Master Thesis Double Degree program

in Innovation and Industrial Management

Leveraging on digitalization for circular economy

A multiple case study on manufacturing and service companies

Supervisors

Ethan Gifford- GU

Richard Tee- LUISS

Student

Ilaria Mania

Graduate School

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Abstract

Competitiveness is a crucial word for describing what todays' business environment requires to enterprises. The issue becomes even more complicated considering that there are several phenomena that are challenging companies' ability to gain a competitive hedge.

On one hand, circular economy appears as the base mark to which companies should urgently work to be aligned to. On the other hand, companies are embarking on changes to become digitalized. Given that, the intuition is that the interplay between circular economy and digitalization might trigger new opportunities. Thus, is there a way in which the former could reinforce and strengthen the latter? Reports from consultancy companies have already answered this question. In fact, they have highlighted that digital technologies could accelerate the transition to circular economy. However, still little scientific research has been conducted to understand if companies are aware of this fruitful interconnection, in particular for service providers, and how managers are rethinking their circular approach to leverage on intelligent assets.
Here comes into play this study since it aims at understanding how companies are perceiving the possibility of leveraging on digitalization for circular economy. It consists of a multiple case study within four Swedish-based companies ranging in a continuum from service providers to manufacturing companies.

The results show that as a prerequisite, companies' shift to circularity still need to be managed. When it comes to the digital side of the coin, technologies as Internet of Things, Artificial Intelligence and blockchain have a great potential in this context.

Connecting the dots, enterprises foresee a positive interplay between digital technologies and circular economy. Besides this rosy picture about general perceptions, this clarity seems to fade away when it comes to proactive actions. Meaning that companies are not actively leveraging on digitalization for circular economy. The reason is twofold. The striking point is that circular economy is not still seen as a competitive factor on a par as digitalization. What is more is that enterprises still conceive these two phenomena separately. By starting to "think in circles", digitalization could be conceived as enabler for circular economy with the potential to unlock a variety of opportunities.

Keywords: circular economy, sustainability, digitalization, data, digital transformation, organizational change, digital technologies.

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List of Abbreviations

- AI artificial intelligence
- BD big data
- BM business model
- CE circular economy
- CE100 circular economy 100
- EU European Union
- FMCG fast-moving consumer goods
- IoT internet of things
- IT information technology
- M2M machine-to-machine
- NPD new product development
- PaaS product as a service
- PLC product life cycle
- R&D research and development
- VC value chain

1. Introduction

The present introduction aims at providing the reader with the theoretical surrounding underpinning the subject of this thesis. Thus, the reader is given an overview of the area of research with an explanation of the main concepts. Afterwards, the problem discussion is presented. The introduction chapter proceeds with the aim of research and the presentation of the research questions. Finally, it ends by explaining the limitations of the study and outlining the structure of the thesis.

1.1Background

Today's sustainability-related data are increasingly becoming the basis for investment decisions and executives are progressively discarding the traditional wisdom that investors do not beware about organization's environmental performance metrics. As a consequence, managers are recognizing the importance of including sustainability strategy at a corporate level (Unruh, et al., 2016). In this context, pioneering business organizations are overcoming the traditional approach to sustainability and some of them have already embraced the circular economy (CE) principles. A proper definition of circular economy is presented by the Ellen MacArthur Foundation (2017), an organization at the forefront for circular economy with over hundreds of global partners. According to it, circular economy is depicted as an economic model conceived to limit the consumption of finite resources in the economic activities not only by reducing waste but also by keeping products and materials in use as long as possible. In this light, the objective is creating loops so that products can be reused in the business process in order to capture value that would be lost otherwise (McKinsey & Company, 2016).

The reasons underpinning the urgency of this translation toward circular economy are various and of different nature. Among them, the traditional linear "make-use-dispose" model is becoming inefficient and it is leading to an impressive amount of waste (European Environment Agency, 2018). Contrary to the what one might think, the focus of circular economy is not to only about recycling, in fact emphasis it entails rethinking product design, business models and supply chains (Lieder & Rashid, 2016). To summarize, the potential of circular economy is likely to bring economic, natural and social capital beneficial effects thus overcoming some of the challenges posed by the linear model (Ellen MacArthur Foundation, 2017).

Given this surrounding, a new wave of disruption is challenging enterprises' activities: not only technologies and society are evolving but the whole economical DNA is undergoing an extensive transformation under the name of "Digitalization". This trend has been defined as the use of digital technologies to transform business models, thus opening up to new opportunities of making profit

and delivering value (Bloomberg, 2018). As a matter of fact, in order to cope with technology-derived changes, business organizations should pursue new targets, processes should be modified and a sufficient technological background ought to be developed (Legner, et al., 2017).
In addition, the process of moving to a digital business is becoming impressively so pervasive that according to the International Data Corporation (IDC) (2017) << *By 2020, 60% of all enterprises will have fully articulated an organization-wide digital platform strategy and will be in the process of implementing that strategy*>> (International Data Corporation, 2017). However, the roadmap toward digitalization requires organizations to develop change management skills and a certain degree of adaptation capacity. Otherwise inadequate responsive actions might result in loss of competitiveness since organizations will not be able to cope with this paradigm shift (Schwartz, 2001).

Taking into account the trends presented above, reports from consultancy companies have outlined that digitalization might improve circular economy business models. Indeed, managers could seize the opportunity of actively exploiting digitalization for their circular initiatives. In the same line of argument, as presented by the World Economic Forum (2018) companies that do not have *"digital at their core"* are unlikely to unlock the disruptive opportunities to lower the environmental impact. To provide a practical example, Artificial Intelligence (AI) might support the transition to circular economy by improving design, operating business models, and optimizing infrastructures (Ellen MacArthur Foundation, 2019).

1.2Problem discussion

Considering both the continuous development of the transition toward circular economy and the impressive evolution of technological disruptions, the interplay of these themes together remains still quite unexplored by the literature on innovation studies. In addition, a clear picture about how companies are considering this dynamic interplay is missing.

Thereby, it seems interesting to study how companies' strategic approach toward circular economy can be supported by digitalization. A preliminary analysis of the author about the presence of reliable and relevant literature in this specific sphere of interest revealed that little research has been conducted about how organizations are rethinking or developing circular economy in order to exploit digital technologies. Thus, it appears not sufficiently addressed by scientific literature if practitioners are aware of these positive opportunities, to what extent and how companies are capitalizing digital technologies to improve the circularity of their business models. In fact, this topic has been primarily addressed by business practitioners belonging mainly to management consulting firms. Further, given the small number of previous studies outlined by the researcher's preliminary analysis, it seems

interesting to seek if and how manufacturers' approach might differ from the one of service-providers companies.

In order to address this gap, the researcher with the help of First to Know Scandinavia AB (FTK), a consultancy company located in Gothenburg, decided to compare four Swedish-based companies: reCreate Design Company, Essity, Volvo Cars and Senab. Companies have been selected on the basis of the author and FTK's belief that they are working to implement circular economy.
These are operating in different sectors and with different business models since this study seek to understand how digitalization for circular economy might be perceived and realized differently in diverging business settings. In particular, the research intentionally includes both companies directly involved in production process and service providers that leverage on external producers.

1.3 Purpose and research questions

The ultimate aim of this research lies in academically contribute on the role that organizations are attributing to digitalization in the context of circular economy. Meaning that this study is intended to disclose how case companies are implementing circular economy within their business activities, how they are understanding and changing for digitalization and how they are considering of exploiting this for circular economy. In addition, the author aims to shed light on the main challenges, opportunities and future expectations related to the possibility of using digital technologies for circular economy.
In other words, the contribution of this study lies in the attempt to gather practical companies' perceptions about the extent to which their circular economy approach has been impacted by digital transformation and how this is happening. As expressed above, manufacturers and service providers are included given the researcher's interest in understanding how the possibility of using digital tools for circular economy might vary for these types of companies. In order to fulfill the aim of the study, the author considered a prior assessment of companies' position in circular economy implementation the basis to answer to the main research question.
Consequently, the main research question and sub-question are defined as follows:
Research question:

"How are companies perceiving the possibility of leveraging on digitalization for circular economy?"

Sub-question:

"How are companies working for circular economy?"

1.4 Limitations

The limitations of this master thesis are mainly connected to both the restricted time available to conclude the entire study and the technical aspects.

As far as the first is concerned, more case companies in the study would have led to more exhaustive results. Moreover, the researcher is aware that for some enterprises a deepen level of analysis would have required data collected from a greater number of respondents for each. Despite this, it was not feasible to interview more that the representatives of the enterprises present in this study (paragraph 3.3.2.1 in 3.3.2). Furthermore, given the limited the time span available and the current geographical location of the researcher, this study includes companies based in Sweden.

Considering the second area, the level of analysis might be deemed superficial for what concerns technicalities related to the mechanisms through which digital technologies work and about environmental specifications that are out of this scope of this study. However, these would not affect the reliability of this study since the author aimed at providing conclusions from a business' point of view.

Notwithstanding this, taking into account the aim of this study and the limitations explained above, the researcher evaluated the results obtained through data collection to provide a comprehensive conclusion and a valuable answer to the research questions.

1.5 Disposition

Table 1: Thesis disposition

Introduction
• Presentation of the background; problem discussion; aim of the study and research questions; limitations.
Literature review
• Presentation of theory related to circular economy, digitalization, and the exploitation of digital technologies for circular economy
Methodology
• Outline of the research strategy; research design; research method; presentation of data collection; analysis' methods; research quality
Data collection
• Presentation of data collected with the interviews
Data analysis
• Analysis of data presented in the empirical findings
Conclusions
• Presentation of final conclusions of the study and answer to the research question and sub research question; final remarks about case companies; suggestions for future research

Source: Own elaboration

2. Literature Review

This chapter presents the theoretical concepts connected to the context of this study. Firstly, an explanation about circular economy, the relationship with sustainability and the challenges is provided. Afterwards, digitalization is presented as an external phenomenon that is exerting pressure on organizations and enforcing enterprises to change. Subsequently, the paper continues providing a review about organizational change in the context of digitalization. Finally, the researcher delineates how digitalization might enhance circular economy.

2.1 Circular Economy

2.1.1 Explaining Circular Economy: drivers and key principles

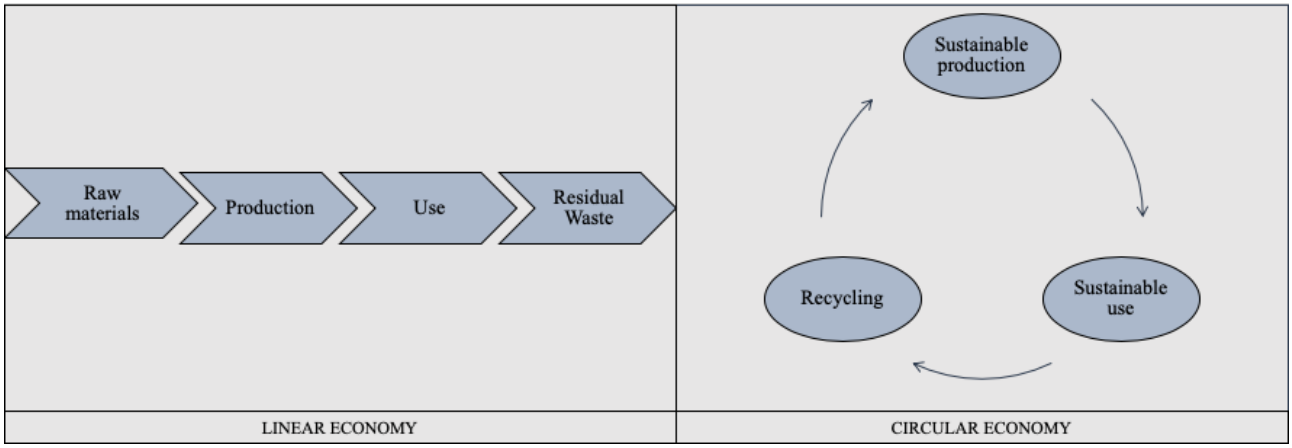
According to Ghisellini, et al. (2015) circular economy is drawing attention as a solution to overcome the current level of production. Given that, it implicitly requires participation and cooperation between different actors of the society. Similarly, Morgan Stanley research team (2017) circular economy (CE) is progressively becoming the next disruptive trend. Meaning that pioneering companies are increasingly converting their strategies on more sustainable footing and rethinking the environmental viability of their business models (Morgan Stanley Research, 2017). Considering that, it appears essential to shed light about how circular economy is conceived, the main challenges and business level implications to unlock its potential.

Although the concept of circular economy has gained momentum recently, as reported by Ghisellini, et al. (2015), already back in 1966 ecological economists like Boulding (1966) introduced the concept of a circular system economy as a prior condition for environmental sustainability. Only a short time after, also Reday and Stahel (1977) in their research report to the European Commission were among the first to bring attention to the concept of a closed-loop economy. In particular, they attributed to it the potential to prevent waste, create job at a regional level, promote resource efficiency and dematerialize the whole industrial economy (Reday & Stahel, 1977). Later on, in 2015, the Ellen McArthur foundation presented the notion of an economic model *restorative and regenerative by design* since it entails not only a preventive approach but, through designing better systems, it aspires to repair previous damages (Murray, et al., 2015; Ellen MacArthur Foundation, 2015). Hence, before going into detail it should be clear that the main target is to maximize the utility and value of products, components and materials. The reason why this approach is spreading nowadays lies in the fact that the traditional "take, make, dispose" economic model characterized by the production of residual waste after use, is becoming progressively unsustainable due to the limited availability of resources

(Ellen MacArthur Foundation, 2015; Van Buren, et al., 2016). In this light, CE is defined to be a paradigm seeking at decoupling the global economic development from finite resource consumption (Ellen MacArthur Foundation, 2015).

Continuing on this line, for the sake of clarity, circular economy approach can be presented as a "closed-loop-system". More specifically, two different cycles can be identified: reuse of goods and recycling of materials. The former suggests an expansion of the life-span of goods and an effort to slow resource loops. This is to be achieved thanks to additional services for extending product's life cycle, reuse of the product itself, repair, and technical upgrading. The latter denotes the closure of the resource loop by tying post-use and production through recycling (Bocken, et al., 2016).

Figure 1: Differences between Linear and Circular Economy



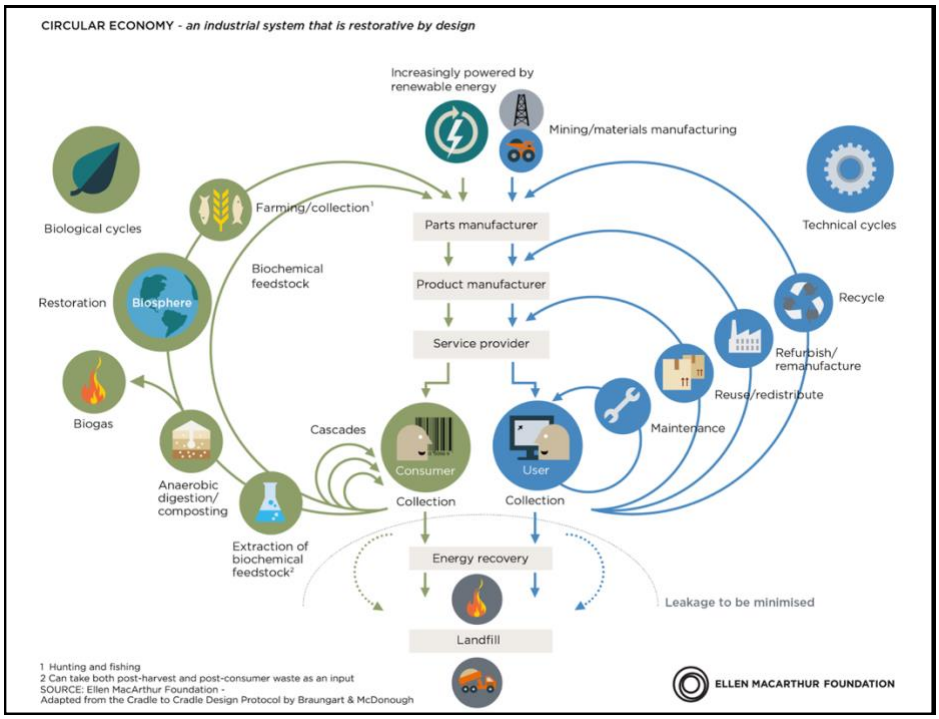
Source: Own elaboration from Van Buren, et al. (2016) , p.4

In particular, some factors have placed the traditional linear model under discussion and, as a consequence, the perception of circular economy practices has lately transformed so dramatically that it is thought to be an environmentally sound solution for enduring sustainable competitive advantage (Planing, 2017). Hence, a non-exhaustive list of the elements that are driving toward more responsible practices is given. First, the most widespread model of economic development has turned out to be impressively wasteful. Suffice to say that, according to the European Environment Agency (2018), the EU per capita generation of waste amounted to 1783 Kg in 2018. Hopefully, this increase is expected to experience a decline by 2020 thanks to the contribution of the Circular Economy Package (European Environment Agency, 2018). Moreover, the last decade was characterized by a higher price volatility for resources than any other decade of the 20th century and companies have turned out to be discouraged to hedge against the risk of being in shortage of this limited availability of resources (World Economic Forum, 2014). In today's world this concern is linked to the challenge of assuring and optimizing global supply chain. Another aspect that should be considered is the gradual

acceptance of alternative business models that enable enterprises to shift toward service-based offerings, following the "servitization" trend that will be outlined below in regard to the consequences of digitalization (Ellen MacArthur Foundation, 2015).

These factors have pushed business organizations to begin to depart from resource-related risks and to understand the urgency to scale up toward circular economy principles. Therefore, the following lines provide an overview about the main principles of the circular economy model. Furthermore, for the sake of clarity, the author presents a system diagram developed by the Ellen McArthur foundation that summarizes the three principles underpinning circular businesses, highlighting the continuous flow of materials in the value circle.

Figure 2: The "Bufferfly diagram" of Circular Economy



Source: Ellen McArthur Foundation (2019)

To start, a regenerative economic model rests on conserving, improving natural capital and assuring the conditions for restoration. Meaning that finite stocks of resources should be used wisely, and renewable resources should be counterbalanced. In this sense, the change is toward a dematerialization of utility (Ellen MacArthur Foundation, 2015).

The second principle lies in optimizing the resources by designing for remanufacturing, refurbishing and recycling to build circular systems where the output of the process can contribute again to the process shifting from design to re-design thinking. Thus, manufacturers can raise the residual value of scraps conceiving products so that disassembly costs are low and already used resources can be

turned out into value (Ellen MacArthur Foundation, 2015; ING Economics Department, 2015; Murray, et al., 2015)

The third principle consists in promoting the effectiveness of the system. This implies disclosing and minimizing negative externalities for instance in the form of environmental pollution. Meaning that, the transition toward circular economy demands a well-management of the impact of the business activities on land use, water and release of toxic substances (Ellen MacArthur Foundation, 2015; Wilts & Berg, 2017).

Finally, it should be noted that circular economy has been extensively addressed in terms of redesign of process and cycle of materials. However, academics have pointed out that this definition might be symptom of limited approach since it doesn't consider the social dimension of CE. Accordingly, a different perspective enlarged its scope by delineating and economic model where the design and management of planning, resourcing, procurement, production and reprocessing are aimed at maximizing the human well-being and ecosystems functioning (Murray, et al., 2015).

2.1.2 Circular Economy and Sustainability

Even if circular economy and sustainability are impressively growing in importance among academics and practitioners, a certain degree of ambiguity has been noted on the distinction between these two concepts. Hence, given these blurred frames, academics had tried to fill this gap and provide a clear explanation of the relationship between the two terms (Geissdoerfer, et al., 2017). According to the Word Commission on Environment and Development (WCED) (1983) sustainable development has been described as a "development that meets the need of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). Thus, it should be noted that the concept of sustainability opens up the scope for different consequences ranging from social, political and economic issues (Geissdoerfer, et al., 2017). Given that, some argues that its potential lies in the flexibility and possibility to be adapted to different contexts, while others claim that its vagueness result in low possibility of operationalization. At the same time, authors have perceived circular economy a narrower concept with a more precise scope (Geissdoerfer, et al., 2017).

Anyway, the concepts of sustainability and circular economy are tightly linked, and this is shown by the fact that circular economy practices have been appointed as the blueprint for the implementation of the Sustainable Development Goals (SDGs) (Schroeder, 2018). In fact, closed-loop related ideas have been reported under the SDG12 "Ensure Sustainable consumption and production patterns" (Wilts & Berg, 2017). Developed by the United Nation, these targets are to be conceived as the

toolbox to build a more sustainable and better future opening up the possibility to address global challenges related to poverty, inequality, climate, environmental degradation, prosperity, peace and justice (United Nations, 2015). In this regard, it has been argued that the major existing convergence between CE and the United Nations targets are related to "clean water and sanitation" (SDG 6), "affordable and clean energy" (SDG 7), "decent work and economic growth" (SDG 8), "life on land" (SDG 15) (Schroeder, 2018). Finally, during the B7 Business Summit of 2017, international leaders placed the accent on "Innovation and sustainability" and among the various dimensions on "Resource efficiency-energy & environmental industrial policy drivers" (Confindustria, 2018).

2.1.3 Challenges of Circular Economy

When enterprises craft circular strategies, some challenges are likely to arise since they are likely to experience changes at different levels. In this sense, circular economy can be perceived as a paradigm innovation given that it affects the underpinning mental model framing what the organization does. Consequently, the shift toward closed-loop approaches means a systemic change with the potential to bring hidden business opportunities on one hand, and challenges and concerns on the other (Tidd, et al., 2005).

Starting from an internal business perspective, it can be argued that managers and executives shall be familiar with the sustainability principles and circular thinking as these concepts should be integrated in the employees' attitudes and behaviors (ING Economics Department, 2015). In this sense, for an effective adoption of the circular economy principles and in order to rethink the products in more sustainable terms, stakeholders should be involved. Meaning that customers, suppliers, designers, NGOs, market, academia, distributors and recyclers are to be considered in the transition (Pinheiro, et al., 2018). Also, conducting the business within the planets' limits implies that the players of the supply chain should understand that mutual trust in sustainability information is essential (Schmid & Ritzrau, 2018). In fact, underdeveloped availability of information, coupled with increased transaction and search cost would challenge CE implementation (Wilts & Berg, 2017). Hence, given the mounting pressure on environmental concerns, a trustful collaboration represents the very first step to let the circular economy concept ready for takeoff. In this light, decision-makers should start to embrace a holistic supply-chain management approach that takes into account the lifecycle of the products and the materials used (Schmid & Ritzrau, 2018).

