisational perspective using interviews with two large manufacturing firms.</td>
<td>Linear product design Low CE integration into production processes Uncertainty about price and quality of recycled material</td>
<td>Not profitable Costs of threatened supplier relationships Unmeasurable benefits</td>
<td>Risk aversion Perception of sustainability Inertia toward new CE business models Sustainability work separate from operations No clear responsibility within firm and in value-chain Low priority for customers</td>
<td></td>
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5. Discussion

5.1 The barriers summarised

In our paper we have assessed academic literature on barriers to the implementation of CE. Some general trends with more prevalent topics were found and we have assembled key words in Figure 2.

Additional papers would of course have to be reviewed to pinpoint the weight that different barriers have. Nevertheless, commonly cited barriers found were:

1) Lack of a market and bad institutions
2) inconsistent policies across countries and for trade,
3) high up-front investment costs with poor access to finance,
4) low consumer awareness and
5) externalities not internalised through taxes (and subsidies).

Consistent with the trend of increased focus on non-technological factors, the diversity and quantity of barriers presented under institutional and cultural barriers were higher. Inconsistent policy and poor institutions for cooperation throughout the supply chain were commonly cited institutional barriers.

As noted by Kirchherr et al. (2018), the awareness and enthusiasm among consumers seem to be low, which is a factor often cited in surveys with business managers. Still, the barriers are interlaced and have inter-dependencies. The fact that the institutional and cultural barriers might
be affected by the economic and technological barriers must be considered when analyzing the obstacles hindering a CE to develop. We will now proceed to present a modular overview of the situation and the possible inter-dependencies.

5.2 How can barriers be solved?
In the previous section the barriers found in earlier research were identified, the current section will visualize these barriers and their inter-dependencies. Returning to Figure 1 of CE from section 2, we claim that the left upper corner of the circle is the crucial part (see Figure 3 below). Both the inflow and the outflow from the desired closed-loop system take place there. In the outflow/inflow part of the system for materials becomes an important market factor.

![Figure 3 Illustration of the Circular Economy with a focus on the in- and outflow.](image)

An ill-functioning market for materials is a barrier connected to all levels of implementation in the economy. For example, a market for recycled materials is an essential factor in developing a CE on a micro-level as well as on an inter-firm level. Additionally, market-failures are commonly solved through operations on a macro-level. Thus, as a point of departure for the mapping of the interlaced barriers, we will discuss a theoretical recycled material market and a virgin raw material market. By theorizing around these markets, the barriers that might hinder the substitution of virgin raw materials with recycled materials are highlighted. Simplified, our theoretical case has two markets: a recycled material market and a virgin raw material market. The markets are driven by demand from producers, who will use the materials in their products, as well as demand from consumers, who will buy the final goods. To create a functioning CE
the virgin raw materials need to be substituted with recycled materials, which means that the demand for recycled materials must exceed the demand for virgin raw materials.

The demand from public and private actors are the basis for a well-functioning market. If demand exists, a market should emerge. Optimally there will be several actors competing, which might decrease the price on the market. Increased competition creates new opportunities when it comes to business strategies and innovations. Entrepreneurs can afford to take some risks and invest in new innovations that foster economic advantages in using recycled material, resulting in an increased demand for recycled material creating a positive feedback-loop. Figure 4 illustrates the desired loop, i.e. a best-case scenario:

![Figure 4](image-url) A desired loop for the recycled material market.

Figure 4 will now be inserted into Figure 5, which illustrates how the desired loop is disrupted by several barriers. The red arrows symbolize a reinforcement of the virgin raw material market, while the green arrows symbolize a reinforcement of the recycled material market. The coloured circles are all disablers for a well-functioning recycled material market and the non-coloured circles are enablers. In Figure 5, “leaks” from the desired loop can be observed, where the demand from private and public actors can take two paths. The coloured circles introduce some of the barriers previously identified to showcase why the demand for virgin raw materials currently exceeds the demand for recycled materials.
Major potential underlying barriers are the institutional factors, marked as a dashed circle around the two markets in Figure 5. The institutional factors vary across countries, as well as across sectors, which make them hard to generalize. The institutional conditions related to the specific markets might create barriers, whilst also having a large potential to foster the positive loop.

An institutional factor is property rights (as discussed by Hayek 1937, 1945, 1948). An example can be found in the Swedish municipalities where the municipalities have the right (monopoly) to collect household trash, and the citizens are not allowed to dispose of it themselves. The municipality uses the household waste as fuel in their heating plants. The monopoly creates distorted competition and hinders the private actors from developing new business models as well as investing in new techniques (Återvinningsindustrierna, 2019 and theoretically discussed by Hayek (1968/2002) who state that without market competition the discovery process in an economy will be hampered.

A lack of property rights can be explained by old legislation, which forces individuals and firms to deposit waste products in a particular way. The old legislation might have been suitable when first introduced, since it was a way to internalize externalities (e.g. take control over trash that was dumped in the countryside, or in other ways not handled properly). It could also have been the case that there was an information problem that made a market impossible. For example, before the development of information technology it was probably hard for a company to find a
buyer of some unexpected waste material if the customer was not geographically nearby. However, for a CE, the legislation of yesterday is no longer adequate.

Another institutional barrier, mentioned in earlier sections, is inconsistent policy throughout the value chain. Policy inconsistency has been found to be a large hindrance to a successful development and diffusion of a green technology and policy inconsistency have been found to prompt dozens of bankruptcies and job losses (de La Tour et al., 2013; Strambo, Nilsson and Månsson, 2015). Policies naturally differ between countries due to a lack of harmonization, and since the value chain is often global CE firms sometimes cannot scale up and become more than just local.