Proceeding on this track, part of the internal organization shall be reshaped to meet sustainability principles (EY, 2015). In particular, new product development (NPD) activities will undergo substantial changes because of the necessity to tailor design and manufacturing activities to reduce

the use of materials and the environmental impact during the whole lifecycle (Kalmykova, et al., 2018). As a matter of fact, consumers might have a distorted perception of remanufactured and recycled materials, considering them to have substandard quality. This potential lack of acceptance could result in a significant obstacle to NPD in CE (Pinheiro, et al., 2018; Wilts & Berg, 2017). Moreover, some products might require particular technologies in order to be aligned with the sustainability principles, thus the need arises to cope with this necessity (Pinheiro, et al., 2018; Wilts & Berg, 2017). Additionally, it should be taken into account that what makes sense environmentally could not be good for an individual company perspective. In other words, the shift toward more durable consumer goods means fewer products to be produced. Consecutively, the volumes of manufacturing enterprises are projected to drop consistently, thus embracing circular models might result in going against their economic interests (The Economist, 2018).

Furthermore, some issues might arise considering the current legal and financial systems in the sense that circular solutions might be vulnerable in the event of major economic downturn (ING Economics Department, 2015). For instance, a new assessment of fiscal analysis should be conducted since in the circular model goods tend to be replaced by services (EY, 2015). Also, changes in the business model are required to minimize the waste produced and, in turn, this might generate financial challenges. In fact, companies' motivation toward the transition to circular economy is related to the possibility of having positive returns on investments (Ghisellini, et al., 2015). In particular, Pinheiro, et al. (2018) reported obstacles for what concerns the development of sustainable products as well as the investments needed to switch to new business models based on CE. More in detail, business insiders have presented five main models that will be discussed in the following paragraph.

2.1.3.1 Circular Economy Business models

The main feature of a "circular business model" is the objective to utilize the retained economic value of products after use and embed it into new offerings (Linder & Wiliander, 2015). Thus, it is characterized by a different relationship between the products and services (Accenture Strategy, 2015).

In particular, management consultants and academic researchers have identified different models that respect this paradigm. To start, the use of renewable, recyclable and biodegradable materials are the main elements of *circular input model*. A different standpoint pertains to *waste value model*, drawing on recovering product value at the end of the production in the form of material, energy and components (Ernst & Young, 2015; Lacy & Rutqvist, 2015). Another form to seize the opportunities of circular thinking is called *product life extension model* since the focus is on maintaining and improving products by restoring, upgrading, remanufacturing and remarketing (ibid.). The last two

models identified imply something beyond the conventional ownership of physical products, meaning solutions that give access rather than ownership. They can take the form of *platform models* where products can be available for sharing, thus increasing efficiency. Lastly, in the *product as service model*, the business organization contnues to own the product and consumers can access the offerings through alternative patters such as paying subscription fees (Bocken, et al., 2016).

2.2 Digitalization

Having presented circular economy as a strategic priority to be sustainable in the long-run, it seems suitable to shed light on digitalization as a phenomenon that is penetrating broadly and is impacting companies in different perspectives. In particular, as explained previously, the purpose of this study exploring how it is shaping circular economy approach.

For the sake of providing a comprehensive view about how digitalization is affecting business organizations, this paragraph is structured so that a general introduction about the surrounding of digital economy is provided, afterwards the narrative proceeds by presenting the technologies enabling digitalization. Finally, the chapter ends by focusing on the business implications.

2.2.1 Digital economy and digitalization

When dealing with digital economy and digitalization, it can be noted that both academic researchers and practitioners often use these umbrella terms interchangbly. Having said that, for the purpose of this study, a distinction needs to be made to enable easier understanding of the as the reader proceeds throughout the thesis.

In this regard, the World Investement Report (2017) defines digital economy as "the application of internet-based digital technologies for the production and trade of goods and services". In particular, the pervasiveness of digital economy is said to be able to unlock a number of potential benefits. Among them, it can be outlined the possibility to support competitiveness in different areas, to uncover new entrepreneurial opportunities and new paths to reach overseas markets (UNCTAD , 2017).

Having presented the digital economy as the surrounding where enterprises are leaving their footprints nowadays, now it is possible to shift the focus to a single business entity perspective, thus getting closer the concept of digitalization. This term stands for the process of transition to a digital business and implies the use of digital technologies to change a business model by offering new products or implementing process automation (Hess, et al., 2016). Having this in mind, from now onwards the author will consider the words "digitalization" and "digital transformation" as

synonymous. As a matter of fact, digital transformation is similarly described as the intentional and progressive digital evolution of a company, business model, operational processes along a strategic and tactical route (Mazzone, 2014). In addition, Ismail, et al. (2017) expressed a more detailed definition of digital transformation taking into account the impact of the technologies on businesses along three dimensions. First, externally the customer experience is enhanced thanks to technological developments. Secondly, business operations, decision-making and organizational structures should be affected by technological intensive advantages from within. Thirdly, a digital business transformation is recognized to be able to holistically impact all business segments and functions (Ismail , et al., 2017). However, greater details on this will be given in a subsequent paragraph (0).

Todays, embracing the wave of the digitalization is becoming imperative to survive in the global competition. However, if the managerial dilemma about whether to start the roadmap toward digital transformation results in a negative outcome, these companies are likely to succumb when they confront themselves with other business entities. In this light, the risk of not being able to keep pace with the new digital economy has been called "digital Darwinism", meaning that only the enterprises able to adapt and cope with changes in the technological trends will hold their positions in the competitive landscape (Schwartz, 2001). As a matter of fact, Newman (2017) recognizes that business organizations should be aware of the strenght of the latest developed technologies and acknowledge when the times has come to change (Newman, 2017). Nevertheless, as it will be explained below(0) it appears evident that organizational changes do not occur overnight. In this regard, Ismail et al. (2017) have studied the importance of deploying a digital business strategy to aid companies' trackway toward the adoption of technologies and achieve an outstanding competitive position.
Moreover, literature on digital business transformation acknowledge that some of the eight critical success factors in Kotter's (1995) guide to lead organizational change are particularly important in this context. As a matter of fact, it has been argued that people should be involved in the transformation process since they need to acquire the right skills to handle the exploit new technologies in the business processes (Ismail , et al., 2017).

2.2.2 Technological drivers of digitalization

At this stage of the literature review, it seems necessary to provide the reader with an overview about the technology's drivers of the business digital transformation. Researchers and consultants have coined the acronym "SMACIT" to identify the digital technologies that are intensively transforming how business is conducted by companies. The technologies under this broad term are social, mobile, analytics, cloud and Internet of Things (IoT) technologies (Ross, et al., 2016). This being said, it can

be argued that this acronym entails also other technologies such as artificial intelligence, blockchain, robotics and virtual reality (Sebastian, et al., 2017).
Taking into account the research question of this study, the author will focus on the technological drivers that have been considered relevant to overcome the circular economy challenges.

First of all, Abolhassan (2017) claims that the launch pad of any digitalized business model consists in the cloud that is presented as the pillar and gray matter of the whole digital business transformation. Indeed, it enables an increased storage capacity for data that can be centrally analyzed thanks to the possibility of high flexible and remote access (Abolhassan , 2017). Moreover, the hidden power of cloud and cloud computing corresponds to the possibility to overcome the need for maintaining expensive and physical computer hardware and software. This argument results in the possibility of strengthening business performance in regard to big data and analytics. In fact, big data that can be defined as the raise in the volume of data that are hard to store, process and analyze with traditional databases, can be tied together with could computing. Meaning that, as the organizational urgency to store, process and analyze a large amount of data is becoming indispensable, one can conclude that the role of cloud computing turns out to be pivotal and decisive (Hashem, et al., 2015).

Apart from cloud computing and big data, in the effort to explain the technologies that play a decisive role to stimulate companies transition toward digitalization, a mention should be made for what concerns Internet of Things (IoT). This technology can be defined as sensors and actuators connected by the internet network to systems capable of processing this information thus unlocking endless opportunities for new interactions and business models (Mckinsey Global Institute, 2015; Abolhassan, 2017). A similar concept to describe the phenomenon of a world where connectivity dominates is Machine to Machine (M2M). This term initially had been revered to a one-to-one interaction between two machines. However, given how transmission capabilities have dramatically expanded, it reflects the fact that data can now allow communication among a wider number of connected devices able to send their own data and receive external pieces of information (Lueth, 2015).

In addition, another technology that the business managerial literature has appointed relevant for becoming a digitalized enterprise as well as to accelerate the transition toward a circular economy is Artificial Intelligence (AI). AI's domain is concerned with the possibility of developing system that demonstrate characteristics that are generally relatable to human behavior. Thus, Artificial Intelligence entails a very broad multidimensional sphere where thanks to specific algorithms human

actions and behaviors such as perception, natural language processing, problem solving and planning, learning and adaptation and acting on the environment can be replicated by artificial agents (Tecuci, 2012). To put it simply, AI concerns a system acting in such a manner that it appears intelligent to any observer (Coppin, 2004). However, it should be pointed out that the idea of developing a system able to reproduce the human being's intelligence is not new. What is absolutely contemporary and extremely recent is the pace it is evolving nowadays. This exponential evolution has been driven by both cutting-edge machine-learning algorithms that have been lately refined and computing capacity that has now reached a stage where sophisticated problems can be solved at a rate higher than ever before (Tecuci, 2012).

Finally, a catalyst role in this sense has been played by big data that can be conceived as a massive amount of input that can be used to train machines. All in all, among these sources of data one that has been included is social media that are considerably offering new opportunities for real-time communications, and sensors embedded in the Internet of Things (McKinsey Global Institute, 2017; Abolhassan , 2017).

On the whole, in the light of what has been discussed above, a comment can be exposed. The technologies underpinning the phenomenon of digitalization could be perceived to act with a knock-on effect since it can be argued that these might boost each other. Thus, one could talk in terms of a digital ecosystem to achieve competitiveness.
All in all, when dealing with the driver technologies, a final remark is to be specified. That is, the mere use of the above-mentioned outputs of R&D labs will not lead companies to reap the benefits of digitalization. Conversely, the holistic integration at different level of the value chain is likely to bring business entities to cope with the changing market conditions (Ross, et al., 2016). A similar perspective is given in the Digital Business Global Executive Study and Research Project by MIT Sloan Management Review and Deloitte (2018) which identifies the potential of digital technologies not in these as independently considered. On the contrary, it lies in the way organizations integrate them to rethink their field of business activities and the way these are performed (Kane, et al., 2015).

2.2.3 Consequences and challenges of digitalization

Before focusing on how digitalization has impacted on companies' businesses, the reader should take into account the fact that the consequences of digitalization are countless, and they span in a long-range perspective from social to employment concerns perspectives. Accordingly, the consequences that will be presented below are the ones that have been evaluated more meaningful for the purpose of this thesis.

When it comes to digitalization, enterprises need to rethink their offerings according to paradigm shifts in the competitive environment and their adaptation capacity should be concretely developed as a reaction to the introduction of digital technologies. Hence, having outlined how the technologies have stimulated companies to develop their digital strategies, the author considers suitable to explain how these digital strategies are actually impacting and challenging the businesses.

Firstly, a study conducted by the World Economic Forum in collaboration with Accenture (2018) has highlighted that the impact of investments in new technologies such as robotics, IoT, cognitive technologies and mobile on revenue and productivity has been considered positive overall (World Economic Forum, 2018). Considering that, automation is increasingly taking root in the activities that were previously undertaken by human beings. This results in an increased availability of data, basically information proliferating by a variety of channels, devices and web analytics. However, a critical aspect of this increased pieces of information available is the necessity to have digital-savvy talent in the organizations that can unlock the potential underpinning digital technologies. This means that business practitioners should be able to deal with data by trusting them and having the ability to work with them (Adobe, 2018).

Another noteworthy aspect that should be considered is the effect on the value chain. Indeed, the conventional relationship between producer-distributor-customer has changed blurring the boundaries between the different economic actors involved and, at the same time, exerting pressure on companies to develop new skills. These are the requirements to implement mediation strategies to involve the different players of the network of organizations, main actors of the value chains in the digital economy (Delmond, 2018). At the same time, this evolving nature of the interdependencies between enterprises performing different business activities is changing the new bases for competition. In this context the increasing shift toward servitization takes place. In fact, digital technologies are playing a role in accelerating organizations' shift toward "digital servitization" that

can be defined as the provision of digital services along the offers of physical products. Thus, thanks to servitization enterprises can pursue differentiation to beat competition and boost customer engagement (Vendrell-Herrero, et al., 2017). These transformations result in evolution to business models characterized by a concrete integration of strategic partners in different ways. It can be the case of suppliers and distributors that are involved providing resources, skills, complementary service offering and access to new customers (Delmond, 2018). At the same time, the way companies profit from their activities can change completely due to the integrations of digital technologies in products, business processes, sales channels and supply chains (Matt, et al., 2015).

All in all, it appears evident that companies should align their IT assets and business strategy to capture the enhancements promised by digital business transformation (Delmond, 2018). This convergence entails the relevance of developing a strategic plan to enhance the digital skills at the different levels of the organizations. In this sense, the interplay between IT and business should be explicit and crystal clear. Accordingly, the need arises to put into practice mechanisms to assess and progressively control the advances of digital business transformation (Westerman, et al., 2014).

2.2.4 Organizational change in the context of digitalization

On the basis of the previous explanation, digitalization could be interpreted as an external force that is exerting relevant pressure from outside the companies' boundaries. What is more, this paradigm shift is currently stimulating organizations to adapt, react and change at different levels. Therefore, it seems suitable to present the reader an overview about how companies react when technologies and external pressures head toward some unpredicted and unexperienced manner. To start, according to Tsoukas and Chia (2002) organizational change is defined as the ongoing transformation of beliefs and experience to accommodate new experiences, derived by interactions with the external environment in order to act coherently in the marketplace (Tsoukas & Chia, 2002).

When it comes to the latest innovation avenues, from a managerial perspective being aware of what is happening in the world of technologies might be insufficient. Today, more than before, executives are required to be able to predict what will happen next in the market place. The reason for this lies in the fact that the pace of evolution is nowadays advancing faster than ever before, and some organizations are experiencing troubles in keeping track and align with those breakthrough turnarounds (Boss, 2016). However, in the view of the fact that the options are either to develop a certain degree of resilience or exit the marketplace, it can be concluded that building adaptation capacity and compelling ways to deal with change management strategy is becoming indispensable

(Page, 2017). As a matter of fact, adaptation for a business organization means reaching a state in which it can survive given the condition of the external environment. Thus, the more complex is the business surrounding the organization is able to deal with, the higher the possibility of survival in the long run and the level of adaptation (Chakravarthy, 1982).

Furthermore, according to Luecke (2003) in the current business environment change is perceived as a routinely essential part of the companies' life, decisive for exerting a leap forward in competitiveness (Luecke, 2003). In this sense, while academics traditionally perceived organizational change as a rare and exceptional event, as Tsoukas and Chia (2002) suggested that change should be treated as a normal condition of organizational life (Tsoukas & Chia, 2002). Hence, in a business strategy perspective, routines and well-established procedures should be designed in such a way to be able to undergo the social, environmental and ethical issues that are increasingly becoming part of the collective consciousness. Thus, these concerns should be defenetely part of the corporate decision making. As a matter of fact, organizations are not acting apart and isolated. On the contrary, they are business players of complex environments whose arrangement derives from the reconciliation and contrasts among multifaced and compounded interests (Hahn, et al., 2010).

Considering the previous line of reasoning, it can be supported that the ability to cope with paradigm shifts in an ever-evolving marketplace is still not a state that characterize every single business organization. In fact, when companies fail, the reason lies not in the occurrence of changes in the external environment, but in the executives' incapability or unwillingness to deal with those changes (Boss, 2016). Contrastingly, there might be some factors that limit enterprises' capacity to respond. These are outlined by several authors as Hannan and Freeman (1984) who distinguish between internal factors and external factors that might result in inability to cope with change. Examples of the ones belonging to the first category are sunk costs deriving from investments in physical assets or human skills, the interaction among political coalitions, while the ones of the second category could lie in legal and other barriers able to influence companies' strategic behavior.

Moreover, companies' resilience should be conceived in a dynamic perspective since reorganizing structure and strategies can be insufficient if these actions are not carried out in a timely manner. Accordingly, what might be the outcome if companies' capability to respond and external surrounding evolve with a different pace? The organizations will probably find themselves in a situation that academics has described as "structural inertia" (ibid.). Meaning that the enterprise has not been able to develop enough adaptation and thus it changes its structure and strategy as reaction to environmental changes, threats and opportunities(ibid.).

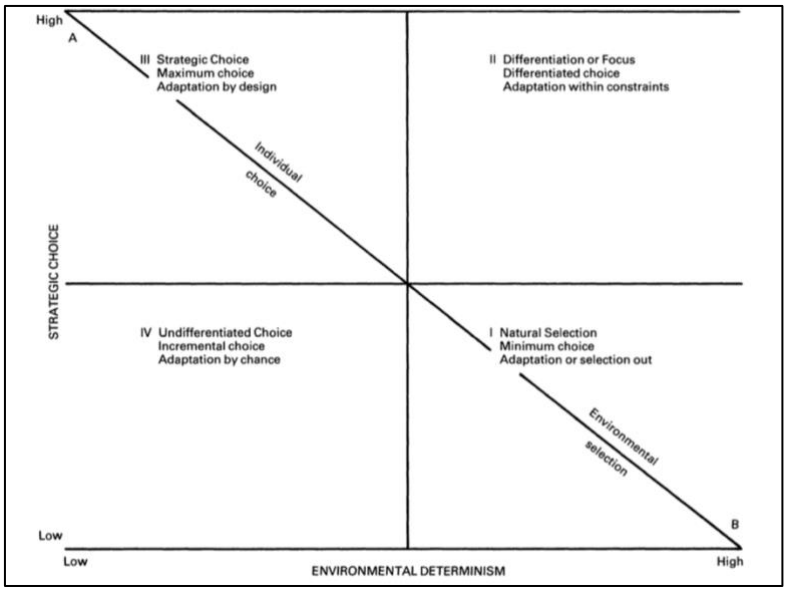
To be clear, the assessment of companies' flexibility and resilience cannot be done disregard the surrounding in which the business actor is operating. In fact, acceptable response times might vary along different industries, markets and social surroundings. All in all, a well-designed strategy to handle with innovations corresponds to a scenario where the speed of reorganization is able to cope at the right moment with the rate at which changes in the encviromental conditions occur (Hannan & Freeman, 1984).

At this point of the literature review, it seems fitting to shed light on the role played by the drivers of organizational adaptation in order to estimate to what extent business' evolution is managerial or environmental derived as Hrebiniak and Toyce (1985) have explained. For the sake of clarity, a scheme outlining the different situations that a company might face when it comes to adapt to pressures of different nature is presented below (Figure 3). It should be noticed that existing adaptation literature had placed the emphasis on the contexts depicted in quadrants I and III that correspond respectively to the perspective of "natural selection" and "strategic choice". Accordingly, in the context of this study it seems relevant to describe the dynamic interplay between the two variables of environmental determinism and strategic choices rather than providing an in-depth discussion of all the possible contexts that can be identified. Thus, the author will focus only on the two extreme situations (Hrebiniak & Joyce, 1985). As the reader can see, the first quadrant describes a context where managerial action is limited due to the fact that single business entities retain little discretional scope of action. In fact, their competitive moves are extensively shaped by environmental forces. The other side of the coin is represented by the third quadrant that depicts a situation that lies at the opposite extreme. In this case, organization is able to actively performs its strategy and exert its domain over the external environment (Hrebiniak & Joyce, 1985).

Taking into account digital business transformation, the researcher considers the model presented suitable to explain the interplay of external pressures conceived as innovative technologies and the importance of internal dynamism. In fact, digitalization is not only stimulating enterprises to translate their business processes in a digital track but also to entirely reshape how their value is delivered in new perspective thanks to digital technologies (Parviainen, et al., 2017). In this sense, these might be seen as extraneous change catalysts, and an active and strategically prone approach is probably required to tackle this deviation from traditional path. Thus, applying this model in the context of digitalization and given the background literature taken into account, the author reckons the equally relevance of environmental determinism and strategic choice.

All in all, it should be clear that these should not be considered with a static mindset. On the contrary, the relationship between them can fluctuate over time and both strategic choice and environmental determinism might result in being drivers of new waves of transition and advance. For this reason, only by "thinking in circles" it is possible to grasp the evolutionary business process in response to paradigm shifts and perceive the stages in-between as part of the organizational evolution over time (Hrebiniak & Joyce, 1985).

Figure 3: Relationship between strategic choices and environmental determinism in organizational adaptation



Source: Hrebiniak and Toyce (1985), p. 339

As suggested by the analysis provided above, the ability of business organization to adapt in order to sustain their competitive position in the market place is strictly linked to its disposition with respect to the external environment. In this perspective, a theoretical framework is provided by Kitchell (1995) who emphasizes the relevance of the corporate culture as an enabler to embrace innovations and technologies and to remain competitive. More in detail, the cited paper describes a study that has been conducted involving a sample of more than hundred companies. The findings outlined a positive relationship between organization's ability to change and the relationship with their external environment. In particular, organizations integration with its surroundings has been categorized based on some specific parameters. According to this study, it could be argued that the more the companies

are flexible and open to change, the most they are likely to develop enough adaptation capacity to cope with external pressures.
Further on this, it seems interesting to point out that among enterprises that have been classified innovative according to assumptions made, technology adoption was not conceived as a leading-edge act, but as a mere sine qua non condition assumed decisive to remain enduring (Kitchell , 1995).

2.3 Moving toward a digitally powered Circular Economy

2.3.1 Use of digital technologies for Circular Economy

Considering that digital technologies are literally transforming every single aspects of business and placing pressures to change, there is little doubt among practitioners that these will have a relevant role in spreading the circular economy principles and enabling a bigger number of companies to embrace them (Lacy, 2015). In particular, the present pharagraph will present an overview on the subject of circular economy in the era of digitalization considering the most relevant business-level implications. It should be pointed out that, given lack of academic literature of this relatively new topic, the point of views taken into account is the ones of business insiders.

The first category of opportunities is related to the possibility to enhance process and product monitoring through Internet of Things, big data and big data analytics. In fact, digital technologies can enable remote control through mobile apps combined with other applications such as machine-to-machine (M2M) connectivity and big data analytics. By doing so, physical elements of the business processes can be remotely and automatedly controlled, thus facilitating predictive maintenance. The reason lies in the fact that prior knowledge of products' condition obtained thanks to IoT and big data analytics has the potential to lead to the replacement of failing components prior to asset failure (Ellen MacArthur Foundation, 2016; Bressanelli, et al., 2018). Meaning that, applying big data analytics companies can optimize product maintenance, thus reducing resource requirements (ibid.).

These are not the only outcomes of this profitable synergy. In fact, the increased possibility of tracking comes also with costs reductions. In fact, expenditures for maintenance are likely to decrease by 30 percent and this figure appears particularly relevant considering that circular economy promises longer product life-cycles through adequate maintenance rather than disposal (Lacy, 2015). The power of real-rime data generation and collection are not just these ones, also having up-to-date information about the precise location of waste, product status and conditions may be useful to boost other closed-loop steps like refurbishment, remanufacturing and recycling (Wilts & Berg, 2017).

In addition, business organizations might consider the opportunity of applying big data analytics and artificial intelligence to optimize logistic and asset management in a circular economy perspective (Ramadoss, et al., 2018).

Another field intelligent assets can contribute to, is concerned with product development. In fact, digital technologies can refine product generation by conceiving products so that their life-cycle can be stretched. As a matter of fact, thanks to a wider availability of information in the form of data, products can become more enduring and additional closed-solutions can be enhanced through effective design for remanufacturing and assembly (Ellen MacArthur Foundation, 2016). Also, when it comes to new materials for production, data and information collected through digital technologies can be quickly analyzed by artificial intelligence to indicate which new material might be suitable to substitute harmful chemicals (Ellen MacArthur Foundation, 2019).

As far as waste management is concerned, digital systems can accelerate the roadmap to waste collection as result of route optimization. Moreover, artificial intelligence can allow the valorization of material and products by using visual recognition techniques to sort post-consumer material flows (Ellen MacArthur Foundation, 2019).

In conclusion, cloud and cloud computing have enabled the shift toward a dematerialization of a variety of sectors. In a circular economy perspective, less physical and tangible assets mean a better environmental outlook. In fact, the use of physical resources is minimized by the possibility of having the same content in intangible forms. A simple evidence is that if a company moves to online newsletter is predicted to decrease the amount of industrial waste generated by 14000 kilograms (ibid.).

Finally, the required transparency between the players of the value chain to shift toward circular economy can be enhanced by the recently introduced IT technologies like connected devices, big data analytics, cloud computing and blockchain. These have the potential to move from a vision of the supply chain where each individual is considered singularly to a comprehensive one. Meaning that the dots corresponding to the players responsible for the individual processes can be connected with modern enterprise resource-planning systems to synchronize material and financial flows and support decision-making (Schmid & Ritzrau, 2018).

All in all, what should be noted is that the improvement of the implementation of circular economy is likely to increasingly be influenced by digital innovations in the next future. Hence, compelling leaders need to realign their sustainable approach trying to create as much value as possible from high-tech introductions. This would result in the possibility to deliver more value and being at the same time environmental-responsible, leading to what has been named Circular Advantage (Lacy, 2015).

Notwithstanding the opportunities presented above, the interplay between circular economy and digitalization might pose challenges. Even if they are not extensively addressed in general terms by the literature, they might be connected to the ones involved in the digital transformation process (0).

2.4 Summary of literature review

In order to streamline the reading process, it seems suitable to provide the reader a support to guide him/her throughout the following parts of the thesis and in particular toward the chapters of data collection, analysis and conclusion. Thus, the following lines provide a brief description of the content of each paragraph of the literature review pointing out relevant patters that will be applied in the analysis.

To begin with, the chapter starts with the topic of circular economy, proceeds exploring digitalization and ends by suggesting how digital solutions could be exploited for enhancing circularity.

In particular, paragraph 2.1 (Circular Economy) concerns a definition of circular economy, its main drivers and the explanation of the relationship with sustainability. Furthermore, challenges for the transition for circular economy are provided and circular business models are explained. In this light, it seems essential to answer the sub-research question.

As far paragraph 2.2 (Digitalization) is concerned, the definition suggested in the literature review is given and selected technologies are explained. Moreover, the author sheds light about how these technologies are impact the businesses perspectives. Finally, selected theories about organizational change are clarified by the author in the digitalization context. Thus, this section appears a crucial prerequisite for addressing the main research question.

Lastly, in paragraph 2.3 (Moving toward a digitally powered Circular Economy) the technologies suitable for providing support for circular economy's development are explained and the main opportunities highlighted. Moreover, given the lack of a consistent scientific literature on the

challenges that companies might face to exploit digitalization for circular economy, the author presents the ones that are more likely to occur.

Table 2: Summary table of literature review

Circular Economy	• Definition • Circular vs linear • Three principles • CE and sustainability • Challenges
Digitalization	• Definition • Technologies • Impact on businesses • Organizational change
Toward a digitally powered circular economy	• Technologies involved • Opportunities in the area of remote control, product development, waste management, transparency

Source: own elaboration

3. Methodology

This chapter is aimed at laying down the rationale shaping the methodological approach according to which the research has been conducted. In particular, the research strategy, methods and design are justified in accordance to the aim of the study. After having explained how primary data are collected, the way data are analyzed is exemplified and the research quality is presented.

3.1Research strategy

As far as the relationship between theory and research is concerned, an inductive approach is considered appropriate for the purpose of this study since the aim of the present research is not to test generally accepted theories in this field, but it aims to provide an exploration of the research question outlined in paragraph 1.3 (Bryman & Bell, 2011). It follows that a qualitative research method seems suitable due to the fact that the purpose of the author is trying to find out *how* management is perceiving the possibility of actively exploit digital solutions to improve companies' alignment to circular economy. On the contrary, if the focus had been to than make a systematic comparison in order to account for the variance in some phenomenon, a quantitative research would have been suitable (Silverman, 2010).

In addition, the themes identified in the introduction of the literature review chapters (paragraph 1.1)are better suited to be explored through a qualitative approach. As a matter of fact, thanks to detailed interviewing, qualitative research enables to approach closer respondent's perspective than what would have been possible to achieve with a quantitative study since this is more characterized on remote, inferential empirical methods and materials (Denzin & Lincoln, 2011).

However, when evaluating the strategy to follow, the researcher balanced the choice about the above-mentioned qualitative approach considering criticisms that might arise. For instance, qualitative research is commonly thought to be too subjective, nonetheless this problem was minimized by the author's effort to rely on systematic views of the practices observed thus including little room for bias (Bryman & Bell, 2011). By the same token, qualitative studies are often said to be difficult to replicate, however this does not affect the outcome of the thesis since one hand, replication issues are normal to arise in studies of social phenomena. In addition, the fact that the study is not suitable to be conducted again will not affect the possibility to address the research question (ibid.).

Further, it could be argued that even if this study cannot be generalized the very first aim of this research is not to provide a comprehensive framework suitable to be directly applied. In fact, when

carrying out this master thesis project, the researcher aimed at disclosing and analyze the data gathered from the case studies taken into account in order to understand how case companies ranging from service providers to manufacturers might consider the support of digitalization for circularity.

Finally, a qualitative study might fall in problems of lack of transparency due to the fact the process according to which the study is conducted could not be explained in a clearly enough manner (Denzin & Lincoln, 2011). Despite that, the impact of this deficiency is limited in this project considering that clarifications are provided about research design(paragraph 3.2) , methods (paragraph 3.3) and analysis (subparagraph 3.5) . Thus, the path followed to arrive at remarkable findings and conclusions is clear. All in all, plainness and explicitness are secured by a precise explanation at the beginning of each chapter about how the content is presented by the author.

3.2Research design

3.2.1 Multiple-case study

A comparative design has been chosen since the aim of the thesis is investigating how the digital surrounding is impacting different business organizations' sustainable strategies with the aim of outlining similarities and differences (Bryman & Bell, 2011).

In particular among the possible comparative designs, a multiple case study seems appropriate given that a line of comparison between the sampled cases is sought so that the researcher can have the possibility to contrast the findings from each of the cases included rather than focusing the attention to the specific surrounding. In addition, it can be argued that being the focus on gaining insight from the cases rather than coming up with general findings, a multiple-case study results more suitable than a cross-sectional design that usually aims at providing more generalizable results (Bryman & Bell, 2011). Hence it can be concluded that thanks to the chosen qualitative approach, insights from companies belonging to different sectors and with different business models, will be gathered in the data collection part. Hence, the purpose is to understand their specific perspective rather than giving relevance to the context in which they were operating.

3.2.2 Selection of case companies

In particular, companies were selected since, being "information rich" cases, they were deemed to accomplish the goal of providing relevant insights to answer the research questions (Devers & Frankel, 2000). The four Swedish-based companies chosen are: reCreate Design Company, Essity, Volvo Cars and Senab. For the sake of precision, the focus of Sweden represents a geographical limitation as reported in paragraph 1.4 . Further, the assumption made by the author in collaboration

with FTK and from the information available on their official websites[1] that they have a circular business model in place. Moreover, the researcher sought for a comparison between different types of enterprises. To better explain, Essity is a manufacturing company pertaining to the FMCG sector; Volvo Cars that is a manufacturing company whose products have a longer life-cycle; reCreate Design Company is a small enterprise offering both products and services. Finally, Senab is a company whose offering consists in providing services to other businesses. For the sake of clarity, it seems relevant to point out that the author embraced the difference between service organizations claimed by Nada and Reid (2012). Accordingly, manufacturing organizations have tangible products as output, while service organizations require the presence of customers for the creation of the service (Sanders & Reid, 2012).

3.3Research method

For the purpose of this study both secondary and primary data are been involved. Primary data refer to the one gained by the researcher with the specific intent of answering the research question while secondary data entail the materials available by the research community, thus had previously gathered for another objective external to this study and used again to address another research question(s) (Joop & Boeije, 2005).

3.3.1 Secondary Data

First of all, it seems necessary to clarify that different approaches can be chosen in order to review the literature. As a matter of fact, Bryman and Bell (2011) distinguish between systematic and narrative review. The former entails a detailed plan to be followed in order to reduce the bias of the researcher through an extensive analysis of both pre-existing published and unpublished existing literature. On the contrary, according to the narrative approach, the literature review is conceived as a tool to obtain a general idea of the topic that need to be explored with the study at stake. Thus, it results to have a more general scope than the systematic approach. For the purpose of this master thesis, a narrative method is chosen. In particular, the decision is deemed suitable for time and resources limitations. Furthermore, narrative review seems to be more suitable for qualitative investigations and interpretative researchers that require the need for flexibility to change the scope of the study as the process goes along (Bryman & Bell, 2011).

[1] For further information about companies' circular economy, the following links are related to specific areas of their websites explaining their circular economy effort: recreatedesigncompany.com; www.essity.com; www.volvocars.com; senab.com

In this light, with the aim of providing a comprehensive theoretical background concerning the research field of the present master thesis, a literature review of sources considered trustworthy by the researcher is conducted. More on this, the objective of relying on existing literature entails becoming aware of the relevant issues concerning the findings in this specific area and of the presence of unanswered research questions (Bryman & Bell, 2011).

In particular, relevant existing literature consists in journal articles, reports, magazine articles, books and it was found through LUISS Library, University of Gothenburg Library, Google Scholar and available online. Additionally, given the topic of interests being relatively new, reports from consultancy companies and international organizations, conference proceedings have also been used for the theoretical background. In particular, it seems appropriate to highlighted that when it was possible scientific literature was preferred. However, when scientific literature was lacking or related to technicalities, the author relied on reports from mainly consultancy firms.
To narrow the scope of the research, the literature was selected considering the adherence to the area of adaptability capacity in regard to innovative changes, paradigm shifts, change management, digitalization and circular economy as two phenomena that are shaping the business environment. For the sake of providing an exemplification of how the papers are founded by the researcher, some key words used are presented: *technological change, organization adaptation, adaptation capacity, organizational change, impact of digitalization, digitalization strategy, drivers of digitalization, shift to sustainability, circular economy, sustainable development, closing the loop, digitalization and circular economy, circularity.*
Furthermore, as far as the languages are concerned, the research for secondary data is restricted to existing literature written both in English and Italian.

3.3.2 Primary data

In addition to the secondary data, this study extensively relies on primary data that include materials collected through the interviews as presented in the data collection chapter (chapter 4). Furthermore, primary data have been collected both with experts and companies' representatives.

3.3.2.1 Sampling and respondent selection

This study draws upon a purposive sample since the author selected the participants considering their ability of meeting preestablished criteria. Meaning that, they should be able to provide insights in order to address the research questions (Samure & Given, 2012). In this sense, purposive sampling can be included among the nonprobability techniques, since within each organization, selected people were assumed to be able to provide knowledge about the state of the art of circular economy, digitalization and their connection. Regardless of their specific position, respondents have been

included as assumed to work practically with the themes of the study. In addition, a purposive sampling seems fitting since this is a technique often used for qualitative researches. Further, the reliability of the respondents has been evaluated to ensure quality of the findings. In particular some interviewees have been selected with the dependable support of FTK that as mentioned earlier played a bridge role between the researcher and some companies/experts.

For the sake of clarity, it seems suitable to point out that respondents have been contacted with messages containing a brief explanation of the topic and a synopsis attached (Appendix 2) of the thesis to have a general understanding of the project. In particular, messages for contacts obtained through FTK (Appendix 3A) and by the author personal effort (Appendix 3B) are different since in the case of respondents provided by FTK, thay had been already contacted by them.

First, empirical findings have been collected from interviews with experts conceived as *"people very skilled in particular activities or with a deep knowledge about a particular subject"* (Collins English Dictionary, 2019a). Hence, to have a comprehensive view about the research question the author has made the choice to include in the empirical findings data collected with four experts from different perspectives: a CEO of a consultancy company committed in helping companies to work profitably with sustainability (Re:profit), a researcher of RISE (Research Institutes of Sweden), a business practitioner (from Plantagon) and a member of an organization NMC (Network for sustainable business). In fact, they have been selected with the aim of adding relevant insights beyond the literature review. Consistently with this, the researcher decided not to include in the empirical findings two additional interviews conducted with experts from RISE due to the fact they are not considered t relevant since they have not provided additional insights with respects to the ones already disclosed by the literature review section. Lastly, experts' interviews details are summarized in Table 3.

Table 3: Experts respondents

Interviewee	Organization/ Research institute	Area of expertise	Date	Method	Length
Sara Fallahi (respondent A)	RISE	Digital business model and circular economy	12/04	Face-to-Face	50 min
Sepehr Mousavi (respondent B)	Earth of Billions Plantagon	Founder & CEO Sustainability director	05/04	Skype Interview	40 min
Magnus Hedenmark (respondent C)	Re:profit	CEO	15/04	Phone interview	55 min
Ingela Wickman Bois (respondent D)	NMC	Member of board	19/04	Skype Interview	45 min

Secondly, the researcher decided to include reliable respondents belonging to the case companies. Within case companies, representatives have been selected conceived as "*people typical of the group to which they belong"* (enterprises in the case at stake) (Collins English Dictionary, 2019b).
The other respondents have been selected by the researcher herself taking into account their position within the case company. In fact, the author established a connection with them through LinkedIn with the keywords "innovation", "sustainability" and "circular economy", thus they are to be assumed to have the potential to share relevant insights for the purpose of the study. Moreover, they have been interviewed since they were considered suitable in terms of availability and willingness to participate and to communicate knowledge and opinions about the impact of the phenomenon of digitalization and circular economy on their organizations (Etikan, et al., 2016). Lastly, a list of case companies' respondents is provided below (Table 1).

Table 4: Case companies' respondents

Interviewee	Company	Role	Date	Method	Length
Michaela Holmasahl (respondent E)	Recreate Design Company	Co-founder	02/04	Face-to-Face interview	45 min
Anonymous (respondent F)	Essity	Global Brand Manager	03/04	Face-to-Face interview	40 min
Axel Edh (respondent G)	Essity	Sustainability Director	03/04	Skype Interview	40 min
Karin André (respondent H)	Volvo Cars	Director, Corporate Innovation Office	08/04	Skype Interview	55 min
Andrea Egeskog (respondent I)	Volvo Cars	Environmental Strategist within R&D department	12/04	Skype Interview	20 min
Johan Selberg (respondent L)	Senab	SWS Manager	10/04	Face-to-Face interview	50 min

3.3.2.2 Interview method and questions

Among the different possibilities to obtain qualitative data, interviews have been chosen since they are deemed to offer the possibility to obtain information-rich insights about the respondent knowledge. In fact, interviews are characterized by open-ended questions rather that closed categories and questions are not set in stones, but they are eligible be modified depending on how the conversation proceeds. Moreover, the researcher himself/herself is entitled to adjust the flow of the interviews in the most suitable form to address the research question (Flick, 2018).

Furthermore, this master thesis relies on semi-structured interviews, meaning that the researcher had a number of questions that guide his/her data collection process. A peculiarity of this type of approach lies in the fact that it is usually based on an interview guide including the main topic and questions that the researcher should address to answer the research question (Bryman & Bell, 2011). The

interview guide has the aim of providing a clear set of instruction that the interviewer can follow to obtain relevant data.

In particular, semi-structured questions have been chosen with the aim of enhance comparability among the case companies considering that they are different for what concerns the sectors and the business model. In fact, the empirical findings are collected into categories derived from the outline of the interview guide. In detail, preliminary questions about the general understanding of core concepts such as circular economy and digitalization are included to assure respondents' general understanding. All in all, through practice semi-structured interviews, the researcher is given a degree of flexibility since he/she can change the questions order as well as include additional ones on the basis of the respondents' answers. The interview guide was not too thightly structured since a certain degree of adaptability should be preserved (Harrell & Bradley, 2009; Bryman & Bell, 2011).
In particular, the researcher grouped the questions into three main areas concerning respectively questions regarding digitalization; circular economy and the exploitation of digital tools for circular economy. In addition, the author elaborated a different interview guide for experts and case companies since as explained above they are to be conceived for different purposes. Besides, experts' questions have been prepared to contribute and complement the basis provided by the existing literature.

Besides, it should be pointed out that when contacting the interviewees, they have been given the possibility to receive in advance the interview guide to provide them the opportunity to have beforehand an idea of the type and number of questions to be addressed in the time slot available.

3.3.2.2.1 Conducting the interviews

As explained in the previous paragraph (3.3.2.2), the author decided to include in this study semi-structured interviews from the case companies and from experts' side. Out of the total ten interviews, four were conducted face-to-face, fours through Skype and one by phone.
As far as Face-to-Face interviews are concerned, the location was chosen by the respondents to assure his/her comfort and convenience (Bryman and Bell, 2011). Considering Skype interviews, scholars have pointed out some challenges such as dropped calls and pauses, inaudible segments, limited possibility to read the body language, loss of intimacy compared to traditional interpersonal interviews. However ,these have been overcome by the author thanks to a stable internet connection, a quiet room without distractions as location, availability to repeat answers and questions and attention paid to facial expressions (Seitz, 2016).

Finally, when it comes to phone interviews the author has tried to follow some practical recommendations that have been outlined by preceding literature. For, instance the researcher put effort to maintain a friendly, courteous, conversational, unbiased style and to give interviewee feedbacks as appropriate (Burke & Miller, 2001).

All the interviews were recorded after having asked the respondent the possibility to do so.
Further, during them, in appropriate moments the researcher tried to relate current topic of discussion with subjects already addressed in order to align with one of the criteria of successful interviewer (Kvale, 1996). Moreover, the majority of the interviews were conducted with the support of a colleague with the aim of helping the researcher to take notes the interview and thus increase the reliability of the research itself. To conclude, since transcription can be considered a really time-consuming activity, all the interviews have been summarized to facilitate the reading process and they have been sent back to the respondents through mail to avoid misunderstanding and enhance the reliability of the findings.

3.4Presentation of data collection

Findings gathered through the interviews are presented in chapter 4 grouped per expert or case company in order to provide the reader with a complete understanding on the perspective of the expert/ company in relation to the topic addressed. Moreover, data collected from each company or expert is divided in categories and subcategories derived by the interview guide and the literature review as they have been considered the most appropriate to answer the research question (this is explained in detail at the beginning of chapter 4). Further, results in each paragraph are divided into categories and subcategories. In particular the categories are: *circular economy; digitalization and moving toward a digitally powered circular economy.* It is noticeable that for some of the experts, some categories or subcategories are missing since as explained below (subparagraph 3.3.2.1 in section 3.3.2) they have been included by the researcher to provide additional information about their specific field of expertise. Meaning that, questions diverging from their focus areas have either not intentionally being addressed or did not provide relevant insights to answer the research question.

3.5Data analysis

The findings collected through the interviews are analyzed in chapter 5 . More in detail, empirics and theoretical frameworks are compared and contrasted in order to acquire knowledge about to what extent a match can be identified between theory and reality. The analysis is structured in the same categories and subcategories present in the data collection chapter. In addition, data are compared within themselves following the patterns within categories used in the data collection. As far as

interviews with experts are concerned, the findings are to be compared with the theory and results from practitioners of case companies.

All in all, along this procedure, critical thinking has been expressed in order to allowed researcher to provide a valuable answer to the research questions by reflecting upon her own interpretation of the results.

3.6Research quality

As far as qualitative research is concerned, the issue of quality in social science studies has been put under pressure through explicit discussions by the researcher's community. In particular, with the aim of assessing the quality of a qualitative study, the concepts of reliability and validity have important implications that are explained below in this paragraph (Seale, 1999). Moreover, the author feels important to highlight that in order to funnel various data sources into a comprehensive view of the phenomena of the present research, the strategy of triangulation was chosen to improve the validity of the results of the study (Mathison, 1988). For the sake of clarity, according to Mathison (1988) triangulation stands for the combination of more than one unique source data.

3.6.1 Internal reliability

Internal reliability can be defined as the degree to which other researchers would relate already generated themes with data in the same way as matched by the original research (Bryman & Bell, 2011). In the case at stake, the risk of not achieving internal validity is limited since only one researcher has carried out this master thesis and the author ensured to be systematic in data collection and analysis.

3.6.2 External reliability

External reliability refers to the extent to which the processes and the results of the study could be repeatable (Bryman & Bell, 2011). One should notice that in qualitative research this definition could be considered challenging and counter-intuitive, however in order to enhance reliability the researcher has followed a methodology of constant comparison to verify the data's accuracy in terms of form and related concepts (Leung, 2015). Finally, as for internal reliability, a systematic approach has been followed for collecting data as well as for the analysis.

3.6.3 Internal validity

Internal validity is concerned with the investigation of what is aimed of being addressed by the research question. That is, the main objective is to assure a coherent link between the data collected through the interviews of the selected companies and the points that the researcher has outlined in the conclusive part of the study (Bryman & Bell, 2011). In this sense, the researcher has tried to limit the

risk of incoherence by conducting an iterative process in order to make the conclusions reflect what has been gathered through in data collection phase.

3.6.4 External validity

Eternal validity is connected to the extent to which the study's results can be applied to other contexts or settings. Since, as in this research, qualitative studies rarely rely on a random sample, generalization in the sense of applying the research's results from a sample to the entire population might be hard to achieve. In particular, since this study has been carried out through a multiple-case study of different companies, one could notice that it could be said to suffer of poor possibility of generalization. However, when the researcher approached the present investigation, the purpose of this study was not building a generalizable theoretical framework (Merriam, 1995).

With this in mind, it can be concluded that the findings of this study should be seen as implications deriving from the contingent setting analyzed in terms of sample chosen. All in all, the conclusions cannot be seen as eligible to be directly applied but as results of the specific settings able to provide additional basis to the existing academic literature in this field and touchstones for management dealing with circular economy in the digitalization era.

4. Data collection

This chapter presents the empirical data from the interviews as reorganized by the author to allow the reader to follow a clear line of argument. In particular, the data are presented per expert and per case companies in order to provide a comprehensive view of each. Moreover, in order to facilitate the reading process, the empirical data are arranged following a clear structure to highlight the main topics of the interviews. Thus, data are divided in categories and subcategories that have been identified thanks to the literature review and reflected in the interview guide as explained in the methodology section (paragraph 3.3.2.2). Finally, for the sake of clarity, the chapter ends with a summary table.