There is a correlation and inter-dependency between institutional and cultural barriers, where regulations can follow culture whilst culture can be a product of regulations (Kirchherr et al., 2018). The institutional barriers are also corresponding with the economic and market barriers. For example, inconsistent policies would create problems on any market, since if a firm does not know what to expect in the near future the investment risk increases and hence investment cost (Kydland and Prescott, 1977; Nemet et al., 2014; Nemet et al., 2017).

One of the economic barriers (yellow circles in Figure 5) decreasing the demand for recycled materials is the, comparatively, low price of virgin raw material. Virgin raw material has an advantage in a linear economic system since the consumers will not bear the full price, i.e. in many cases the external costs are not internalized. One example is if non-degradable materials, or even toxic materials are put in a landfill where the future generations must finance the clean-up. Another explanation is the inelastic supply of waste, which makes the substitution of virgin raw materials less beneficial. Both these factors result in a price volatility correlated with an uncertainty on the market for recycled material.

Milios et al. (2018) argue that the recycled plastic is ultimately more costly since there is a need for a quality control of the recycled plastic compared to the virgin plastic. The need for a quality control is an indicator of another barrier mentioned in the earlier section: the asymmetric information triggering “the market for lemons” which is a typical market failure. The uncertainty on the quality of recycled materials obstructs the demand on that market, consequently it becomes easier to meet the customer specifications with virgin raw material.

These economic barriers closely connect to other barriers. Kirchherr et al. (2018) point out that a low virgin material price affects the consumer interest for recycled material, which is a cultural barrier. Consumers of recycled materials are almost certainly, as all other consumers, cost
conscious. Thus, a difference between the price on virgin raw material and recycled material will result in a lack of interest in final goods made by recycled material. That in turn might lead to a more hesitant company culture. The lack of consumer interest in recycled material products is equal to higher risks for companies if substituting virgin raw material with recycled material. The company culture will therefore remain hesitant if the consumer interest is low. A status quo bias is a common occurrence in all parts of decision making and could be an explanation to a hesitant company culture. Status quo bias refers to when people prefer things to stay the same by doing nothing, or by sticking with a decision made previously (Samuelson and Zeckhauser, 1988). Status quo bias is consistent with the observation that people feel greater remorse for bad outcomes resulting from active actions taken than for bad consequences that are the consequence of inaction (Kahneman and Tversky, 1982).

The macroeconomic potential for a CE has been estimated to be around $600 billion globally per year from 2025 (0.71 % of world GDP) due to a multiple of reasons, e.g. net savings on material and energy costs and an improved mitigation of volatility and supply. Despite the possible gains, individual firms face difficulties in funding CE economy business models (Ellen MacArthur Foundation, 2013). Part of the explanation is related to the lack of markets. A lack of markets will hinder the entrepreneur from contributing with solutions by providing creative responses to new opportunities (Schumpeter, 1934, 1942).

However, there are also concerns about the costs of operating a CE business model, such as the need for new human resources capabilities or increased costs of logistics in reversed supply-chains and many firms report small or no economic benefits, at least in the short run (Mangla et al., 2018). Difficulties in measuring the impact of a CE and the lack of such data, which are technological barriers, might add fuel to the hesitant company culture and the limited funding for a CE (Kirchherr et al., 2018). Rizos et al. (2015) found that the funding issue is particularly difficult for SMEs when data on the benefits is missing. High upfront investment costs seem like a good technical “excuse” for not implementing CE strategies and embracing these investments.

6. Concluding remarks and implications

The purpose of this paper is to examine why the implementation of a CE is slow in some areas and illustrate how barriers (technological, market, institutional and cultural) can prevent the implementation of a CE. We approach the research problem in a two fold way. Firstly, recognizing the barriers that currently seem to hinder a CE from developing. Secondly, mapping these barriers to understand how they are interdependent and entangled. The purpose was
achieved through a systematic literature review where academic articles and grey literature on the barriers to a CE transition were analyzed and classified into technological, market/economic, institutional/regulatory, and cultural/social barriers.

The empirical findings show that the most cited barriers were those linked to institutions and culture. When analyzing further we can see that these barriers are closely connected to market and technological barriers. The connection might indicate that removing barriers in one of these categories could be a catalyst for a disentanglement. Still, the question of “where to start” remains, and with the obtained information we can barely theorize about it. A suggestion would be (based on our case presented in section 5) to stimulate supply for recycled materials which could increase reliability of supply and drive down acquisition costs. Adherence to the suggestion would reinforce the demand on recycled material, which in turn would foster the positive desired loop and thereby create new business opportunities and innovation-openings for entrepreneurs.

Policymakers should step up their work on taking down barriers if they want to create momentum for a CE. There is plenty of room for governmental interventions regarding the identified market barriers, e.g. making entrepreneurs able to exist on the market and creating a possibility for property rights, price signals and the easing-out of subsidies that favor linear products. Even with this push, however, there is no guarantee that the CE concept will succeed unless we are able to internalize some of the costs a linear economy creates.

Admittedly, our study has limitations. First, our sample size is limited, since we looked at the issue from what could be called a helicopter perspective and we did not go into so many case studies of particular issues on a national level and caution is thus justified regarding the external validity of our findings. However, we hopefully succeed in conveying that some barriers, even seemingly small, could prevent the opportunity for a market to form and hence no economic activity. What we show is that sometimes it seems like no one picks up the bills on the street but when looking at the issue from a market perspective we get a clear picture of why.

Learning from other countries and understanding the heterogeneity in the challenges faced in different sectors is crucial for successful national implementation of a CE. To be able to accelerate the development towards a CE, it is of relevance to map and distinguish these barriers.
References