Guide to data collection

For the purpose of clarity, it seems appropriate to provide the reader with a guide to the empirical findings. First, the categories correspond to the main points that constitute the interview guide (Appendix 1A; Appendix 1B) and that have been highlighted during the interviews. Moreover, their connection with literature review is now explained.

The first category of the empirical findings (Circular Economy) is related to the first chapter of the literature review (2.1). In particular, the subcategory "Explaining Circular Economy" is connected with the subparagraphs (2.1.1 2.1.2 2.1.3) , thus it sheds light on the respondents' insights on circular economy definition, relationships with sustainability and challenges. The "future expectations "subcategory is not directly connected with one section of the literature review since it provides respondents speculations that have not been extensively addressed by scientific literature.

The second category of the empirical findings (Digitalization) is connected to the second chapter of the literature review section(2.2) since they have a corresponding paragraphs. However, a distinction should be highlighted for the "Future expectations" category. In fact, it is not directly part of the literature, since it involves interviewees' own perceptions of the forthcoming years.

Finally, the third category (Moving toward a digitally powered CE) is connected to the third chapter of the literature review (2.3) However, the final two subcategories have not specific connections to the literature review due to the fact that they have not been extensively addressed by previous theoretical studies.

Data collection from experts

4.1Senior researcher at RISE

Sara Fallahi is a senior researcher in the digital innovation field. She works at RISE (Swedish Research Institute and Innovation Partner), whose mission lies in offering unique expertise to support all types of innovation processes to contribute to a competitive business community and a sustainable society through their international collaboration with industry, academia and public sector (RISE, 2019).

4.1.1 Circular Economy

4.1.1.1Explaining Circular Economy

According to respondent A, circular economy entails certain types of activities that companies are undertaking to extend the life-time of the product, to make the production process more efficient, to be able to re-use and repair certain materials or products in the cycle and to deliver products as services. On the other hand, she believes that sustainability is a much broader concept. To be precise, she highlights that if a company is working with renewable energy, it is not implementing circular economy. According to interviewee A, the reason lies in the fact that the enterprise is not changing its business model, while circular economy activities entails changing the value proposition and how they are capturing value.

Interviewee A points out that servitization itself could be considered as a circular economy activity as it results in extended time of the product life. However, she clarifies that this shift toward servitization has not always derived from and environmental logic but from a sale logic.

When it comes to the role of consumers in this regard, for circular economy to work properly they should have the willingness to contribute, for instance by bringing back the product to the company after use. In addition, companies should implement well-functioning systems for developing circular solutions and this might be challenging depending on the sectors.

In particular, respondent points out that having control is the key for circular business. While this might be challenging when looking into private consumer market, for municipal organizations it could be easier to arrange circular solutions. For instance, one application could be the use of batteries from buses for other purposes like home stationery energy storage systems.

As respondent A suggests, today circular economy implementation is really scattered since companies do not have all the aspects of CE in place. In particular, interviewee A highlights that CE requires

companies to share information with each other, work together and many companies do not have the systems in place to work with that.
As far as the relationships with external actors, interviewee A clarifies that the traditional "make-use-dispose" production line required mainly financial KPIs in companies that now need to be transformed to become circular. For instance, in procurement activity, price was the only KPI determining the supplier to work with, without taking into account any environmental KPI.
All in all, she outlines that the whole relationship in the value chain should be rearranged in the circular economy and this might be hard since different companies do not "*speak the same language"* in terms of contractual agreement.

In addition, respondent A points out that, if companies aim at producing outputs with extended life-cycle, they need to use expensive materials. In that sense, some of them might face a dilemma as they could increase their revenues streams by producing shorter life-cycle products with lower quality materials.

Finally, as far as the relationship between circular economy and sharing economy is concerned, she considers the latter a branch of the former. Respondent A adds that the challenge is about measuring the impact of the sharing economy, because if it is not implemented in a circular way, it will negatively impact the environment rather than improving it.

4.1.1.2Future expectations on Circular Economy

Interviewee A argues that the potential still unrealized but, in the future, she sees possibilities of developments thanks to the use of digital technologies.

4.1.2 Digitalization

4.1.2.1 Understanding digitalization

Respondent A considers digitalization as *"an enabler, a mean for companies for other strategic changes and a tool for transformation of companies' needs"* [speaking about the definition of digitalization].

4.1.2.2. Challenges of digitalization

According to interviewee A, a challenge lies in the resources in terms of skills and competence required.

4.1.2.3. Future expectations on digitalization

Respondent A believes a future where businesses will acquire the competences to overcome the challenges implied in the transformation. As a matter of fact, companies might create units or spin offs for handling digital solutions.

4.1.2.4 Organizational change in the context of digitalization

According to respondent A, change for digitalization was perceived as a threat in the beginning by companies, but she claims that digitalization does not entail only transforming the physical content into a digital one, but also evaluating what companies could do with this. In this sense, she believes that companies should start to consider digitalization more as an opportunity rather than an external pressure for change.

4.1.3 Moving toward a digitally powered Circular Economy

4.1.3.1 Use of digital technologies for Circular Economy

To start, respondent A outlines that thanks to M2M communication, improvements in the internal processes can be achieved and predictive maintenance can be enhanced.

When it comes to recycling, interviewee A suggests that sorting of materials activities can be supported by the use digital technologies or image process technologies for separating different streams that require specific processes to be used again.

Finally, respondent A concludes that digital technologies can be used to calculate the residual value of products.

4.1.3.2 Challenges of the use of digital technologies for Circular Economy

Interviewee A points out that the challenges related to the possibility of leveraging on digitalization for circular economy lie in the competences and skills required by the digital transformation itself. In particular, in this case the need arises to have software developers to write algorithms for machine learning, AI experts that are often lacking in manufacturing companies. In fact, todays companies are starting to realize the logic underpinning the possibility to use digital technology for circularity, but they do not have the resources, or are not in the right decision-making position to use those.

Finally, the cultural aspect and managerial mindset of the companies should change to use technologies to deliver long-lasting products particularly if they are used to offer large quantity of spare components.

All in all, she comments that even if data can be interpreted as digital solutions to enable actors in the value chain to collaborate, some concerns about data sharing might arise since companies could be

resistant to give their partners information about their own business and customers behaviors in order to optimize the production accordingly in a circular perspective.

4.1.3.3 Opportunities and future expectations on the use of digital technologies for Circular Economy

Respondent A speculates on the fact that the next couple of years will be characterized by match-making activities between companies to use the technologies to become more circular. Given that, she outlines that companies need to develop these technologies first, before taking a step further.
Depending on the different strategic agenda of companies, if related to changes in the relationship in the value chain, the production or shift to services, they will have to develop different technology clusters.

In the future, interviewee A believes that *"companies will realize the connection between digitalization and circular economy even more and start to connect the dots to find the competences they need either in house or outsourcing them"*.

4.2CEO at Re:profit

Magnus Hedenmark is the CEO of Re:profit AB, a consultancy company supporting enterprises in taking steps forward sustainable profitability. In fact, they perform services ranging from solutions in the area of marketing communications to circular economy and sustainable development (Re:profit, 2019; Hedenmark, M., personal communication, 2019).

4.2.1 Circular Economy

4.2.1.1Explaining Circular Economy

According to respondent B, companies should have control over their product lifecycle to implement a circular business model. He asserts that if the production is on a small scale and with simple and limited materials, circularity is not hard to reach. On the contrary, in reality there are products that are much more complex, and it is a big challenge to obtain all the data involved in these offerings.
In fact, the main challenge is about taking record about what materials are in the products from the beginning, otherwise it is difficult to claim companies are approaching a circular economy. Also, interviewee B argues transparency as one of the main obstacles, considering that suppliers could have different standards, thus it could be tricky to arrange the different activities. In fact, it is important to

have "common languages" and this aim is generally pursued by international organizations as GS1[2] that should be seen as a landmark by companies.

Respondent B suggests that if companies are providing services, hence they are not directly engaged in the manufacturing process, it follows that they are *"approaching circular economy by offering products as services"*. Also, he points out that even if a company is not really involved in manufacturing, products and materials come from somewhere and service-providers shall be aware of that.

When it comes to fast moving goods, respondent B argues that it might be simpler to manage them in a circular way since you could implement a circular business not only recycling the materials but also by adding services in order to extend the lifecycle of products. On the other hand, managing complex products life cycles particularly if the different activities in the value chain are located across different geographic locations might be challenging for more technological products.

4.2.1.2Future expectations on Circular Economy

Respondent B argues that in the future to achieve the complete implementation of CE, companies should agree on a common possibility of dialogue, thus enhancing transparency in their activities.

4.2.2 Digitalization

4.2.2.1 Understanding digitalization

Interviewee B clarifies that digitalization entails using digital techniques for simplifying operations compared to conventional ways of transferring data, "*it is about doing things quicker, smoother and simpler"*.

4.2.2.2 Challenges of digitalization

Respondent B argues that a challenge of digitalization lies in the necessity of standard protocols. In fact, companies need to cooperate in order to decide common standards everybody can agree on. However, as interviewee points out this represents a different way of conducting business from the traditional one since enterprises usually compete with each other and are used to be non-transparent.

4.2.2.3 Future expectations on digitalization

Interviewee B argues that some companies will realize to understand the value of cooperation for digital transformation, hence companies will need a shared infrastructure to contribute to and benefit from.

[2] GS1 is an organization aiming at developing standards to enable organizations to identify, capture and share information smoothly, creating a common language that underpins systems and processes all over the world. (https://www.gs1.org)

4.2.2.4 Organizational change in the context of digitalization

According to the interviewee B, managers should understand that employees in the organization should be involved in the change process and inside the organization a common agenda should be implemented.

4.2.3 Moving toward a digitally powered Circular Economy

4.2.3.1 Use of digital technologies for Circular Economy

Interviewee B highlights that companies could use digitalization to have access to databases that contain relevant information about how to implement products with a longer life-cycle and this could lead to cost-efficiency.

4.2.3.2 Challenges of the use of digital technologies for Circular Economy

Respondent B argues that companies willing to use digitalization for circular economy should work together with international organizations that establish international standards and that provide consultancy services to become digitalized. He highlights that a big challenge is to have some *"great architecture"* behind the technology to manage technologies like big data in a smart way especially in the long term for circular economy.

Finally, he points out that engaging with competitors is crucial since if they use the same protocols, then the benefits can be shared, and a common understanding can be reached between the partners of the value chain.

4.2.3.3 Opportunities and future expectations on the use of digital technologies for Circular Economy

Interviewee B outlines that having a digital platform for sharing data about products can help companies to develop circular economy and decrease costs.

Respondent B argues that leveraging on digital techniques for circular economy *"pose the need for companies to change their mindset of doing business".* Thus, enterprises are projected to increasingly become aware of sharing the idea of mutual benefits arising from exploiting digital tools for circular economy. As a matter of fact, he points out that the technologies are already there and managers that take decisions should realize that this approach should be changed.

4.3 Founder and CEO at Earth of Billions

Sepehr Mousavi is an innovation, sustainability and circular economy strategist, and has professional experience with Swedish cleantech companies such as Plantagon and SweGreen. He is the chairman of Swedish national 'Sustainable Smart Cities and Communities' standardization committee and holds a membership in the chair advisory group of ISO (International Organization for Standardization) for sustainable cities; in 2019 he founded his own company "Earth of Billions".

4.3.1 Circular Economy

4.3.1.1 Explaining Circular Economy

Interviewee C highlights that thanks to circularity, companies could increase their profit or reduce their expenses. Therefore, he conceives this concept nowadays attractive for them. In this regard, companies can shift to circular with the support of external consultants or internal sustainability directors. Also, respondent C points out that circular economy might be confused with sharing economy and product as a service business model, however he suggests that these are two different concepts.

4.3.1.2 Future expectations on Circular Economy

Respondent C also adds that circular economy would be of simpler implementation in private companies with a production line because of the higher control of *"what gets in and what out"* in a holistic context of the production process and how they could be reintroduced again in the circle. For what concerns the sector of infrastructure and real estate, developing circular business models might be challenging.

Furthermore, interviewee C suggests that companies that offer services will probably develop circular solutions by introducing again in the circle what would have been considered waste otherwise. Also, taking into account intangible products such as energy, companies will become familiar with the possibility of leveraging on digital tools such as sensors, artificial intelligence, and data-base systems to manage the resources within their system.

4.3.2 Digitalization

Respondent C argues that it is crucial for companies to have a digital feasible strategy about how to manage their processes, assets, costumers and data extracted from them. In addition, data banks can provide meaningful results.

4.3.3 Moving toward a digitally powered Circular Economy

4.3.3.1 Use of digital technologies for Circular Economy

According to respondent C, digitalization can be seen as an *"enabler and catalyzer factor for circular economy"*. For instance, it can support companies to change their whole production process into

circular ones and accelerate the process or digital twinning could be a less-costly solution to define a model and then try in the real production environment.

Interviewee C also disclose the potential of digital solutions that can be unlocked by the use of business models called "products as a bank for materials" where products can be seen as banks for materials, thus traceability, consequently, is enabled.

4.3.3.2 Challenges of the use of digital technologies for Circular Economy

Interviewee C highlights that a challenge about leveraging on digitalization for circular economy might lie in the financial viability since it will require huge investments. Another obstacle to overcome in this regard, is the "human factor". Meaning people *"who think inside the box rather than outside the box"*. In fact, to take investments for long-term actions, decision-makers should be open to change. Policies at national, regional and global scale and regulations are two other important factors with have huge impact on pushing the private sector for going circular or continuing 'the business as usual'.

4.3.3.3 Opportunities and future expectations on the use of digital technologies for Circular Economy

When considering artificial intelligence, respondent C suggests that it could be used for decision-making about the use of materials to develop circular products and the stage of the product life-cycle but he points out that this application is not currently implemented but it can be considered as a future opportunity. Also, AI conducting research and development on model for optimization is another exponential positive factor which could enable acceleration of this shift significantly.

4.4 Specialized consultant and member of NMC

With experience in large corporations in sustainability, product development and process design in large corporations within the FMCG, food and energy industry, Ingela Wickman Bois works as specialized consultants for helping organizations to grasp circular business opportunities. She is a member of NMC (Network for Sustainable Business) and in 2019 she finalized the Master programme "Enterprise, Innovation and Circular Economy", at University of Bradford hosted by Ellen MacArthur Foundation (UK) (SB Insight, 2019; Bois, I.W., personal communication, 2019).

4.4.1 Circular Economy

4.4.1.1 Explaining Circular Economy

Respondent D conceives circular economy as a broader concept than sustainability. In fact, the latter can be seen as *"doing less bad"* regarding energy used and emissions while circular economy aims at not creating a negative footprint. She also adds that circularity entails the concept of profitability,

while sustainability has been a cost to the business rather than an opportunity for the companies. However, for companies shifting toward CE it might be hard to have satisfying returns on investment (ROI) in the short term. Despite this, she asserts that circularity is economically convenient since the price of raw materials is volatile and increasing, hence companies have incentives to take their materials back. Interviewee believes that companies might fall in misconception of thinking they are circular even if they are not. That is, they might continue to produce in a linear way and try to fix the error by closing the loop at the end with recycling. In this regard, she thinks that the way of producing should be different and practices such as design for re-manufacturing, eliminating toxic materials from the chain and using renewable energy.

Interviewee D argues that challenges of circular economy depend on the sector and the type of company (B2C or B2B). Respondent D explains that considering business-to-consumers, problems might arise regarding both low quality of the secondary materials and the fact that consumers are stuck in the "take-use-dispose" model of consumption, hence it is very hard for companies to have their mindset changed. On the other hand, she believes that for B2B companies it could be easier to find a circular business model that can work; however, some constraints might arise such as lack of infrastructure for collection to enable re-using and re-manufacturing. To conclude, interviewee believes that, given the absence of a national-based system in place, it is very hard and expensive for companies to create a "reverse logistic", a supply chain that takes the products back. She identifies another barrier in legislations and regulations that are not in place for using secondary materials, consequently a lack of match-making between buyers and sellers can be observed. For instance, if we take into account multinationals, they are not allowed by law to transport materials across countries.

4.4.1.2 Future expectations on Circular Economy

For future implementation of circular economy, companies need to collaborate within the company itself but also across sectors and industry. This helicopter view would enhance their capability of "thinking outside the box" by taking examples from other industry.

4.4.2 Digitalization

4.4.2.1 Understanding digitalization

Respondent D associates digitalization with technological innovation including IoT, artificial intelligence, big data and blockchain that can help to optimize the production process and decreasing costs.

4.4.2.2 Challenges of digitalization

Interviewee D perceives the investments needed as a challenge to become digitalized.

4.4.2.3 Organizational change in the context of digitalization

Respondent D recognizes the existence of a pressure from the outside to become digitalized, otherwise companies will not survive. Hence, she pictures the current situation as *"digitalize or die"*, meaning that if companies will not take this into consideration they will not be on the market in the future. In this sense, to change she believes that companies should question and understand their position along the digital transformation journey and the external surrounding about what is happening regarding technical innovations in their specific sector. Then, companies need to implement this pressure in their structure and infrastructure.

4.4.3. Moving toward a digitally powered Circular Economy

4.4.3.1 Use of digital technologies for Circular Economy

Respondent D argues that digitalization is an enabler for circular economy in all sectors but in different ways. She explains that circular economy *"would not fly if it was introduced 10 years ago"*, meaning that it would not have been possible without digitalization. For instance, she considers digitalization as the basis for sharing economy that the interviewee considers as a business model of the circular economy. In this perspective, she stresses the importance of data and RFID[3] to trace the materials and component to know exactly *"where they are, what shape are they in, if they need any kind of refurbishment or maintenance".* She argues that these opportunities are particularly important when you have a "product as a service" business model. Thus, she supports that there are a lot of way through which internet of things and artificial intelligence can be used and also blockchain in order to increase transparency for the circular solutions.

4.4.3.2 Challenges of the use of digital technologies for Circular Economy

According to interviewee D, challenges are external rather than within the company since she perceives that legislation and government support are lagging behind. This is not about only environmental legislation but also incentives for creating secondary markets for closing the loop.

4.4.3.3 Opportunities and future expectations on the use of digital technologies for Circular Economy

Respondent D argues that politicians need to pave the wave for circular business model weather it is digital or not. Given that they have already introduced the EU circular economy package, they should also adopt measure to enhance the exploitation of digital technologies. She projects that in ten years a lot of circular business model will happen in fact interviewee thinks that companies need

[3] RFID (radio frequency identification) is a form of wireless communication characterized by the use of electromagnetic or electrostatic to distinguish in a unique manner an object, animal or person.

digitalization to implement circular economy in an economical viable way. All in all, she believes that digitalization will boost the process.

Data collection from case companies

4.5 reCreate Design Company

Founded in 2014, reCreate Design Company is a B2B enterprise engaged different activities related to furniture and interior design details. Even if it is a really small business, it represents a striking example of a business model almost entirely founded on circularity. In particular, the main part of their business lies in manufacturing custom-designed and custom-made furniture for business customers, offering workshops and consulting services (reCreate Design Company, 2019; Holmasahl,M., personal communication, 2019).

4.5.1 Circular Economy

4.5.1.1 Explaining Circular Economy

Respondent E argues that circular economy consists in the activity of "*re-using existing materials"* coupled with a *"cradle-to-cradle*[4] *(C2C) way to re-use these materials and prolong their lives".* Also, she underlines the fact that the service industry has also been impacted by the necessity to shift toward circular models. As far as the two concepts of circular economy and sustainability are concerned, the interviewee believes that these go hand in hand since CE enables a wider sustainable development that would not be possible with the current linear model of consumption.

When it comes to reCreate Design Company, respondent E considers it really circular because in running their business "*we used to do everything by re-using at 100%, now we buy some new components because we have a higher volume, but I would say we are still using recycled material by 99.9%"*. Moreover, the company commitment toward sustainability is evident also by the fact that even when they do not use as inputs already existing materials, they have made the decision to promote small local producers and have those material inputs transported by train.

[4] A "cradle-to-cradle" production technique is inherently waste free since it aims at creating a cyclical process instead of a linear one (Sustainability Dictionary, 2019).

4.5.2 Digitalization

4.5.2.1 Understanding digitalization

Taking into account the theme of digitalization, respondent E argues that the concept is related to the possibility of carrying out transactions that were previously done physically, through online channels. Further, she believes that the impact of digitalization will be so widespread that "*the digital world will be the next world fire"*. Indeed, she shares her thoughts that businesses, societies, governments are currently empowered by digitalization. The company has been impacted by digitalization in the way they "*share information and run their business"*.

4.5.2.2 Challenges of digitalization

Respondent E claims that generally the company has faced some difficulties in this change.
For what concerns technologies, she believes that there is no way of moving out from the potential of AI, but social implications should be kept in mind since most of the jobs in the services sector will be taken over because AI that is dramatically much efficient. In her view, this will result in the need to create new ways to create new jobs, different from the ones we are used to.

4.5.2.3 Future expectations of digitalization

Interviewee claims that their digitalization process will continue as they will always have the need to share information with their customers.

4.5.2.4 Organizational change in the context of digitalization

According to the interviewee, their change process went through different steps because the speed of advances on technology is really rapid and they faced the need to cope with this pace, however being a small business impose them some budget limits. In this sense, they have not been really able to evolve at the same speed the business environment has changed. Respondent E argues that they perceive this change as an external pressure since customer were demanding for it, on the other hand their own strategic choice was made to became more digitalized. In fact, other enterprises might not be prone to these changes. As a matter of fact, she shares her thoughts about resistance to change since *if people have been doing in the same way for so many years, why shall they change?* In this regard, the co-founder interviewed perceived her company flexible in this term because they seek out to become digitalized despite their sector and their relatively small size. According to the respondent, the reason for this lies in the fact that in their field nobody else have done before what we have done, in this term they might be considered as the "ice-breakers" and their path will be much easier to follow from other companies. In fact, she claims that the way they are running their circular activities is dramatically different from the traditional way of doing business. This is the reason why they have

been questioned for everything they have been doing so far and this has posed to them the need to share information through digital channels.

4.5.3 Moving toward a digitally powered Circular Economy

4.5.3.1 Use of digital technologies for Circular Economy

Respondent E argues that at the moment she does not see the possibility of using digital technologies for their re-use activity. In fact, in her words *"a computer can design a space but when it comes to how things are re-used, this process is done by humans"*. However, the interviewee recognizes the importance of information sharing through digitalization in circular economy. Respondent E specifies that they are often asked by their customers to understand the specific material with which old objects that they use as inputs are produced as well as the chemical content of some specific types of furniture. In this sense, they have participated to a project aimed at trying to use digital tools to understand the "history" of a product in terms or materials used. In fact, as the interviewee highlights there is a lot of discussion going on about the possibility to use digitalization to track furniture, thanks to digital tools such as bar codes.

4.5.3.2 Challenges of the use of digital technologies for Circular Economy

In her view also the use of the current digital technologies for information sharing might present some limitations due to the fact that the amount of information that can be virtually stored is limited. Thus, she argues that an issue arises concerning the decision on which information is vital and which one is unnecessary. In this regard, she points out that making a choice on what information to use is a subjective matter since actors at different levels of the value chain might pursue different interests.

4.5.3.3 Opportunities and future expectations on the use of digital technologies for Circular Economy

Finally, respondent E as representative of Recreate Design company brings to light that in the future they will be more impacted by digital tools to keep track of the activities they do, obtaining evidence of the "history " of their materials so that they will be able to offer these information to their customers when they will be asked about that. "*With digitalization"*, she continues *"we can actually prove the history of the materials we use; thus, we need to go further about the development of coding in the business furniture area"*.

4.6 Essity

Essity is a global hygiene and health company. It was listed on Nasdaq Stockholm in 2017 after the separation of the SCA group, founded in 1929 into two different listed companies. Essity's business span along three main areas: personal care, consumer tissue and professional hygiene (Essity, 2019a)

The company has the target to develop products and services for a circular society, in fact it is working among the CE100 (Circular Economy 100) network in the Ellen MacArthur Foundation (Ellen MacArthur Foundation, 2019; Essity, 2019b; Essity , 2019c).

4.6.1 Circular Economy

4.6.1.1 Explaining Circular Economy

As far as the relationship between circular economy and sustainability is concerned, both respondents conceive them to be two distinct concepts. In this regard, respondent G argues that they are two different areas that the company is working for. In fact, from one side they are trying to improve each of the three parameters of sustainability (social, environmental and economic) without actually considering aspects of circularity into it. On the other side the company is trying to implement circular economy in the same system developed to deal with sustainability issues. In the same line of argument, both respondents share the idea that circular economy is a target that the company has not entirely achieved yet, but it could be related it to a future perspective. In fact, respondent F believes that circular economy "*is something that is coming, and it is not already there"*. Defining CE, respondent G clarifies that for their company it will be mainly focused on reducing the amount of waste, of material needed and increase the use recycled materials, oppositely he reckons the other aspects highlighted by the "butterfly " picture of the Ellen McArthur Foundation such as re-use or re-manufacture is more difficult to be implemented. At the same time, Essity is looking at the opportunity to recycle materials from their own products or other sources back into the loop.

In the same line of argument, respondent F claims that one of the solution available for them now, even if it is not the best solution, is their dedication to use almost only fiber-based materials from FSC (Forest Stewardship Council[5]) (Forest Stewardship Council (FSC), 2019). In fact, in his words, this represents a way of securing, at least on the bio-side, that they are acting within the limits reducing the impact on the planet.

Moreover, respondent G clarifies their effort within the Ellen Mc Arthur Foundation and outlines their commitment to assure that the different materials for packaging are mixed so that current technologies are able to recycle them.

Finally, taking into account the circular economy activities implemented by the companies, respondent F conveys that sustainability comes in many steps, from the product but also in the process stage and customers themselves should change their behaviors in this sense. As a matter of fact, he

[5] A compliance to FSC certification represents a sign for the customers that the products FSC-labelled come from a forest and that the supply chain is managed responsibly (Forest Stewardship Council (FSC), 2019).

clarifies that even if the company could implement "sustainability by design", consumers share part of the responsibility since 99% of their products they are not used to the full capacity.

Further, both respondents spontaneously highlight the presence of some issues that might challenge the complete implementation of circular economy within Essity.

In this light, Respondent F claims that even if circular economy is something every company is working for, technology is not yet mature, thus at the moment it cannot be implemented in a financial sustainable way because it requires huge investments since the process is not sophisticated yet. As a consequence, he points out that an attractive business model for circular economy has not yet taken place since, with his own words *"if companies could use all bio-degradable materials, they would have done it already"*. For instance, according to interviewee E, taking into account a product made of plastic and pulp, the company need to use a specific technology to separate the components sand this process is not still cost-effective, thus resulting in inefficiencies in the process. In fact, he insists on the fact that circular projects are possible only on a small scale while they are still not feasible on a country-wide level.

Respondent G independently explains that circular economy might be really hinder to implement since *"it is not necessarily true that the benefits of the closing the loop will appear within our part of the circular chain".*

4.6.1.2 Future expectations on Circular Economy

Taking into account company's future perceptions both respondents share the possibility of implementing a more "circular" business model in the future. In this regard, interviewee G argues that Essity is working to reach a target of 100% recycled packaging materials by 2025.Interviewee F appears optimistic for the future by stating that the full potential of circular projects *"is coming in the future and more possibilities will be opened up"*. Likewise, he sheds light on the fact that something has changed, *"now there is a pressure from the society to shift toward circularity because customers and consumers are increasingly worrying about it and what comes out of a product"*. Meaning that, constumers, want to attract consumers and at the same time government and NGOs are pushing toward this shift. All in all, interviewee F explains that it is all moving in this direction, but it will need some time to reach its potential.

4.6.2 Digitalization

4.6.2.1. Understanding digitalization

Looking at the interviewees' viewpoints about digitalization in general terms, they freely express their perceptions from different angles. As a matter of fact, respondent F from a marketer perspective, considers the change both of how products are sold (e.g. online channels) and of the way companies can communicate with consumers and how they consume. Also, he points out that the way they work

has been digitalized because digital tools are the basis for internal communications within the organization. Another perspective is offered by respondent G, who describes digitalization as such profoundly IT related. It is noticeable that he, being the sustainability director, spontaneously associate digitalization with the opportunity to use data in order to improve sustainability performance. In his own words, it means *"building a data world that mirrors what you actually have in the real world, you need to have control over the material you use".*

According to respondent G, they started to collect data with life-cycle analysis back in the 90s with life-cycle analysis and now they have now a very large internal databases that can be used, for instance to understand which type of packaging material can be used. He also clarifies that the company top-management realized digitalization can act as an enabler to be more efficient in the future since *"if you know the details about your operations, you could improve the details, on the contrary, in you do not know these details you do not have a clue about how to improve"*. Also, interviewee E refers to the company digitalization of the production phase thanks to self-regulating processes, smart sensors, data analysis and robotization. Finally, he sheds light on different degree of digitalization inside the company since the departments that have been more affected are the ones dealing with the production due to the fact that they feed data into the system and the IT department. Apart from them, there are other areas that are affected such as marketing that leverages on digital tools to understand how much different customers are buying and people working within sustainability doing life-cycle assessment. In fact, the latter defenetely need to have in the system a large amount of data to be able to produce this analysis.

4.6.2.2 Challenges of digitalization

Interviewee G highlights that one challenge is related to the concerns of trusting the data. He clarifies that somewhere in the long supply chain, data are fed into the system by humans, consequently the need arises to assure that there are not errors along the chain. According to respondent G, another challenge is related to the necessity of having the competence of working with the data because it could be difficult to understand the production parameters. As a consequence, the company need to have the right competences and skilled employees in its toolbox to be able to work with data. A similar perspective is presented by respondent G who argues that a challenge of digitalization is making sense out of the data to perform better. Moreover, respondent F considers that in the production phase even if performance might be optimized, there are negative aspect since less workers are needed given the increasing automation of processes.

4.6.2.3. Future expectations on digitalization

Both respondents believe that Essity is in the journey toward digitalization that will increase over time as they have set out an agenda to reach this goal of digitalize the entire company as respondent F comments.

4.6.2.4 Organizational change in the context of digitalization

Respondent F argues that their change toward digitalization encompassed different phases. As the digital transformation proceeds, there will be some reluctance to transform but so far, they have perceived it as a slightly change in the way people work rather than a dramatic change. Moreover, he adds that the change to digitalization has not really reached out all the employees' company since only a small number of departments are dealing with it so far. Finally, when respondent F considers the change process inside the company, he associates it to a paradigm shift of existing processes that requires effort to change, in particular if people within the organization are used to determined routines and procedures.

4.6.3 Moving toward a digitally powered Circular Economy

4.6.3.1 Use of digital technologies for Circular Economy

Both respondents share the perception that digitalization can act as an enabler for CE. Respondent F, states that digitalization is really a prerequisite for CE, because they are trying to use the data for CE activities in order to try to build a new business model to understand what drives the cost and what drives the business opportunities. Another perspective is offered by interviewee E who perceives that some CE projects can be digitalized.

Considering the possibility of using digital technologies for product design to increase the life-cycle of the product, interviewee F argues that they are using business warehouses or business intelligence functionalities built into the organization to deal with data to enable people to work with the information they have. To be precise, he specifies that the data he refers to are derived from different sources such as their suppliers and the ones form the production facilities collected though embedded sensors used to optimize the performance. However, in interviewee G's view, it is not possible to talk in terms of big data.

As far as waste management is concerned, respondent F argues that they do not have a function for monitoring the waste process already in place. The respondent clarifies that they have knowledge of the production volume in different markets, but they do not use any digital technology to understand what happens with the waste once the product is used. However, interviewee G adds a last point on this and shares his belief on the need of data in this regard. Indeed, smaller companies might escape

the necessity of data, but for a company at the size of Essity they need information to understand the impact of their activities to have an overall picture.

Beside this, respondent F asserts that in order to minimize the amount of resources used in the production process, optimization can be achieved thanks to data collected from machines and products. Hence, he believes that *"you cannot really separate digitalization and being sustainable, it is a mindset, they go hand in hand".* Respondent G offers the example of a paper mill generating a large amount of data as the production of the product is ongoing, that can be used to understand the environmental performance of this.

4.6.3.2 Challenges of the use of digital technologies for Circular Economy

In the perspective of interviewee F, digital technologies might increase the level of CO2 emissions but looking at the entire circle tying CE and digitalization will have mostly positive aspects. Moreover, when it comes to challenges related on leveraging on digital technologies for circular economy, according to respondent G, a challenge could be related to the sharing of information that is a prerequisite for developing a circular model. Thus, he highlights that everyone in the system should be open to the other part of the chain. Obviously, interviewee G clarifies that there could be reluctance since the players of the chain need to feel confident to share their business secrets and knowledge with competitors, but people should understand that it is a survival action for the future. Another problem that might arise is the fear of sharing the knowledge with competitors.

Moreover, respondent F argues that the technology is probably not yet mature. Thus, even if there are pressures from society, legislation and technology advancement in these terms, he highlights the importance of the strategic choice of the company. Moreover, for what concerns the use of AI for circular economy, the interviewee focuses on the necessity of investments from shareholders. In this regard, he asserts that "*we are now to approaching to a clear turning point in the society and there is a race about who will become more sustainable first".* Thus, his view, if companies invests in this sense, circular economy is likely to be implemented.

4.6.3.3 Opportunities and future expectations on the use of digital technologies for Circular Economy

Interviewee G admits "*it is a great opportunity to be driven by data to have information on production and to change and take the step to go into CE"*. For instance, respondent G argues that the company could use data to develop fossil free materials in the future. Thus, he lightens that digitalization is the key since if the enterprise is data-driven in its activities, sharing of information can be enhanced. Finally, interviewee F believes that circular economy projects will be led by digital advantages in the

future and respondent G believes that they are going in the direction of exploiting AI to come up with products that can be used again by design.

4.7 Volvo Cars

Starting from the first series-manufactured back in 1927 in Gothenburg, today Volvo Cars is one an established car brand with sales in over hundreds of countries (Volvo Cars, 2019a). Since 2000 they are committed to observe the Ten Principle of the Global Compact and they have endeavored to support the Sustainable Development Goals. As far as the impacts of their products is concerned, they are committed to deliver a safer and cleaner mobility by optimizing the life-cycle performance of their cars, delivering real-life safety and by 2025 they aim at achieving the target of 25% of plastic in cars made up of recycled materials as well as selling 1 millions of electrified vehicles by 2025 (Volvo Cars, 2019b).

4.7.1 Circular Economy

4.7.1.1 Explaining Circular Economy

Taking into account circular economy and sustainability, interviewee H asserts that the latter corresponds to a much bigger area. In fact, even considering only the environmental sustainability, she observes that it can be related to different activities such as limiting energy consumptions in the plants, logistic and reducing pollution in the air and water. On the contrary, interviewee H affirms that circular economy is at the opposite extreme of our current way of thinking since it affects every stage of their business activities from procurement of components and raw materials to the way they could manage their value over time. A slightly different definition is provided by interviewee H that considers circularity as one way to achieve sustainability by reducing costs and environmental impact.

In this light, higher level of collaboration among different departments within the organization and the actors in the value chain is necessary in respondent H's view. As far as the impact of circular economy on the different parts of the company, she asserts that at the moment, R&D, manufacturing and procurement are heavily involved. However, as interviewee I clarifies, a challenge lies in the possibility of having the entire company working toward circular economy since at the moment purchasing department and R&D are not collaborating between each other for this purpose.

Also, interviewee H discloses that for their business, circular economy makes most sense when owner of the product is the one that can control and manage the product. Respondent H clarifies this concept by stating that *"sharing economy is a way to go to the market with a circular business model"*. Besides, respondent H clarifies that last year they established a baseline to assess their position in the

transition to circular economy in order to understand where they could improve their actions. Consequently, she highlights that they are currently working toward these potential areas of improvements.

4.7.1.2 Future expectations on Circular Economy

Both respondents highlight that the company will improve as time passes in fact, as clarified by respondent I the vision is to reach *"freedom to move in a personal, sustainable and safe way"*. Respondent H disclose that company's effort for the already established re-manufacturing systems, will increase and it is likely to impact the entire company in the future. By doing so, components previously used could take part again of the process. What is more, interviewee H suggests that the company is recognizing the possibility to re-design. However, she clarifies that, being the process to develop a new car model long, it is not something they can achieve overnight but it will take time.

Further, interviewee H asserts that they are looking also into limiting the amount of energy used both with their cars thanks to electric vehicles and they have a target to of reducing energy consumptions in their operations too. Another aim of the company in this context is disclosed by respondent I that explains that Volvo has the target of having 25% of plastic coming from renewables.

Taking into account the future of circular economy, if it is implemented in the right way, she considers it to be financially sustainable and positive in the long run but along the transition phase she imagines that there will be an in-between situation that would probably be costly.

Finally, respondent H concludes that circular economy will impose them to change completely how business activities are conducted since, as clarified by respondent they are still in the learning phase. Thus, as interviewee H explains, it can be assimilated to a big technology shift and according to respondent I it will be hard to set new requirements for the business transactions among actors in the chain. All in all, as interviewee I suggests in the future it will be harder for companies not being sustainable.

4.7.2 Digitalization

4.7.2.1 Understanding digitalization

Respondent H argues that digitalization consists in the use of data and digital tools and method to the fullest for their business activities. As far as the company alignment toward digitalization, interviewee H explains that the company is fairly well positioned and in the middle of the journey toward digitalization. In respondent I view, they are moving from an *industrialized company to a digital one.*

For what concerns departments affected by digitalization, interviewee H asserts that R&D department, marketing part and service-development and manufacturing are probably the most advanced.

4.7.2.2 Challenges of digitalization

Interviewee H argues that challenges are related to the issues of sharing, trusting and analyzing data and take actions based on this knowledge. Moreover, interviewee H points out that investments in new technologies are required, while respondent H claims the importance of a clear managerial direction.

4.7.2.3 Future expectations on digitalization

According to both respondents, the digital side of the company is growing and the ongoing process is moving forward, and they project it to speed up in the future. Moreover, she believes that there will be transformations, but they are not totally attributable to digitalization. In fact, interviewee H suggests that products and offerings will change anyway since organizations usually reflects their product offering. In this regard, she asserts that digitalization will bring some changes to be better aligned with new ways of delivering their market, particularly in respect to their shift toward the sharing economy.

Finally, she adds that digitalization will impact the internal organization of the company.

4.7.2.4 Organizational change in the context of digitalization

In the view of interviewee H, the company had an active role in managing digitalization. In fact, she perceives the role of managerial strategic actions crucial. Respondent H adds that even if it is not possible to ignore threats from the external environment, without a strategic component from within the company would not have been so fast to change. Further, interviewee H admits that they have not reorganized the entire company after digitalization but that some changes in the way of working arose as normal of the process.

All in all, interviewee I highlights the importance of developing organizational flexibility as a mean to cope with barriers to transform the old systems.

4.7.3 Moving toward a digitally powered Circular Economy

4.7.3.1 Use of digital technologies for Circular Economy

Currently, interviewee H claims that their circular economy effort is not totally aligned with digital technologies. In fact, she believes that data can be used to share knowledge, optimize the process, keep track and document. All in all, sharing of information required by circular economy is enhanced by digitalization.

4.7.3.2 Challenges of the use of digital technologies for Circular Economy

Respondent H argues that circular economy affects every part of the company with an impact of the same magnitude of digitalization. She points out that circular economy requires the necessity to pose specific demands to the suppliers, collecting data from them and have access to information about the

specific components over their life-cycle and what will happen afterwards and in this sense. According to respondent H, this pose the need for reliable logistic systems that could be supported by digitalization. In this sense, costs and profits will appear in completely other way respect to current model of economy.

As interviewee H explains challenges are likely to arise since companies have not a clear understanding of what circular economy need to work properly and which data should be used in ways we have not done before. She also asserts that the company should implement circular economy in a new way, applying digitalization to something we have not completely achieved yet and this will be part of the target that needs to be pursued.

4.7.3.3 Opportunities and future expectations on the use of digital technologies for Circular Economy

Interviewee H hopes that in the future digitalization will represents the core part to leverage on for understanding the value of their activities, components, materials and developing analysis to be more efficient to manage a new type of business in circular economy where assets are managed more efficiently. She clarifies that, while the way they have conducted their activities in the linear economy, is linked to experiences, materials and the knowledge in the company, now in order to shift to circular economy "*we need to have digitalization and data for going into something new and different and speed up the processes"*. Finally, respondent H explains that opportunities that could be grasped in the future arise form sensors that directly transmit data to computer and thanks to cloud it is possible to retrieve and understand the state of the components over time and intervene accordingly.

4.8 Senab

Founded in 1975, Senab is a B2B company based in Stockholm. It currently operates as part of the Edsbyn Senab Group as supplier of interior design furniture with over 250 employees and more than 350 million in net sales. Apart from the Nordics where it has local offices in Sweden and Norway, they have branches in Asia and North America too. Senab has recently increased its effort toward sustainability as a result of the increasing pressures from their customers in the sense of circular furniture flow and reuse. It is interesting to point out that Senab works with over 450 suppliers in the different geographical locations and their customers are small, medium and larger enterprises, public organizations, hotel, restaurants and private customers (Senab, 2019; Bloomberg, 2019).

4.8.1 Circular Economy

4.8.1.1 Explaining Circular Economy

Respondent L argues that circular economy is mainly related to the possibility of re-using of materials and up-cycling products. Regarding sustainability, he believes that it corresponds to a much wider

concept because it entails also the social sphere when it comes to creating sustainable work environments for the employees. On the other hand, he claims that circular economy means having the possibility of overcoming the linear usage of different products in order to extend product life cycle and use them again for another company. Taking into account circular economy in companies that deliver services or products, respondent L adds his opinion on that. He clarifies that when it comes to services, the company could find a second life for an existing product to include it again in the circular loop. On the other side, interviewee L considers reasonable that companies engaged in the production process might use digital technology to implement circular economy within their own business process, while service providers need to collaborate with other actors to implement circular businesses.

As far as circular economy implementation interviewee L explains that the company is helping their customers to find new ways of using existing furniture without buying new ones. Further, respondent L explains that they offered the possibility to rent or lease the furniture for a limited time-span and take them again afterwards, but they have not succeeded in taking back the furniture again because customers have extended the lease. Considering that, interviewee L claims that, in this case, even if the business model is different, practically business activities are not changed. Further, respondent L highlights that they strive to have their furniture environmental certified so that they have control over the way their furniture are produced.

4.8.1.2 Future expectations on Circular Economy

In the future respondent L sees the necessity to adapt their business model to circular economy.

4.8.2 Digitalization

4.8.2.1 Understanding digitalization

In the view of respondent, L, digitalization entails the shift from physical tools to digital ones. This has a huge impact on the way they work thus opening up the possibility to work whenever they want and from wherever they want. Moreover, interviewee L related digitalization to the possibility of adding more services to their existing offerings.

According to the interviewee, digitalization is hugely impacting the way they work in the office. From his perspective of business developer, he believes that digitalization in their company materializes in the possibility of relying more on data to take decision rather than feelings and to have their future offerings more digitalized. To be precise, he refers to data from web services and sensors in the showrooms to understand how people use the facilities. Meaning that, an increasing the usage of digital channels such as e-commerce to deliver their products and adapt their offerings accordingly.

4.8.2.2 Challenges of digitalization

Respondent L argues that they are trying to understand how they can adapt their business model to add services and transform their offerings. He also points out that, if they automate, their processes, less people are needed, and they could release sales more people to do more value-adding activities. Interviewee L explains that the issue is that *"they might not have the competences and the abilities to complete these more value-adding activities"*. The challenge is about being able to succeed into transforming the organization for thinking more digital and having the right competences and abilities to work into that environment.

4.8.2.3 Future expectations on digitalization

According to respondent L their business model will probably change as result of changes in their customers' behavior. They have thought about how they should change their business model, but they have not changed yet. Thanks to digitalization, respondent L perceives that digitalization in the future could have the potential to enhance internal efficiency, meaning that they could have less people doing the same things and hence these people could be involved in other activities that would lead to more value in their business. Interviewee L concludes that they could change the business model by transforming the way they provide their offerings (e-commerce) and how to create more value to the customers.

4.8.2.4 Organizational change in the context of digitalization

Interviewee L points out that the importance of looking at data instead of feelings for decision-making is not completely understood among all the parts of the organizations especially when it comes to sales department. Moreover, as part of change management tools, respondent L remarks that they are also implementing workshops to widespread the role that data can have for decisions. In fact, he points out that employees need to develop new competences and abilities to complete different tasks or new tasks in different ways.

In respondent L view, external changes have contributed to make the company change their business model accordingly. However, he perceives the shift to become more digitalized to be more a strategic choice since digitalization has not consistently affected their line of business, hence it could not be perceived as a pressure in these terms.

As far as the speed of internal change compared to the speed in the external environment, interviewee L comments that their company is probably an early mover considering their line of business, but probably it is their line of business to be a long way behind. In respondent L's view, *"compared to other sectors the company is quite behind, however compared within their sector they are positioned in a pretty advanced position"*.

Since their line of business has not really changed so much because as he had previously explained, they have tried to change business model by leasing furniture or re-using existing ones, but their customers are not that advanced, their business model has not changed so much. This, consequently, has not created enough changes in their business model either because the customers. However, his role is the evidence that the organization has started to introduce new position to better cope with those changes, however it is probably the only one.

4.8.3 Moving toward a digitally powered Circular Economy

4.8.3.1 Use of digitalization technologies for Circular Economy

Respondent L clarifies that the use of digital technologies for circular economy has not really impacted their sector, and their company consequently. Thus, he suggests that at the moment they are not supporting each other's.

4.8.3.2 Challenges of the use of digital technologies for Circular Economy

According to respondent L the company need to gain awareness about digitalization and circular economy to take further steps in this sense and know more how they can affect their business and how other are using it for creating value. In fact, circular economy might just end up in the cost side and so the potential remains still undervalued. Thus, circular economy should be developed in a way to deliver more value to the customers. All in all, companies should acquire more knowledge about circular economy and the possibility of implementation and as well about how digitalization could in turn affect circular economy.

4.8.3.3 Opportunities and future expectations on the use of digital technologies for Circular Economy

Interviewee L imagines that with blockchain techniques, traceability of materials could be improved. Also, he highlights that thanks to sensors resource management could be enhanced. Finally, respondent L suggests that they are evaluating how they could use digitalization and platform thinking to enhance their sustainability of their offerings.

Table 5: Summary of data collection

	Circular Economy		Digitalization				Moving toward a digitally powered CE		
	Explaining CE	**Future expectations**	**Understanding digitalization**	**Challenges**	**Future Expectations**	**Organizational change in the context of digitalization**	**Use of digital technologies**	**Challenges**	**Opportunities and future expectations**
Senior researcher at RISE (respondent A)	Extended PLC; CE = sharing economy; PaaS BM; control issue; KPIs; financial viability	Potential unrealized; digital technologies for future developments	Enabler for strategic change	Skill and competences	Competences will be acquired	now opportunity instead of external pressure	Predictive maintenance with M2M; image process technologies	Skill of digitalization; mindset	More match matching; technology clusters
CEO at Re: profit (respondent B)	Easier with simpler products; CE and PaaS BM; issues with dispersed VC; transparency; common standards needed	More transparency	Operations and processes simplified, transfer data easily	Changes needed; standard protocols required	Shared infrastructure	Employees should be involved in the process	Database for longer life-cycle	Standards; long terms plans	Digital platform for data sharing
Founder and CEO Earth of Billions (respondent C)	CE to increase profit; CE≠PaaS and sharing economy	sensors, AI, DBMS for resource management	Digital strategy; data bank for meaningful results	-[6]	-	-	"products as banks for materials"; traceability enhanced	Financial viability; human factor	AI for decision-making for materials
Member of NMC (respondent D)	Long term goal; need for "reverse logistic" supply chain	Collaboration needed	Tech innovation (IoT, AI, BD, blockchain); process optimization	Investments required	-	External pressure; change for competitiveness; change in the structure/infrastructure of company	IoT, AI blockchain for transparency	Legislation; openness to undertake investments	Support from politicians; digitalization spread;
reCreate Design Company (respondent E)	Extended PLC; 99% circular BM	-[7]	Impact in the company for information sharing	Difficulties to change; unemployment	Necessity of information sharing	Phases of change; flexibility; external pressure and strategic choice	No digital technologies for re-using; information sharing and tracking	Amount of information storage	Digital technologies for tracking/coding
Essity (respondent F, G)	Technology not mature/ long term-financially sustainable on large scale; focus on reducing waste and recycling; difficult to implement other aspects	100% recycled packaging materials; pressure from consumers, governments, NGOs	Data for control over materials used; self-regulating processes; robotization	Trust data; skills to work with data; unemployment	Entire company more digital	Phases for change; incremental changes	Digitalization=enabler for CE; data and business intelligence for performance optimization	CO2 emissions; information sharing; immature technology; investments	Data-led; use of AI for circular product development
Volvo Cars (respondent H, I)	Collaboration across department and actors of VC needed; CE =sharing economy; involved R&D and manufacturing and procurement	25% of plastic in cars from recycled materials; financially sustainable in the long-run, new requirements	Use of data for business activities; in the middle journey of digitalization	Sharing; analyzing data; take actions on data; investments	Speed up digitalization process; changes to be aligned	Managerial strategic action needed; flexibility to change	Data for traceability; Performance optimization	Reliable logistic system; data knowledge missing	Efficient asset management; value of materials; sensors for data collection
Senab (respondent L)	Re-use materials; up-cycle products; PaaS; need changes in costumers' behaviors	Need to adapt BM to CE	More services could be added; data to take decisions	Skills; competences;	Changes in BM; more value to costumers	New job position needed; new skills; workshops as change management tools	Not supporting each other	Gain awareness	Blockchain for traceability; digitalization for resource management

[6] As explained above (paragraph 3.4) for some experts some categories are not present since, given their area of expertise, they did not provide additional information to the theory
[7] In the case considered data have not been collected for this category since reCreate Design Company has already developed a circular business model

5. Data analysis

*This chapter is dedicated to a comparison between empirical findings and theory, inter-cases and between case companies and experts. In order to deepen the level of analysis, the author used critical thinking throughout the chapter. For the sake of clarity and coherence, the analysis is presented following the same categories and subcategories included in chapter 4. The categories are the following: Circular Economy; digitalization; moving toward a digitally powered Circular Economy. In particular, data collected are compared along similar patters expressed by the interviewees. Finally, summary tables (*Table 6; Table 7; Table 8; Table 9*) are provided at the end of each category to provide a graphical support for the reader.*

5.1 Circular Economy

5.1.1 Explaining Circular Economy

As highlighted in the research design 3.2 case companies have been selected since they were assumed by the researcher to have a circular business model thanks to information publicly available and to FTK's background knowledge. In practice, this assumption has been confirmed in different degrees in the cases considered. As a consequence, the general understanding of the concept and the underlying related themes vary across cases. Hence, even if theoretically speaking a specific definition of circular economy is provided by the Ellen Mc Arthur Foundation (2015) and Murray, et al. (2015) as an economic model aimed at both preventing environmental damages and repair the already occurred ones, some experts, notwithstanding their academic background explained it with a slightly different nuance.

To begin with, it is interesting to point out that that the definition of circular economy provided by respondent A, a researcher from RISE, is really specific and complete as she stresses the role of stretching the life-time of the products, the possibility of re-using, repair and offering product as a services. This conception is not entirely aligned with what respondent C commented since he considers circular economy and "product as a service business models" two different concepts. Examining the opinions of case companies' representatives, both respondents E from reCreate Design Company and L from Senab focus on the possibility of re-using material to prolong their life cycle. In this regard, respondents form Essity provide a different view: they recognize the possibility of re-using materials for a "closed-loop-system" (Bocken, et al., 2016), however for their company they admit they can only focus on recycling and reducing the amount of waste for the moment as

respondent F suggests. In fact, according to respondent G, CE is something that the company has not already developed. Taking this into account, even if it was not explicitly recognized by Essity's respondents, the model outlined can be assimilated to the circular business model that Ernest and Young (2015) and Lacy and Rutqvist (2015) describe with the terms "circular input "and a "value waste".

The last point to highlight regarding the definition of circular economy concerns the difference between it and the traditional linear model. In fact, in the view of Ellen McArthur foundation (2015) circular economy coincides with a closed loop system and this view is shared by both respondent E from reCreate Design Company and respondent H from Volvo cars.

When it comes to the modes circular economy and sustainability are connected, as outlined by Geissdoerfer, et al. (2017) there is not a clear delimitation of these two concepts even if Schroeder (2018) points out that they have some elements of similarity. Case companies perceive these notions extremely interconnected even if sustainability seems to have a broader scope for the majority of respondents. For instance, although respondent F from Essity admits a preliminary distinction, during the interviews he answers to questions directly tied to circular economy in terms of general environmental sustainability. This can be interpreted as symptom that CE is not completely understood as proposed by scholars in this specific case company. An opposing view is provided by interviewee D from NMC that argues that circular economy could be seen as a wider concept that sustainability since it relates not only to *"doing less bad"* [in terms of energy used and emissions] but also to avoiding a negative impact. A similar idea is shared by Murray et al. (2015) that argue that circular economy entails a wider sphere than processes of cycle of materials.
Another argument included in the interviews is the relationship between circular economy and sharing economy. Existing literature did not provide a clear explanation on this and the respondents included in this study have shared divergent opinions. On one hand, respondent H from Volvo Cars clarifies that sharing economy could be interpreted as a way to go to the market with circular business model. On the other hand, respondent C highlights that they should not be confused since they are inherently different.

A different outlook concerns the product as a service form of circular business model, as it was recognized by Bocken, et al. (2016) as well as respondent A from RISE. In particular respondent L from Senab explains that even if they are trying implement it, customers are not embracing completely this new business model. The state of the art differs for FMCG for the case company

taken into account because it is noticeable that respondent F from Essity highlights the pressure for their customers to produce in an environmentally responsible way.

All in all, the differences in terms of circular economy implementation that have resulted from the empirical findings, are in line with that interviewee B from Re:profit commented since circularity is hard to achieve when products are complex, the production sites located in different geographic locations and managed by different actors in the chain, thus the need arises to have the support of data. In fact, while reCreate Design Company is implementing has an almost 100% circular business model in place, for bigger companies such as Volvo Cars and Essity the journey is still ongoing. In particular, interviewee F from Essity shows the process is still not cost-effective as suggested by Pinhero et al. (2018) and this concern is particularly relevant for big size companies offering more complex products. This fits conveniently with the conjecture that product complexity increases risk of undoable financial viability. Probably, forecasts about positive monetary returns in the short-term would appreciably encourage companies more than a number of stimuli from different players for a more sustainable society.

As a consequence, all respondents from bigger-size companies such as Volvo Cars highlight the necessity of collaboration within the company's department. This idea is in line with EY (2015) that argues that internal organizations should be reshaped to meet the sustainability principles. Obviously, this consideration appears to be pointless for smaller companies such as reCreate Design Company and Senab and, consequently, has not been specified in the interviews. Furthermore, Pinhero et al. 2018 have outlined the importance of collaboration also at the wider level of different actors in the value chain to achieve mutual trust in sustainability information (Schmid & Ritzrau, 2018). This argument that academics have addressed only in general terms is brought to a more specific level by the different experts. For instance, A from RISE that suggests that new KPIs should be established for selection of suppliers while interviewee B from Re:profit proposes the establishment of common standards to enhance dialogue.

5.1.2 Future expectations on Circular Economy

In reviewing experts and representatives of case companies' impressions, it can be mapped a general positive tone about what the future holds for circular economy. Having pointed out this, when it comes to the forces able to accelerate the transition to CE experts interviewed share diverging standpoints: while respondent A from Rise spontaneously attribute a key role to digital technologies, interviewee B of Re:profit perceives sharing of information a prerequisite for future developments.

Taking into account the type of enterprise that might embrace a circular business model relatively easier, interviewee C from Plantagon argues that in the forthcoming years companies operating in manufacturing sector are likely to enjoy a preferential path given the possibility of control over the inputs and outputs. This condition is not properly reflected in practice bearing in mind that respondents from Essity share a number of dilemmas on this front. Despite having its business activities based on production lines, company's representatives declare that their possibility of implementing a circular business model is related to the future. Beyond that, when disclosing their future circular economy plans, interviewee G from Essity and interviewee H from Volvo argue that their efforts will have their main focus on recycling. However, this practice is recognized by respondent D as "misconception of circular economy", since these companies will continue producing in a linear way and will concentrate their effort only in finding a way to close the loop (through recycling) ex-post.

Furthermore, it is interesting to point out that respondent E from reCreate Design Company does not express to have a roadmap toward circular economy in the future. This might be explained since its business is almost completely founded on re-using, given that they use existing materials as inputs. The motif of the relationship with external suppliers is also explored by respondent H from Volvo Cars that claims the importance of setting novel requirements for business transactions, need that is underlined also by the researcher from RISE. However, it should be clarified that the coming years will probably be characterized by a greater degree of strategic coherence within the enterprises since respondent H from Volvo Cars projected that circular activities are likely to impact the entire company. This is in accordance to interviewee D who suggested that collaboration inside the organization, among departments is crucial.

To conclude, the future will potentially be forged into more circular forms, in fact, as suggested by respondent I from Volvo Cars *"in the future it will be harder not to being sustainable"* [discussing about future expectations of circular economy] and theoretically speaking by Ellen MacArthur Foundation (2015) and Van Buren, et al. (2016) describe the linear model of economy to be unsustainable . Furthermore, also according to Planing (2017) circular economy can be considered an environmentally sound solution for enduring competitive advantage. As a matter of fact, respondent L from Senab names the transition toward circularity as a "necessity". Even more precisely, respondent F from Essity clarifies that this change is required not only by NGOs and governments, but also by consumers and customers.

Table 6: Summary of analysis- Circular Economy

Circular Economy							
	Explaining Circular Economy						**Future expectations**
	Activities for closing the loop	**CE=PaaS BM**	**Sustainability=broader concept than CE**	**CE=sharing economy**	**Collaboration**	**KPI/standards**	**More circular activities in the future**
Senior researcher at RISE (respondent A)	✓	✓	✓	✓	-	✓	✓
CEO at Re:profit (respondent B)	-	X	-	-	-	✓	✓
Founder and CEO Earth of Billions (respondent C)	-	✓	-	X	-	-	✓
Member of NMC (respondent D)	-	✓	X	X	-	-	✓
reCreate Design Company (respondent E)	✓	-	✓	-	✓	-	-
Essity (respondent F,G)	-	-	✓	-	-	-	✓/ X
Volvo Cars (respondent H,I)	-	-	✓	✓	✓	-	-
Senab (respondent L)	✓	✓	-	-	-	-	✓/ X
Theory	✓	✓	✓	✓	✓	✓	✓

Legend: "✓" stands for what respondents and/or theory agree on;" X" stands for what respondents and/or theory disagree on; "- "stands for what was not explicitly mentioned by respondents, "✓/ X" stands for what respondents partially agree on.

5.2 Digitalization

5.2.1 Understanding digitalization

In order to evaluate how companies' representatives are considering the potential of digital technologies for circular economy, the researcher considers as prerequisite exploring to what extent digital transformation is affecting the production process of the companies at stake. In fact, as shown by the literature review (2.2 Digitalization) major opportunities have been linked to tools for automating their operations. Given that, it seems suitable to compare if these companies have integrated digital tools at different levels of the value chain as supported by Ross et al. (2016) starting from the manufacturing phase. This is embraced by Essity as respondent G includes self-regulating processes, smart sensors and robotization as technologies that are part of their processes.
In addition to that, it seems interesting comprehending if other applications of smart assets might lead to advantages for implementing circular activities apart from the ones already explored by mainly consultancy companies.
Theoretically speaking the World Investment Report (2017) focuses on the technological aspects of digitalization for the production process and this aspect is mirrored by respondent's D definition whose focus is the exploitation of IoT, AI, big data and blockchain to optimize manufacturing activities. A different angle is provided by respondent's A definition that pertains to enabling change and that could be assimilated to the possibility of uncovering new entrepreneurial opportunities and reach overseas markets proposed by UNCTAD (2017).

Another aspect considered by respondents regards the possibility of leveraging on data collected through digital technologies for guiding decisions for business operations that was also supported by Ismail (2017). In practice, this materializes in Essity's use of data for the assessment of life cycle analysis as outlined by respondent G and in Volvo's exploitation of data and digital methods for conducting their operational activities as explained by interviewee H.

Moving away from the application of digital technologies within an industrial perspective, respondent I from Volvo Cars and L from Senab dwell on different concepts linked to the wide sphere of digitalization. The first suggests that Volvo Cars is shifting from an industrial to a digital company, where the term "digital" does not stand only for automatization of production processes paving the wave of industry 4.0 but it is also connected to sharing economy. In this light, it should be highlighted that as explained above (subparagraph 5.1) some of the respondents assimilate this concept to circular economy. The respondent from Senab, instead, perceives digitalization in the light of the transition

toward "servitization" (Ellen MacArthur Foundation, 2015). This last point is eligible to be related to circular economy since, as presented in the literature review the gradual acceptance of alternative business models to shift toward service-based offerings can be seen as a driver for businesses to overcome linear models of economy.

5.2.2 Challenges of digitalization

When it comes to digital technologies, it follows that an initial investment should be faced by the business organizations as respondent D explains. As interviewee A presents, another straightforward consequence is related to the skills and competences needed. This is mirrored in respondent L's concerns that exemplify Senab's necessity to develop new abilities and change their business model, requirement that was also considered by Hess, et al. (2016). As a matter of fact, being the furniture industry to which Senab belongs not yet extremely digitalized they still need to exert a leap forward by developing capabilities leading to competitiveness on this front.

A peculiar notion is revealed by reCreate Design Company that does not include any digital technology apart from social media in its current and future strategy. The fact that they relate challenges of digitalization to social implications such us unemployment can be explained in the light that it is very unlikely that they will firsthand face problems correlated to consequences of digitalization. As result, she swells on social level and national level implications that have not been addressed by the literature review as it was stated as limitation of this study since social and unemployment concerns are considered out of the scope of the research.

Continuing on the challenges, it is intriguing that the two bigger case manufacturing companies' taken into account in this master thesis, share similar perceptions about the obstacles that needs to be overcome to become fully digitalized. In fact, respondent G from Essity expresses his concerns related to the ability to trust data to perform better since human errors might arise along the chain. The same fear is shared by respondent H from Volvo Cars who reveals also the problems connected to trusting and analyzing data. Anyway, respondents H proffer another insight for embracing digital solutions, that is the necessity of having a clear managerial direction to set out the path to follow by deploying a clear digital strategy as outlined by expert C from Plantagon. With similar tones, both Ismail et al. (2017) and Kotter (1995) have recognized the importance of a planned guidance toward the digitalization process. As far as means to facilitate digital transformation are concerned, respondent B from Re:profit believes in the relevance common standards protocols. It is evident that for this respondent, digitalization comes hand in hand with collaboration, however this belief is not probably shared by practitioners since none of the representatives consider this aspect in the interview.

5.2.3 Future expectations on digitalization

With the literature review provided in the second chapter, the author did not focus on future expectations since this section is deemed to involve respondents' own perceptions. However, to strengthen the conclusive reflection about the research questions it is essential to understand how case companies foresee they can cope with the digital surrounding in the coming years. Thus, the present paragraph will present a comparison between experts as well as companies' representatives without taking speculation of existing literature into account.

A general outlook to the findings concerning future expectations reveals that companies in most cases project to embrace more and more digital tools. Surprisingly, this appears to be true also for reCreate Design Company, even if only in regard to social media platforms since respondent E argues that they will increasingly reveal information to their customers. Respondent L from Senab associates the future of digitalization with the customer relationship as well since he projects a change in the business model for what concerns the delivery channels.

Differently, both respondents from Volvo Cars and interviewee G from Essity claims that in the future the entire company will be digitalized. This can be explained considering that they are two companies whose structure is divided in different business units supported by specific functions, so the impact of digitalization is likely not to have overrun the entire company equally. As for the challenges, respondent B from Re:profit stresses the importance of cooperation and of having a shared infrastructure for digital transformation. Even if this has not been taken into account spontaneously by companies' representatives, it might be interpreted as collaboration within companies' departments that is defenetely a necessity felt by these.

5.2.4 Organizational change in the context of digitalization

As explained in the literature review, in consideration of the lack of a specific academic references for the transition faced by traditional businesses to become digital enterprises and being organizational change a wide topic to address, the author has selected the literature considered more appropriate and suitable to be interpreted in this context. Thus, it follows that the analysis of this category about organizational change is based on the comparison between case companies, experts and authors' choice on the change literature most appropriate for this study.

With this clarification in mind, the case companies perceived the integration of digital technologies in their business activities as a convoluted process. Changes to become digitalized are perceived as elements of a journey as exemplified by respondent G from Essity who argues that the transaction encompassed several phases and could be considered an incremental rather than a radical change. The viewpoint expressed by the company can be considered in line with Tsoukas & Chia (2002) that rejected traditional literature that considered change as an exceptional event rather than a routinely

transition of organizational life. This development has also been felt by reCreate Design Company, whose representative admits that they have not been able to cope with the same speed of transformation of the external environment. This result can be seen considerably foreseen due to the fact that it is a small business that is facing difficulties in scaling up in the digitalization process. When taking these issues into account, on top of that one should recognize that reaching a digitalization level to be competitive in this line of business would not entail an enormous impact as the sector is moderately delayed. Moreover, for this case company as from what share both Essity's respondents the factors analyzed theoretically by Hannan and Freeman (1984) that lead the risk of falling into "structural inertia" are mainly related to the investments needed and thus are internal to the enterprise.

Also, it is indicative that respondent H from reCreate Design Company considered digitalization as an external pressure. In fact, the way they embraced digitalization, even if to a little extent primarily with social media, could be considered environmental derived referable to the "natural selection" situation outlined by Hrebiniak and Toyce (1985).

It seems significant to compare this finding with the perceptions of representative L of Senab, a company operating in the same sector (furniture industry) but larger in size. In fact, he gives relevance to managerial strategic choice, thus positioning the enterprise in the left-up side of the graph proposed by Hrebiniak and Joyce (1985). In addition to that, respondent L's perspective is also related to the importance of developing a certain degree of flexibility, concern that also respondent H from Volvo Cars expresses. Meaning that, as Kitchell (1995) outlines the more flexibility and openness to change is reached, the most companies can develop adaptation capacity to deal with those changes. Further, a different positioning is offered by interviewee H of Volvo Cars who believes in the interplay between strategic choice and natural selection in conformity with the indication to think in circles to comprehend the evolutionary process in response to paradigm shifts that is the same way interviewee F from Essity names these changes. Considering the reasonings explained above, it seems particularly pertinent what one expert believes. To explain, respondent A from Rise expresses her idea about how companies generally have changed in the way they consider digitalization, respectively from a threat to an opportunity to be exploited in a managerial design. On the contrary, another expert, interviewee D interprets this just as an external pressure, a threat from the external surrounding that might challenge enterprises' ability to survive.

Moving from considerations related to companies' relationship with external environment to taking into account the internal business perspective, respondent G from Essity deplores that digital

transformation process has not been totally aligned in different departments of the company. This situation is contrasting with respondent's B view of the fact that a common agenda to guide the change should be set out. In this light, Ismail et al. (2017) argue that change for digitalization should take highly into account Kotter's principle to involve the employees. This recommendation has been followed by Senab establishing workshops to provide people the right skills to work with data.

Table 7: Summary of analysis-Digitalization

	Digitalization									
	Understanding digitalization			**Challenges**			**Future Expectations**	**Organizational change**		
	Automated processes	**Optimization**	**Servitization**	**Investments**	**Skills/competences**	**Trust and analyze data**	**More digitalized**	**Environmental determinism/Strategic choice**	**Flexibility**	**External pressure and paradigm shift**
Senior researcher RISE (respondent A)	-	✓	-	-	-	-	✓	X /✓	-	X
CEO at Re:profit (respondentB)	-	-	-	-	-	-	✓	-/-	-	-
Founder and CEO Earth of Billions (respondent C)	-	-	-	-	-	-	✓	-/-	-	-
Member of NMC (respondent D)	-	-	-	✓	✓	-	✓	✓/ X	-	✓
reCreate Design Company (respondent E)	-	-	-	-	-	-	✓	✓/ X	-	✓
Essity (respondent F,G)	✓	-	-	-	-	✓	✓	-/-	✓	✓
Volvo Cars (respondent H,I)	✓	-	✓	-	-	✓	✓	✓/ X	-	✓
Senab (respondent L)	✓	✓	-	-	✓	-	✓	X /✓	-	-
Theory	✓	✓	✓	✓	✓	✓	✓	✓/✓	✓	✓

Legend: "✓" stands for what respondents and/or theory agree on;" X" stands for what respondents and/or theory disagree on; "- "stands for what was not explicitly mentioned by respondents, "✓/ X" stands for what respondent partially agree on.

5.3 Moving toward a digitally powered Circular Economy

5.3.1 Use of digital technologies for Circular Economy

To provide a general outlook on the case companies and experts' opinions, all the respondents except interviewee E from reCreate Design Company share the view that there could be positive interactions between digitalization and circular economy. Interviewee E's skepticism might be due to the fact that in their case talking about digitalization for circular economy seems to be out of context, thus considering it for circular activities like re-using is perceived to be ahead of themselves. In this regard, she suggests that these types of activities are better performed by human beings rather than digital technologies. A totally different idea is proposed by experts C and D ad well as respondent F from Essity that share the view that digitalization can be considered an enabler for circular economy.

Taking into account the technologies, experts and companies' representatives have often suggested technologies whose application is presented in reports and articles included in this thesis as secondary data. On top of that, some of the interviewees reveal potential applications of digital solutions that might open up to new opportunities. To begin with, the majority of the applications of digital technologies are related to the enhanced possibility to have information about the product during the production process. First, respondent A argues that M2M communications coupled with IoT, AI and blockchain could be used to enhance transparency and for predictive maintenance, that according to interviewee D could be achieved also thanks to data and RIFID to trace materials and components. A similar potential has been disclosed also by Ellen MacArthur Foundation (2016) and Bressanelli, et al. (2018) but only concerning big data and IoT. In addition to this, respondent D argues that the potential of digitalization is really important when it comes to services, however this has not been implemented by Senab that even if it is trying to implement product as a service business model, as respondent L admits, it is not exploiting digitalization as a support for circular economy. An incomplete alignment of digital technologies for CE is indicated by interviewee H from Volvo Cars too. To be precise, she supports the view that data could be exploited for information sharing that Wilts and Berg (2017) considered a challenge of developing a circular business.

As Lacy (2015) and respondent B point out, digital technologies could also allow to reach cost-reductions obtained by keeping products for longer lifecycle rather than disposing them after use. Similarly, respondent G from Essity argues that digital technologies could be used to understand what drives costs and find new opportunities for developing circular business models. Interviewee G also recognizes the convenient use of data for waste management, and for this respondent A from Rise

considers the importance of digital or image/process technologies for separating streams of materials. However, he admits that they are not already collecting those kinds of data. This can be understood having regard to the company itself. In fact, being Essity a multinational whose brands enjoy a presence in approximately 150 countries, the author could foresee that implementing an infrastructure to obtain detailed information about what is considered as residual value in the operations would be undoubtedly demanding. In this light, it appears really contrasting and definitely premature for Essity speaking about artificial intelligence for sort post-consumer material flows as proposed by Ellen MacArthur Foundation (2019).

To sum up, the potential of digital technologies is related to increased availability of information that would not have been possible to achieve without digital technologies. This concept is taken to its extreme by interviewee C that claims that, thanks to digital technologies products can become banks for materials.

Having presented the main technologies involved, it is intriguing to specify that the author impression coincides with the fact that even if Volvo Cars, Essity and Senab are aware and agree of the possible positive outcomes they are either not exploiting digitalization for circular economy, or if they do it, not to the full potential. The reasons for this might be of different nature, thus a following paragraph will be dedicated to the challenges that are likely to arise.

5.3.2 Challenges of the use of digital technologies for Circular Economy

First, it is necessary to notify the reader that given that precedent literature did not focus extensively on the challenges, the author exemplifies that the main obstacles that enterprises might face could be related to what companies need to develop to become digitalized.

To give the reader a key of interpretation of the results, some specifications need to be made. Even if the researcher asked specific questions to address respondents' perceptions about exploiting technologies for circular economy, most of them share their thoughts about difficulties to be overcome in order to integrate digital solutions in their operations or to develop a circular business, considering the fact that case companies are still in the process of digital business transformation and/or in the transition to circular economy. Thus, it seems early for their stage of development to actively leveraging on the former to improve the latter. This is perfectly in line with respondent L from Senab view who supports that before doing this step beyond, the company should first gain awareness about digitalization on one side and circular economy on the other. Thus, a concrete combination of the two aspects is probably anachronistic for this company since as highlighted by

interviewee C investments in technologies such as AI as outlined by respondent F are required for the implementation, thus financial viability might be considered challenging. Respondent G from Volvo Cars share a similar view, since she acknowledges that companies do not have the peculiar competences to understand the data that could be used for circular economy activities. Researcher A from Rise considers the same obstacle but from a slightly diverging angle. She talks in terms of competences and skills required by digitalization itself and in the same light, the author considered them in the literature review section (paragraph 0). In addition, respondent A suggests a peculiar aspect by saying that another obstacle might lie in the fact that those people with the expertise to use digital technologies for circularity as AI might not be in the right position within the organization to independently decide to use those for circular economy.

A different aspect that is outlined by interviewee B is the necessity to build a common infrastructure for working together to manage technologies effectively for circular economy. However, this idea might be perceived a bit too idyllic for companies especially noting that interviewee G from Essity highlights the problems related to trust when it comes to information sharing and none of the company shows to be prone to collaborate with key stakeholders on this. In addition, it is remarkable to mention that, as the author explained above, respondent's G perceptions are mostly related to challenges of transition to circularity, hence to solely one side of the coin. Similarly, respondent D agrees on the importance of developing a link between the different players, this being said she considers a different aspect from the one proposed by interviewee G as she demands a more active role of the government through supporting legislation.

Finally, another obstacle can be identified in what respondent C names as "human factor" and interviewee A as "managerial mindset" since undertaking investments for long-term results would require openness to change. To some extent this seems to be applicable to the argumentation of interviewee E who recognize the potential of digitalization to enhance traceability, but she seems to be skeptical about the amount of information that cloud technologies could hold. However, her attitude could be due to her little familiarity with technologies applications in her business.

5.3.3 Opportunities and future expectations on the use of digital technologies for Circular Economy

For the sake of clarity, theoretical references considered in the literature review did not offer a specific argumentation of their projection for the future of the interplay between circular economy and digitalization.

Both representatives of case companies and experts appear confident that digital technologies will bring positive results in the future for circular economy. On a generic level, respondent H from Volvo argues that efficient asset management can be improved, and business intelligences could lead to better comprehend value of activities, components and materials in a circular economy. Likewise, expert D and interviewee F from Essity notice that digital technologies will boost circularity in the future. Together with that, interviewee A explains that it should not be neglected that the first step would be to create fertile ground upon which companies could take strategic actions like developing technologies clusters, right competences or engaging in outsourcing. Afterwards, according to expert B, once the technologies are implemented, managers should change their approach in order to unlock the potential of digitalization for circular economy.

It is interesting to point out that analysis of the reports and academic literature about the possibility of exploiting digital technologies for circular economy conducted by the author highlighted the absence of a specific focus on the service-based enterprises. Results of this study show that even if clear actions have not been realized yet, respondent L from Senab, a service-based company, argues the possibility of exploiting blockchain to enhance traceability and sensors for resource management in their line of business. Similarly, respondent E of reCreate Design Company projects future developments in the coding area.

A peculiar view about future expectations in relation to the information collected is given by both Essity and Volvo Cars. In fact, these two manufacturing companies, associate the hidden potentiality of data to the production process. In particular, interviewee G from Volvo Cars claims the ever-increasing opportunities arising from the use of data for predictive maintenance. The fact that this opportunity has not been subject matter of the interviews with representatives from Essity reflects the situation that predictive maintenance is unquestionably more proper in case of the automotive industry[8] rather than in the FMCGs. Not without reason, respondent G from Essity supports the use of data acquired through digital technologies for the development fossil-free materials for their products. In particular, it is intriguing to point out that interviewee C suggests the specific use of AI for decision-making about materials as a future development. Furthermore, interviewee B recognize the potential of having a digital platform for data sharing.

[8] For additional information about predictive maintenance in the automotive industry : https://resources.ema-eda.com/predictive-maintenance-for-automobiles

Finally, respondent D perceives the urgency in the future to have international organizations to put in place incentives with the aim of stimulating the use of digital tools to accelerate the transition to circular economy on the heels of the EU Circular Economy package. As mentioned in the literature review, according to the European Environmental Agency (2018) the initiative set out targets that are expected to be reached by 2020. Having achieved this, positive spillovers are likely to arise for what concerns possibility of collaborations among actors in the chain and information sharing as interviewee A claims.

Table 8: Summary of analysis- Moving toward a digitally powered Circular Economy (1)

	Moving toward a digitally powered Circular Economy							
	Use of digital technologies for circular economy				**Challenges**			
	Positive interactions	**Enhanced transparency and traceability**	**Uncomplete alignment**	**Importance of data**	**Financial resources for investments in technologies**	**Competences, Skills and knowledge**	**Collaboration among different parties**	**Human factor and mindset**
Senior researcher at RISE (respondent A)	✓	✓	-	-	-	✓	-	✓
CEO at Re:profit (respondent B)	✓	-	-	-	-	-	✓	-
Founder and CEO Earth of Billions (respondent C)	✓	-	-	✓	✓	-	-	✓
Member of NMC (respondent D)	✓	✓	-	✓	-	-	✓	-
reCreate Design Company (respondent E)	X	-	✓	-	-	-	-	✓
Essity (respondent F,G)	✓	-	✓	✓	✓	-	✓	-
Volvo Cars (respondent H,I)	✓	-	✓	✓	✓	-	-	-
Senab (respondent L)	✓	-	✓	-	-	✓	-	-
Theory	✓	✓	-[9]	✓	-	-	-	-

Legend: "✓" stands for what respondents and/or theory agree on;" X" stands for what respondents and/or theory disagree on; "- "stands for what was not explicitly mentioned by respondents, "✓/ X" stands for what respondent partially agree on.

[9] It is noticeable to highlight that for this table (Table 8), for topics not explicitly addressed by the literature review, the author tied them to circular economy /digitalization process.

Table 9: Summary of analysis- Moving toward a digitally powered Circular Economy (2)

	Moving toward a digitally powered Circular Economy			
	Opportunities and future expectations			
	Digital technologies will improve circular economy	**Digital technologies for traceability and coding**	**AI and data**	**Incentives from external organizations**
Senior researcher at RISE (respondentA)	✓	-	-	✓
CEO at Re:profit (respondent B)	✓	-	✓	-
Founder and CEO Earth of Billions (respondent C)	✓	-	✓	-
Member of NMC (respondent D)	✓	-	-	✓
reCreate Design Company (respondent E)	✓	✓	-	-
Essity (respondent F,G)	✓	-	✓	-
Volvo Cars (respondent H,I)	✓	-	-	-
Senab (respondent L)	✓	✓	-	-
Theory	-[10]	-	-	-

Legend: "✓" stands for what respondents and/or theory agree on;" X" stands for what respondents and/or theory disagree on; "-"stands for what was not explicitly mentioned by respondents; "✓/ X" stands for what respondent partially agree on.

[10] [10] It is noticeable to highlight that for this table (Table 9), for topics not explicitly addressed by the literature review, the author tied them to circular economy /digitalization process.

6. Conclusions and future research

6.1 Conclusions

The final chapter is dedicated to the conclusions. Once the aim of the study is recalled, answers to the research question and sub-research question are provided and the key points are highlighted in a table(Table 10*). The chapter proceeds with final remarks about the peculiar situations of each case companies. Finally, the author presents suggestions for future research.*

As depicted in the introduction (1.1) the current business surrounding is driving companies to embrace the idea of a circular resource flow involving the entire economy. Thus, forward-looking enterprises are planning and starting to embrace circular business models. At the same time, digital transformation is occurring rapidly across enterprises. Companies are understanding that discerning this paradigm shift might not be enough. Indeed, the competitive edge requires enterprises to actively enfold digital technologies. Reports presented in the literature review (paragraph 2.3) have illustrated the fact that that circular economy and digitalization combined could uncover a number of opportunities. On that account, digitalized enterprises are likely to be facilitated in their transition to circular economy.

The aim of this study was to contribute to the existing research with a qualitative research conducted with a multiple case study design. Meaning that, the author felt relevant to explore how selected companies are implementing circular economy, embracing the digitalization phenomenon by changing for it and considering the move toward circular economy with the support of digital technologies. The last point was deemed to be comprehended by highlighting challenges, opportunities and future believes. Nevertheless, as it will be explained in the following lines, the state of the art of the case company enforced the author to seek for slightly different results. In fact, given that case companies are not actively using digital technology for the shift to circular economy, the research question is formulated hypothetically in terms of "possibility".
As a result, the research question and sub-question are stated:
Research question:

"How are companies perceiving the possibility of leveraging on digitalization for circular economy?"

Sub-question:

"How are companies working for circular economy?"

Since the author aims at providing a comprehensive argumentation on the main conclusions, the research question and sub-question are widely addressed together from this point onwards.

A necessary preliminary step seems to consider how case companies conceive circular economy. Generally, their **definition** coincides clearly with the image of the closed-loop, however when it comes to implementation this clarity seems to fade away. Despite their promising intentions, de facto, the author's initial supposition that enterprises had already implemented circularity was not confirmed. As a matter of fact, the picture for circular practices appears to be characterized by only minor actions for both manufacturing enterprises and service providers. Moreover, case companies' **implementation of circular economy** differs, and some patterns of variation could be highlighted. To be specific, manufacturing companies seem to concentrate their effort on the final part of the loop by focusing on recycling while service-providers are probably focusing more on "product as a service" business model in the form of "lease and take back".

A challenge expressed by the manufacturing companies relates to the existence of a dispersed value chain that limits the possibility of control over the production process. Therefore, scaling up circular business models resulted to be tough due to the fact that full availability of information can be seen as both a prerequisite and challenge in line with the literature review. This requires collaboration that in turn entails communication and agreement through KPIs as well as standards. Another barrier that seems to prevent existing projects to expand lies in the reluctance of consumers' and customers' (respectively for B2C and B2B enterprises). Indeed, some case companies suggest that they might discard re-used products or stick to traditional business models. Given on one hand the difficulties experienced by the two large-sized manufactures and the successful outcome of a little enterprise like reCreate Design Company on the other, it could be inferred that a relation exists between companies' size and their easiness in terms of circular economy implementation as explained above (paragraph 5.1).

All in all, the author can deduce that the change toward circular economy still need to be managed. Indeed, this study outlines that to accelerate the transition, enterprises should accomplish a higher degree of internal cooperation among departments since a true collaboration involving the company as a whole is still missing. In fact, only once a satisfactory level is reached, enterprises could decipher how to work strategically to implement circular business models. In view of this, while the author prefigurated that organizational change could be related to digital transformation, de facto the

roadmap to circular economy appears still on a long way. Thus, organizational change might be considered also in the move to circular economy.

Moreover, this state of the art about circular economy implementation affects the possibility of using digitalization to enhance it. In fact, if companies have not shown proactive actions for circular economy implementation yet, how could they leverage on digital technologies to enhance it? Presumably, it would be ahead of themselves since they lack the means to increase control and subsequently the availability of information. As exemplified in the literature review, digital technologies could support on this aspect. Thus, it seems pivotal to propose some crucial remarks about digitalization process to point out the most relevant aspects for the accelerating the transition to circular economy. In particular, from the research it becomes apparent that the aspects of digitalization companies are integrating is disparate and this contrast might be due to their belonging to different sectors. Before providing an outlook, the author feels the need to point out that a separate mention is deserved for reCreate Design Company that for its unique features mainly related to its size cannot be considered along the digital transformation process for what concerns the production process. Besides the differences, the factors more remarkable for the aim of this study are the digital platforms enabling sharing models of economy and industrial technology applications.

The former could be directly connected to the fact that results revealed that sharing and circular economy are often perceived as models for working toward the same final objective. Regardless, there are reasons to believe that they cannot be considered synonymous since the impact of sharing economy is hard to measure, thus it might turn out in a negative environmental impact. Lastly, the validity of this consideration is likely to be confined for products with long life-cycle, given that a sharing model would not be suitable for the FMCG sector.

When it comes to industrial applications, companies have highlighted the potential of digitalization in the production phase thanks to technologies able to collect data such as smart sensors, robotization, M2M communications, IoT, digital image technologies. At this point, the author considers relevant to portray a snapshot about how companies are moving in this context. On average enterprises included in this study are not already paving the way of a circular business model powered by digital technologies. For this reason, the research question was changed by the author. Before, it was related to the purpose of exploring how companies are currently exploiting digital technologies in these circumstances. However, given the partial circular economy implementation on one hand and the little or the absent use of digital technologies for this objective on the other, the final version or the main research question was deemed more appropriate. Thus, the researcher decided to structure the

following line of reasoning by firstly presenting companies' perceptions on present and future opportunities and proceeding with the challenges.

Firstly, companies have noticed positive interactions between **digitalization and circular economy**. Thus, the researcher's interest stated in section 1.3 to understand if they were aware of the interplay is satisfied. Suffice it to say that, the former has been extensively presented as an enabler for the latter and the two together are seen as interinsecly tied by experts as well. Obviously, a remark should be posed for reCreate Design Company in which the application of digital technologies to the production process seems to be infeasible as explained in the analysis.

Overall companies **use of digital technologies for circular economy** is limited. In fact, manufacturering companies highlighted the vital opportunity from data collected through digital technologies. This is the case of Essity that is currently evaluating the possibility of exploiting internal data gathered from production facilities in the product design phase for expanding product life cycle. Similarly, Volvo Cars relates data with traceability and information sharing. This can be facilitated thanks to reliable logistic systems. In the future both companies imagine opportunities arising from increased amount of data for efficient asset management, for understanding of value of components, materials and for developing fossil free materials. Additionally, AI could be adopted to develop products that can be re-used by design, cloud technologies to retrieve information about state of components over time for predictive maintenance. The latter, suggested by Volvo Cars, is connected to the fact that predictive maintenance is inherently suitable for products with long life-cycle.

As far as considerations about service providers are concerned, Senab outlined that their circular economy approach is limited and not supported by novel technologies. This could erroneously convey to think that opportunities do not appear in the service sector, nonetheless both reCreate Design Company and Senab highlighted the enhanced traceability that could be reached thanks to digital solutions. In fact, Senab foresees the future possibility of using blockchain technologies to trace materials. Hence, companies not directly engaged in the manufacturing operations are likely to focus their circular effort ex-post by exerting more control over material used by external producers.
Considering the reasoning explained above, **challenges** could be related to the issues faced throughout the transition to become both circular on one hand and digitalized on the other. In truth, enterprises expressed the necessity of investments in technologies that could be related to the digital transformation process. At the same time, they insisted on the indispensability of disclosing

information about materials used and environmental practices and the demand of specific KPIs on suppliers that could be connected to circular economy.
This reflection is applicable to both studied companies in the service sector and in the production process. In fact, Senab claims that a very first step should be creating alignment by gaining awareness about these two phenomena first and how they could be integrated and combined together. On the contrary, Volvo Cars deplores the lack of knowledge about which data should be used and capabilities about how to manage the data collected. These are general skills and capabilities part of the organizational change to become digitalized.

In conclusion, the overall picture for companies' perceptions about digitalization for circular economy is puzzling. The missing pieces are many since the enterprises are struggling to implement circular economy and probably it is not still seen as a competitive factor as digitalization. In the service sector a real opportunity for this association has not been identified yet while manufacturing companies appear little advanced in this regard. Anyway, in the light of the results, the author considers that a new possibility could be unlocked in the **future**. Indeed, the author feels that companies might leverage on digitalization to implement rather than to develop and enhance an already existing circular business model. All in all, the outcome of this research is in line with World Economic Forum' (2018) projection that companies that do not have digital at their core will not benefit completely from circularity. Needless to say, that this transition would require organizational changes particularly in relation to what experts have named "human factor", intended as changes in management' and customers' mentality. Ultimately, this represents a last challenge that companies are striving most to overcome.

Table 10: Key points of the conclusions

Circular Economy definition	• Activities for closing the loop • Different perceptions about sharing/PaaS BM
Circular Economy implementation	• Difficult to reach complete circular business model • Focus on recycling for manufacturers/PaaS for non-manufacturers • Difficult on a large scale (only small projects) • Challenges→ control with dispersed VCs, information availability, collaboration, internal cooperation, specific KPIs, financial viability
Perceptions about the exploitation of digital technologies for Circular Economy	• Mostly positive interactions between digital technologies and circular economy • Benefits mostly for manufacturers • Technologies involved: data, AI, cloud, IoT, M2M, blockchain
Digitalization	• Different degree of implementation • Main factors considered for enhancing circular economy→ industrial application of digital solutions & digital platforms for sharing models
Current use of digital technologies for Circular Economy	• Overall puzzling picture • Use of data in limited contexts
Challenges	• Related to the changes for becoming digital/circular • Lack of capabilities about how to use data for circularity
Future expectations	• Increasingly pressures to shift to circular → transition possible thanks to digital technologies • Digital technologies for the transition of circular economy not enhancing it • Manage the change in mentality to overcome the “human factor”

6.2 Final remarks about case companies

Having provided the reader with the main conclusions emerging from this study, the author recognizes the needs to present some final elucidations. Indeed, taking into account the research design of a multiple case study, it is deemed appropriate to contribute with considerations about the case companies' status in this context and the reasons underpinning their current situation. All enterprises are aware of about the implications of circular economy. However not only their stage of implementation is different but also the reason leading to this result is peculiar to each specific business entity. As a matter of fact, the author aimed to seek how these practices might be different because of mainly the following factors. On one hand, the researcher envisaged as a condition that could be connected to differences, the fact that the companies were either manufacturing or service providers. On the other hand, the type of product with long or short life-cycle was thought to be a potential element determining differences.

At this point of the paper, it seems appropriate to express a clarification. In fact, all the case companies included in the study are digitalized even if to a different extent. This might be explained by the fact that digital transformation is considered essential to play a relevant role at the competition frontier. Discordantly, circular economy is still not a practical reality. Presumably it still not perceived as a competitive factor. With this in mind, differences in implementation are probably not as much dependent on offerings but on the idiosyncratic degree to which business activities are dispersed among different actors.

With an almost complete circular business model, reCreate Design Company reached this level of implementation probably due to the simpler control achievable for its small size. As far as the use of digital technologies, they did not foresee opportunities in the manufacturing process since little room for benefits might be reserved in their context. As a matter of fact, digitalization potential grows could be assumed to increase as long as management difficulties arise.

Senab's lack of relevant strategic actions toward circular economy might be interpreted through the lens of the author consideration (at the beginning of the present paragraph) that circular economy and competitiveness are still not synonymous.

Finally, Volvo Cars' and Essity' low control of their dispersed value chain acts as a barrier to the transition to circular economy. It must be said that opportunities have been foreseen for digital solutions in particular from data that could be collected through smart sensors, robotization and self-regulating processes. Despite this, these companies are still lacking in proactive approach. All in all,

it may be presumed that change management should occur to leverage on digitalization for circular economy.

6.3 Future research

As presented in the literature review, to ensure a future availability of resources, our model of consumption could not anymore be identified in a straight line. Additionally, digital disruptions can support circular economy that is rapidly rising up business agenda. Thus, it seems relevant to present a number of further studies that the author considers able to contribute to the results outlined in this master thesis.

First, given the fact that this study included both manufacturing companies offering products with long life-cycle and FMCG, a future research might concentrate solely on one of the two categories in order to increase inter-case comparability and come up with conclusions relative to enterprises with peculiar products. This acquires relevance considering the potential for predictive maintenance foreseen for products with long life-cycle. Moreover, given the fact that circular economy building blocks ranges from industrial sector to emerging ones, other studies could take into account enterprises whose business model is characterized by sharing models.
Another option could be to focus on companies that have already implemented circular models with a focus on the Finland market given their effort on a government level[11].

Secondly, the present thesis was focused on Swedish-based enterprises, while further research could expand geographical horizons. In particular, since the main opportunities have been glimpsed for manufacturers, additional studies could be conducted in Germany given its leading role for the fourth industrial revolution[12].

Further, the research overlooked details about specific measurements for circular economy implementation. A more precise study would include a more detailed overview thanks to the use of business metrics to evaluate circularity introduced[13]. The outcome would be a more precise assessment of degree of circularity.

[11] More details about Finland world's first road map to the circular economy 2.0 available at: https://www.sitra.fi/en/
[12] For further information about German leading role for Industry 4.0: kpmg/industry-4-0-industrial-revolution-in-germany.html
[13] For further information about business metrics to assess circularity introduced: https://circulatenews.org/

References

Abolhassan , F., 2017. *The Drivers of Digital Transformation.* s.l.:Springer International Publishing Switzerland.

Accenture Strategy, 2015. *Waste to Wealth,* s.l.: Palgrave Macmillan.

Adobe, 2018. *The 2018 Digital Transformation Report,* s.l.: s.n.

Bloomberg, 2019. *Senab AB.* [Online] Available at: https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=35268895 [Accessed 5 June 2019].

Bloomberg, J., 2018. *Digitization, digitalization, And Digital Transformation: Confuse Them At Your Peril.* [Online] Available at: https://www.forbes.com/sites/jasonbloomberg/2018/04/29/digitization-digitalization-and-digital-transformation-confuse-them-at-your-peril/#439c623b2f2c [Accessed 16 February 2019].

Bocken, N. M., de Pauw, I., Bakker, C. & var de Grinten, B., 2016. Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering,* 33(5), pp. 308-320.

Boss, J., 2016. *Staying Competitive Requires Adaptability.* [Online] Available at: https://www.forbes.com/sites/jeffboss/2016/04/26/staying-competitive-requires-adaptability/#cb9c00c7e6f9 [Accessed 18 February 2019].

Boulding , K., 1966. The economy of the coming spaceship earth.

Bressanelli, G., Perona, M. & Saccani, N., 2018. Exploring how usage-focused business models enable circular economy through digital technologies. *Sustainability,* 10(3).

Bryman, A. & Bell, E., 2011. *Business research methods.* 3rd Edition ed. New York: Oxford University Press Inc. .

Burke, L. A. & Miller, M. K., 2001. Phone interviewing as a means of data collection: lessons learned and practical reccomendations. *Forum Qualitative Social Research,* 2(2).

Chakravarthy, B. S., 1982. The Academy of Management Review. *Adaptation: A Promising Metaphor for Strategic Management,* 7(1), pp. 35-44.

Collins English Dictionary, 2019a. *Definition of "expert"*. [Online] Available at: https://www.collinsdictionary.com/dictionary/english/expert [Accessed 28 April 2019].

Collins English Dictionary, 2019b. *Definition of "representative"*. [Online] Available at: https://www.collinsdictionary.com/dictionary/english/representative [Accessed 28 April 2019].

Confindustria, 2018. *Il ruolo dell'industria italiana nell'economia circolare*, Roma: Confindustria.

Coppin, B., 2004. A brief history of artificial intelligence. In: *Artificial Intelligence Illuminated.* Sudbury: Jones and Bartlett Publishers, p. 4.

Delmond, M.-H., 2018. *How Digital Transformation Impacts Companies.* [Online] Available at: https://execed.hec.edu/en/news-resources/news/how-digital-transformation-impacts-companies
[Accessed 25 February 2019].

Denzin, N. K. & Lincoln, Y. S., 2011. *Handbook of Qualitative Research.* 4th Edition ed. s.l.:Sage Pulblications Inc..

Devers, K. J. & Frankel, R. M., 2000. Study design in qualitative research--2: Sampling and data collection strategies. *Education for health*, 13(2), p. 263.

Ellen MacArthur Foundation, 2015. *Toward a circular economic business rationale: for an accelerated transition*, s.l.: s.n.

Ellen MacArthur Foundation, 2016. *Intelligent assets: unlocking the circular economy potential.* [Online]
Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Intelligent_Assets
[Accessed 2 March 2019].

Ellen MacArthur Foundation, 2017. *What is circular economy? A frameork for an economy that is restorative and regenerative by design.* [Online] Available at: https://www.ellenmacarthurfoundation.org/circular-economy/concept [Accessed 9 March 2019].

Ellen MacArthur Foundation, 2019. *Artificial intelligence and the circular economy - AI as a tool to accelerate the transition.* [Online] Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/Artificial-intelligence-and-the-circular-economy.pdf
[Accessed 1 March 2019].

Ellen MacArthur Foundation, 2019. *Infographic.* [Online]
Available at: https://www.ellenmacarthurfoundation.org/circular-economy/infographic
[Accessed 1 March 2019].

Essity, 2019a. *Essity's business.* [Online]
Available at: https://www.essity.com/company/essitys-business-and-operations-worldwide/
[Accessed 5 April 2019].

Essity, 2019b. *Circularity and after-use.* [Online]
Available at: https://www.essity.com/sustainability/sustainable-solutions/circularity-and-after-use/
[Accessed 5 April 2019].

Essity, 2019c. *Essity and CE 100 release report on renewables materials role in a circular future.* [Online]
Available at: https://www.essity.com/sustainability/reporting-and-data/ce100report/
[Accessed 5 April 2019].

Etikan, I., Abubakar Musa, S. & Sunusi Alkassin, R., 2016. Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics,* 5(1), pp. 1-4.

European Environment Agency, 2018. *Waste Generation.* [Online]
Available at: https://www.eea.europa.eu/airs/2018/resource-efficiency-and-low-carbon-economy/waste-generation
[Accessed 28 February 2019].

EY, 2015. *Are you ready for the circular economy?,* s.l.: Ernst & Young Accountants LLP..

Flick, U., 2018. Collecting verbal data. In: *An Introduction to Qualitative Research.* 6th Edition ed. London: Sage Publications Ltd, pp. 205-215.

Forest Stewardship Council (FSC), 2019. *FSC Certification.* [Online]
Available at: https://ic.fsc.org/en/what-is-fsc-certification
[Accessed 5 April 2019].

Geissdoerfer, M., Savaget, P., Bocken, N. M. & Hultink, E. J., 2017. The Circular Economy - A new sustainability paradigm?. *Journal of Cleaner Production,* Volume 143, pp. 757-768.

Ghisellini, P., Cialani, C. & Ulgiati, S., 2015. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production,* Volume 114, pp. 11-32.

Hahn, T., Kolk, A. & Winn, M., 2010. A New Future for Business? Rethinking Management Theory and Business Strategy. *Business & Society,* 49(3), pp. 385-401.

Hannan, M. T. & Freeman, J., 1984. Structural Inertia and Organizational Change. *Americal Social Review*, 49(2), pp. 149-164.

Harrell, M. C. & Bradley, M. A., 2009. *RAND Corporation.* [Online] Available at: https://apps.dtic.mil/dtic/tr/fulltext/u2/a512853.pdf [Accessed 8 February 2019].

Hashem, I. A. T. et al., 2015. The rise of "big data" on cloud computing: Review and open research issues. *Information Systems,* Volume 47, pp. 98-115.

Hess, T., Matt, C., Benlian, C. & Wiesbock, F., 2016. Options for formulating a digital transformation strategy. *MIS Quarterly Executive,* 15(2).

Hrebiniak, L. G. & Joyce, W. F., 1985. Organizational Adaptation: Strategic Choice and Environmental Determinism. *Administrattive Science Quarterly,* 30(3), pp. 336-349.

ING Economics Department, 2015. *Rethinking finance in a circular economy ,* s.l.: ING Bank N.V..

International Data Corporation, 2017. *IDC Reveals Worldwide Digital Transformation Predictions.* [Online]
Available at: https://www.idc.com/getdoc.jsp?containerId=prUS43188017 [Accessed 25 February 2019].

Ismail , M. H., Khater, M. & Zaki, M., 2017. Digital Business Transformation and Strategy: What Do We Know So Far?. *University of Cambridge*, November.

Joop, J. H. & Boeije, H. R., 2005. Data Collection, Primar vs. Secondary. *Encyclopedia of Social Measurement ,* Volume 1.

Kalmykova, Y., Sadagopan, M. & Rosado, L., 2018. Circular economy- From review of theories and practices to development of implementation tools. *Resources, Conservation & Recycling,* Volume 135, pp. 190-201.

Kane, G. C. et al., 2015. *Strategy, not technology, drives digital trasformation,* s.l.: Deloitte University Press.

Kitchell , S., 1995. Corporate Culture, Environmental Adaptation, and Innovation Adoption: A Qualitative/Quantitative Approach. *Journal of the Academy of Marketing Science,* 23(3), pp. 195-205.

Kotter, J. P., 1995. Leading Change. *Harvard Business Review*, March-April, pp. 59-67.

Kvale, S., 1996. *InterViews: An Introduction to Qualitative Research Interviewing.* Sage ed. CA: Thousand Oaks.

Lacy, P., 2015. *Using digital tech to spin the circular economy,* s.l.: Accenture .

Legner, C. et al., 2017. Digitalization: Opportunity and Challenge for the Business and Information Systems Engineering Community. *Business & Information Systems Engineering*, 59(4), pp. 301-308.

Leung, L., 2015. Validity, reliability, and generalizability in qualitative research. *Journal of Family Medicine and Primary Care ,* 4(3), pp. 324-327.

Lieder, M. & Rashid, A., 2016. Toward circular economy implementation: a comprehensive review in context of manufacturing industry. *Journal of Cleaner production,* Volume 115, pp. 36-51.

Linder, M. & Wiliander, M., 2015. Circular Business Model Innovation: Ingerent uncertainties. *Business Strategy and the Environment,* 26(2), pp. 182-196.

Luecke, R., 2003. *Managing Change and Transition.* Boston: Harvard Business School Press.

Lueth, K. L., 2015. *IoT basics: Getting started with the Internet of Things,* s.l.: IoT Analytics .

Mathison, S., 1988. Why triangulate?. *Educational Researcher,* 17(2), pp. 13-17.

Matt, C., Hess, T. & Benlian, A., 2015. Digital Tranformation Strategies. *Business & Information Systems Engineering*, 57(5), pp. 339-343.

Mazzone, D., 2014. *Digital or Death: Digital Transformation - The Only Choice for Business to Survive Smash and Conquer*. 1st ed. Mississuaga, Ontario: Smashbox Consulting Inc..

McKinsey & Company, 2016. *Why the circular economy is all about retaining value.* [Online] Available at: https://www.mckinsey.com/business-functions/sustainability/our-insights/why-the-circular-economy-is-all-about-retaining-value
[Accessed 3 March 2019].

Mckinsey Global Institute, 2015. *The Internet of Things: Mapping the Value Beyond the Hype,* s.l.: s.n.

McKinsey Global Institute, 2017. *What's now and next in analytics, AI, and automation,* s.l.: s.n.

Merriam, S. B., 1995. What Can You Tell From An N of 1? : Issues of Validity and Reliability in Qualitative Reseach. *Journal of Lifelong Learning*, Volume 4, pp. 51-60.

Morgan Stanley Research, 2017. *Is the Circular Economy the Next Disruptor?.* [Online] Available at: https://www.morganstanley.com/ideas/circular-economy-recycling
[Accessed 6 March 2019].

Murray, A., Skene, K. & Haynes, K., 2015. The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. *Journal of Business Ethics,* 140(3), pp. 369-380.

Newman, D., 2017. *Innovation vs. Transformation: The Difference In A Digital World.* [Online] Available at: https://www.forbes.com/sites/danielnewman/2017/02/16/innovation-vs-transformation-the-difference-in-a-digital-world/#310534b565e8: [Accessed 28 February 2019].

Page, S., 2017. *Adapt Of Die-- Businesses Must Embrace Change To Remain Relevant.* [Online] Available at: https://www.forbes.com/sites/forbescommunicationscouncil/2017/12/01/adapt-or-die-businesses-must-embrace-change-to-remain-relevant/#7c87dab761b5 [Accessed 3 March 2019].

Parviainen, P., Kääriäinen, J., Tihinen, M. & Teppola, S., 2017. Tackling the digitalization challenge: how to benefit from digitalization in practice. *International Journal of Information Systems and Project Management,* 5(1), pp. 63-77.

Pinheiro, M. A. P. et al., 2018. The role of new product development in underpinning the circular economy: a systematic review and integrative framework. *Management Decision.*

Planing, P., 2017. Will digital boost circular? Evaluating the impact of the digital trasformatio on the shift toward circular economy. *International Journal of Management Cases*, February.

Ramadoss, T. S., Alam, H. & Seeram, R., 2018. Artificial Intelligence and Internet of Things enabled Circular economy. *International Journal of Engineering and Science*, 7(9), pp. 55-63.

Re:profit, 2019. *Sustainable profitability Profitable sustainability.* [Online] Available at: http://www.reprofit.se/ [Accessed 2 May 2019].

reCreate Design Company, 2019. [Online] Available at: https://recreatedesigncompany.com [Accessed 4 April 2019].

Reday, G. & Stahel, W. R., 1977. *The potential for substituting manpower for energy,* Genevs: Battelle, Geneva Research Centre.

RISE, 2019. *RISE Research Institute of Sweden.* [Online] Available at: https://www.ri.se/sv [Accessed 2019 April 2019].

Ross, J. W. et al., 2016. *Designing and Executing Digital Strategies.* Dublin, Thirty Seventh International Conference on Information Systems.

Samure, K. & Given, L. M., 2012. Nonprobability Sampling. In: *The SAGE Encyclopedia of Qualitative Research Methods.* Thousand Oaks: SAGE Publications, Inc..

Sanders, N. R. & Reid, R. D., 2012. Introduction to Operations Management. In: *Operations Management: An Integrated Approach.* Hoboken: John Wiley & Sons.

SB Insight, 2019. *The Nordic Market for Circular Economy*, s.l.: s.n.

Schmid, D. & Ritzrau, W., 2018. *Why the circular economy must link up the whole supply chain.* [Online]
Available at: https://www.weforum.org/agenda/2018/09/why-the-circular-economy-needs-to-link-up-the-whole-supply-chain/
[Accessed 9 February 2019].

Schroeder, P. M., 2018. The Relevance of Circular Economy Practices to the Sustainable Development Goals: Circular Economy and SDGs. *Journal of Industrial Ecology*, February.

Schwartz, E. I., 2001. *Digital Darwinism: 7 Breakthrough Business Strategies for Surviving the Cutthroat Web Economy.* New York: Broadway Books.

Seale, C., 1999. Quality in Qualitative Research. *Sage Publications, Inc.,* 5(4), pp. 465-478.

Sebastian, I. M. et al., 2017. How Big Old Companies Navigate Digital Transformation. *Mis Quarterly Executive*, September.

Seitz, S., 2016. Pixilated partnerships, overcoming obstacles in qualitative interviews via Skype: a research note. *Qualitative Research,* 16(2), pp. 229-235.

Senab, 2019. *About Senab.* [Online]
Available at: https://senab.com/en/about-us/
[Accessed 5 June 2019].

Silverman, D., 2010. *Doing Qualitative Research.* 3rd Edition ed. London: SAGE Publications Ltd.

Sustainability Dictionary, 2019. *Cradle-to-Cradle.* [Online]
Available at: https://sustainabilitydictionary.com/2005/12/03/cradle-to-cradle/
[Accessed 28 04 2019].

Tecuci, G., 2012. Artificial intelligence. *WIREs Comput Stat* , Volume 4, pp. 168-180.

The Economist, 2018. *Introducing a more circular economy will meet with resistance.* [Online]
Available at: https://www.economist.com/special-report/2018/09/29/introducing-a-more-circular-economy-will-meet-with-resistance
[Accessed 19 February 2019].

Tidd, J., Bessant, J. & Pavitt, K., 2005. *Managing Innovation*, Chichester: John Wiley & Sons, Ltd.

Tsoukas, H. & Chia, R., 2002. On Organizational Becoming: Rethinking Organizational change. *Organizational Science*, 13(5), pp. 567-582.

UNCTAD , 2017. *World Investment Report 2017: Investment and the Digital Economy,* s.l.: s.n.

United Nations, 2015. *Sustainable Development Goals.* [Online] Available at: https://www.un.org/sustainabledevelopment/sustainable-development-goals/ [Accessed 19 February 2019].

Unruh, G. et al., 2016. Investing for a sustainable future. *MIT Sloan Management Review,* May.

Van Buren, N., Demmers, M., Van der Heijden, R. & Witlox, F., 2016. towards a Circular Economy:

The Role of Dutch Logistics Industries and Governments. *Sustainability,* 8(7), p. 4.

Vendrell-Herrero, F., Bustinza, O. F., Parry, G. & Georgantzis, N., 2017. Servitization, digitization and supply chain interdependency. *Industrial Makerketing Management,* Volume 60, pp. 69-81.

Volvo Cars, 2019a. *This is Volvo.* [Online] Available at: https://www.volvocars.com/se/om-volvo/foretaget/detta-ar-volvo [Accessed 13 April 2019].

Volvo Cars, 2019b. *Safer and cleaner mobility.* [Online] Available at: https://group.volvocars.com/sustainability/product-impact [Accessed 13 April 2019].

Westerman, G., McAfee, A. & Bonnet, D., 2014. *Leading Digital- Turning technology into business transformation.* s.l.:s.n.

Wilts, H. & Berg, H., 2017. *The digital circular economy: can the digital transformation pave the way for resource-efficient materials cycles?,* s.l.: Wuppertan Institut.

World Commission on Environment and Development, 1987. *Our Common Future,* s.l.: Oxford University Press.

World Economic Forum, 2014. *Toward the circular economy: Accelerating the scale-up across global supply chains,* Geneva: World Economic Forum.

World Economic Forum, 2018. *Digital Tranformation Initiative* , s.l.: s.n.

Appendix

1. A Interview Guide for experts

Introduction of the interviewee:

- Organization/research institute
- Role in the organization/research institute

Circular Economy /Sustainability

- How do you interpret the concepts of circular economy and sustainability?
- Can you give me some examples about what companies are currently doing for circular economy?
- Challenges of transition toward circular economy?
- Could you identify some types of business model suitable for circular economy?
- Circular economy activities are different for companies that are producers and that provides only services?

Digitalization

- How would you define digitalization?
- To what extent do you think companies are undergoing digital transformation?
- How do you think companies are perceiving digitalization? As an external pressure toward change or strategic choice from within?
- Which of the companies' activities are more impacted by digitalization?
- Change for digitalization
    - Change: do you think that routines/procedures should be designed to be able to undergo social, environmental and ethical issues? Importance of organization's flexibility and openness in this sense?
    - Internal/external factors that might determine inability of the company to change and structural inertia?

Digitalization and Circular Economy

- To what extent do you think digitalization is influencing circular economy projects?
- How do you think digital technologies (such as big data and analytics, AI etc.) can be used for product design to increase product life cycle? For predictive maintenance?
- How do you think companies can use digital technologies to prevent waste or use renewable sources of energy? You need to have digital tool to maintain the product
- Role of data in the production process to implement CE?
- Can you identify the main challenges and opportunities arising from digitalization applied for circular economy purposes?

Final remarks

- Lastly, is there anything that you want to add or comment to this interview?

1. B Interview Guide for case companies

Introduction of the interviewee:

- Company
- Role in the company

Circular Economy /Sustainability

- How do you interpret the concepts of circular economy and sustainability?
- How would you define your company in terms of circular economy implementation?
- What has your company done so far to implement circular economy?
- What are the next circular economy projects for the future?

Digitalization

- How would you define digitalization?
- To what extent is your company strategically aligned with digitalization?
- What is the digitalization strategy of your company? What are the main technologies that has been integrated in your business?

    - How has this change to digitalization occurred?
    - Did your change process undergo different phases?
    - Have you perceived digitalization as and external pressure? (or it was a decision taken from within your company)
    - Have you noticed changes at organizational levels?
    - What are the main consequences on your companies in terms of opportunities and challenges?

- How do you think your company will undergo digital transformation in the next future? (digitalization strategy for the future)

Digitalization and Circular Economy

- To what extent digitalization is influencing circular economy activities?
  If not, do you think digitalization will influence your circular economy project in the next future? If yes, how? If not, why? [if not →go to the last question of this section]
- How do you use digital technologies in your product design to increase the life-cycle of your product?
- Do you use digital technologies to prevent waste or use renewable sources of energy? How?
- Which technologies are you using in this sense? [which do you think might be useful, if any]. How?
- Have you faced some problems in implementing circular economy, do you think that digital technologies can be used to tackle them?
- Can you identify the main challenges digitalization applied for circular economy purposes?
- What are the main opportunities and future expectations of tying digitalization and circular economy?

Final remarks

- Lastly, is there anything that you want to add or comment to this interview?

2. Synopsis

Given the pace digitalization is evolving nowadays, companies' activities have been challenged and they should be able to adapt their strategies accordingly. At the same time, the traditional "make-use-dispose "linear model of consumption is becoming unsustainable. As a consequence, in managers' agenda sustainability is becoming a priority. All in all, it is evident that both these paradigm shifts are driving organizations' need to adapt, change and react.

Considering these phenomena, it is interesting to find out *how digitalization is shaping companies' strategic approach toward more sustainable outcomes and "circular economy"*. This will be achieved by interviewing experts in innovation and sustainability. As a matter of fact, the aim is to get insights about how the digitalization pressure is impacting their organizations' circular economy approach.

3. A Message to contact respondents (through FTK)

Dear Y,
I am Ilaria Mania and I am writing my thesis with the help of First to Know Scandinavia. As Per has probably anticipated to you, the topic of my master thesis is about how companies can leverage on digitalization for their circular economy approach. I have attached to this email a brief synopsis of my research area.
I would really appreciate if we could set up an interview so that I can ask you some questions about this topic. When you would be available?
Also, if you think that it would be suitable to interview another person to gain more insights from your company, please let me know.
Thank you in advance.
Kind regards,
Ilaria Mania

3.B Message to contact respondents (individually)

Good morning,
I am Ilaria Mania and I am writing the thesis of my master in "Innovation and Industrial Management" at the University of Gothenburg. The topic of my thesis is about how companies can leverage on digitalization for their circular economy approach and you can find attached a brief summary of my research's topic. Given company X' effort toward circular economy and your position within it, I would really appreciate if you could give me a time slot to conduct a short interview to have your perceptions about this theme or if you could redirect me to someone within your company that would be willing to contribute to my research. Please let me know your availability.
Thank you in advance.
Regards,
Ilaria